Hinweis Second International Conferences on AIDE - 2023 & PCES - 2023

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AIDE - 2023 and PCES - 2023

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Blink-An Intelligent Personal Assistant for Enhancing Accessibility for Differently-Abled People

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***Abstract*— The Advanced Research Projects Agency's support of speech understanding research has led to a significantly increased level of activity in this area since 1971. Several connected speech recognition systems have been developed and demonstrated (Speech Recognition by Machine). Now more developments such as a personal assistant are designed to assist a busy knowledge worker in efficiently managing various tasks. (Myers et al., 2007) Our work aims to develop a personal assistant for Computers - *Blink*. Blink has its inspiration from Google Assistant on Android as it's the leading and smartest assistant, but it is limited to mobile phones. Mobile phones are easy to use and learn due to just remembering a few things but this is not the case with computers. Smart Assistant tried to enter computers earlier but failed miserably. Apple's Siri, and Microsoft's Cortana are the most popular voice assistants (Hoy, 2018) that exist on OSX and Windows respectively but are extremely limited with Microsoft removing most of the functionality from Cortana. This is where Blink Comes in, it would be a personal assistant that would make using computers easier and more accessible to differently abled people. If they have some issues typing, they could just use the personal assistant via voice command to request their task or type it if they have issues speaking. It would also make doing stuff easier and faster for the young and older generations. Blink could rapidly directly compete with the competition as it would be able to listen to all the voice commands locally without the need for an internet connection and would maintain privacy which has been a major concern in most of the assistants.**

I. INTRODUCTION

As industry 4.0 is growing tremendously, AI has increasingly contributed to the betterment of human life. (Balakrishnan et al., 2021) It is claimed that AI is exciting, but no one said what it is (E = m c 2). The interaction between computers and humans has been done via keyboard and some sort of mouse for most of the time since the beginning. But as the industry is growing the use of AI is rising, as of now 4.2 billion voice-based assistants are being used in devices around the world. IOT has brought in a type of personal assistant service (Zhang et al). The fact, computers were not so advanced to convert our voice into text let alone do commands based upon audio back then, but this has rapidly changed with the advancements in AI and computer processing power. In 2015, found that more than half (55%) of all U.S. teens use voice search every day (Burbach et al). Products such as "Ok, Google", "And Alexa" use automated speech recognition and NLP to perform various tasks for users, Smart assistants are useful in many fields such as education, home appliances, etc. and the voice assistant is also useful for blind people(Shabu et al., 2021), similarly if we talk about Personal Assistants, these are also a trend in society on mobile phones with Google Assistant and Siri being the market leaders in mobile phones but there is a lack of them on computers and specifically the Windows operating system(Buteau & Lee, 2021). People are now moving

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towards these SPA (smart personal assistants) (Srinivasan & Madheswari, 2018). A personal assistant is the modern method of input, it's software that makes doing tasks easy and more accessible for older and differently abled people. It can do actions based upon the inputs via voice commands or text commands as per the wish and ease of the user. Taking actions based on voice commands needs some key/essential components to make it work that includes voice processing which is done via NLP using a utility called NTLK (Bird, 2006). Input would be taken via voice/text then various ML algorithms would be applied to take actions, it would include tokenization where the voice commands would be broken into individual words, and based upon these words action would be taken. Well-defined scripts would allow the computer to know exactly what action to do, so it can easily respond to the voice command to the user. The personal assistant can highly improve accessibility and ease of use as computers have way more to discover and are more user-friendly. Opening applications to find files can be quite challenging for first-time users or differently-abled people. With the help of a simple voice/text command, they can easily request to open an application which would make it simple and easy for them to use. Everything cannot be perfect, and that's true with a personal assistant as well, privacy is the main concern as the user's microphones are being used 24*7 and could be uploaded onto the web. In a study released in May 2018 by scientists at the University of California, Berkeley, it was revealed that imperceptible audio instructions could be seamlessly incorporated into music or spoken text. This method allowed for the manipulation of virtual assistants, prompting them to carry out specific tasks without the user's awareness. The researchers achieved this by making subtle modifications to audio files, effectively nullifying the recognizable speech patterns targeted by speech recognition systems. Instead, they inserted alternative sounds that the system would interpret in a distinct manner, enabling actions such as making phone calls, accessing websites, or transferring funds. (NATURAL-LANGUAGE VOICE-ACTIVATED ASSISTANT,) The possibility of this has been known since 2016,(NATURAL-LANGUAGE VOICE-ACTIVATED ASSISTANT)and affects devices from Apple, Amazon, and Google. This is a place where Blink would be extremely ahead due to being OSS in nature and not uploading and voice communication with/without user consent, unlike major assistants. (Mitchell et al.,)

II. Related Work

One prominent example of a smart assistant is Apple's Siri, which was introduced in 2011. Siri replaces the dance of your fingers on the glass of the screen of an iOS device with a conversation. (Goksel Canbek & Mutlu, 2016) Siri understands your voice and places what you say in context with the apps that it works with. Siri's success paved the way for the development of similar voice-activated assistants, such as Amazon's Alexa and Google Assistant, (Assefi et al., 2015) which expanded the capabilities of smart assistants and integrated them into smart home devices. There is a huge impression that voice assistants would be used more if the capacity for conversation were improved, with 68 percent of people saying that when it works as expected it is fantastic and extremely useful. Google Assistant, Siri, Cortana, Alexa etc. (Pramod)

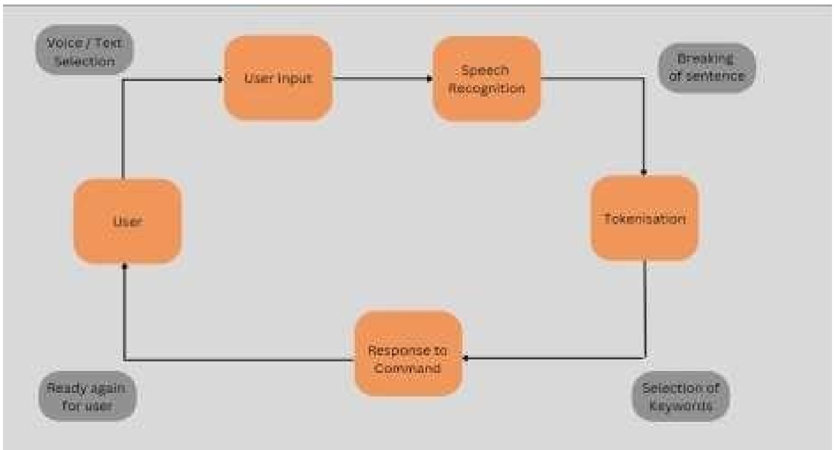
In recent years, natural language processing (NLP) and machine learning techniques have played a significant role in advancing the capabilities of smart assistants (Reddy et al., 2020). Projects like Google's Duplex demonstrated the ability of a smart assistant to make phone calls on behalf of the user, schedule appointments or make reservations (Grevatt, 2018). This development showcased the potential of NLP models in understanding and generating human-like conversational responses.

Moreover, advancements in speech recognition technologies have contributed to the improved accuracy and reliability of smart assistants. Systems like Microsoft's Cortana and IBM's Watson have utilized deep learning models to enhance speech recognition capabilities, allowing for more precise interpretation of user commands and queries. Amazon also provides a feature called 'voice profile' to store the voice of each user (Hofing et al.,). Since they can't do more complex tasks such as scheduling doctor's appointments or arranging dinner at a restaurant with a friend, research is going on to make these systems better or develop more systems like them.

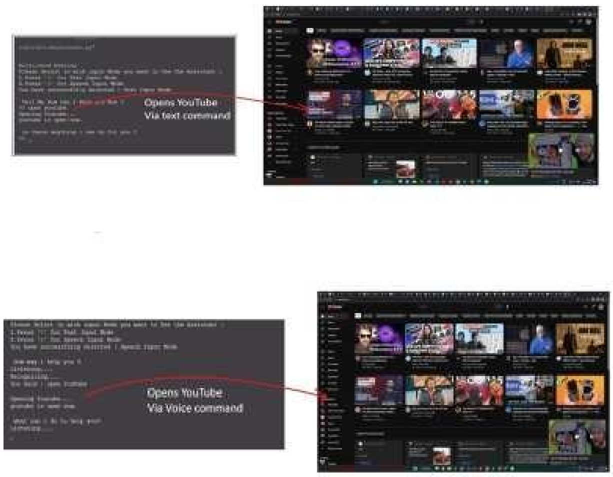
Additionally, research has been focused on incorporating contextual understanding into smart assistants. This involves the ability to analyse user preferences, habits, and the context in which commands are given to provide personalized and relevant responses. Context-aware assistants, such as Samsung's Bixby and Microsoft's Cortana (Klein et al., 2020), leverage user data and machine learning algorithms to adapt to individual needs, offering recommendations, reminders, and suggestions tailored to the user's preferences. Furthermore, open-source frameworks and platforms, like Mozilla's Deep Speech have enabled developers to build their intelligent smart assistants. One of the recent taken forward in the release of the large language model software OpenAI which will support the dissemination of relatively simple, accessible information (Hill-Yardin et al., 2023). Many articles have been published in the recent year about these brilliant assistants. These frameworks provide pre-trained models and tools for speech recognition, natural language understanding, and generation, empowering developers to create customized and versatile smart assistant applications.

III. METHODOLOGY

We used the model of a waterfall for the development of the project:
The waterfall is cheaper to develop as compared to other models, (Kakde et al.,) supports small projects better as compared to other models' resources are available and trained, (Petersen et al.,) and the main goal of the project is already set so we won't be needing many changes which is the major limitation of the waterfall model.
The waterfall model would also allow us to follow the path properly to develop the project so that we don't skip any portion of the project because the waterfall model does not allow us to do so. Transfer of information is also one of the key features so as the activity coordinator and mentor get to know about the project as well and stay up-to-date with the project development. The following UML diagram is a proper representation of the working of the assistant through user input to process to action taken.



IV. BLINK – AT A GLANCE



It is an innovative application designed to serve as an intelligent smart assistant, aimed at enhancing user experiences and simplifying everyday tasks. The primary objective of this project is to develop a versatile assistant that seamlessly integrates into the user's digital ecosystem. With the significantly increased popularity in recent years the motivation of audio-based assistants resides in their versatility, (Principi et al.,) since audio signals allow for capturing people's activity, monitoring the acoustic environment and they enable speech-based user interfaces

with the power of voice and text commands, users can effortlessly control media playback, conduct web searches, and open applications, providing a convenient and personalized user experience.
One of the key ideas behind Blink is, it focuses on simplicity and ease of use. Using instinctive vocal and written instructions, individuals can engage with the assistant in a seamless and natural way. This ensures that even individuals with limited technical knowledge or physical disabilities can benefit from the application's capabilities.

V. Conclusion

With the latest advancements in computer science, accessing and disseminating information can now be accomplished within seconds.(Goksel Canbek & Mutlu, 2016). In the computer world, there is no smart assistant that can help you, Windows OS lacks any Smart Assistant that can help in improving the user experience of the user. There is a lack of software that allows improved accessibility to challenged people or elderly people. People are using cell phones daily, but most people are not aware of the usage of computers or the power they can provide over a cell phone. To overcome this problem, we have developed software that improves accessibility and makes it easier for people to use computers. The overarching objective is to create a personal computer assistant that encourages children to adopt a healthy lifestyle while engaging in their daily activities at home. (IEEE Staff & IEEE Staff,)

Future Scope

The future scope of intelligent smart assistants is exciting and diverse. The main reason that the user wants to use the personal assistant is to make the life easier (Reddy et al., 2020). Below mentioned features can be facilitated.
As technology progresses, there are numerous areas for future advancements in smart assistants, including improvements in Natural Language Processing (NLP), the integration of smart home devices and third-party services, personalized recommendations, more sophisticated multimodal interactions, better contextual understanding, and stronger privacy and security measures. This ongoing evolution suggests that smart assistants could become increasingly intelligent, intuitive, and essential tools in our everyday routines.
As technology continues to evolve, smart assistants have the potential to become even more intelligent, intuitive, and indispensable in our daily lives.

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Hector SLAM Mapping and Localization System using ROS and LIDAR

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***Abstract*— This paper demonstrates the use of laser technology in environment scanning for performing indoor positioning and mapping. A 360-degree LiDAR forms the core of the project and the input device used for understanding its surrounding. Hector SLAM and ROS are the two technologies implemented in this project. Hector SLAM where SLAM stands for Simultaneous Mapping and Positioning, is the algorithm used to map the environment and improve navigation accuracy. The aim of this project is to allow an autonomous mobile robot to understand an unknown environment and map its surroundings to perform further tasks using the created map.**

***Index Terms*— SLAM, ROS, lidar, map, scan.**

I. INTRODUCTION

We are in the age of automation, where technology has become a lifestyle. From home applications to military operations, technology has advanced. And with advancement, come new features to make functions easier for humans to use. Features like safety, visualization, and navigation have become primary elements. One such feature used in most of these applications is environment mapping. This is the most crucial factor in robot vacuum cleaners as well as military robots. Environment Mapping is used by machines (robots) to visualize and understand their environment.

The proposed system involves the use of the Hector Slam Algorithm that uses LiDAR for Simultaneous Mapping and Positioning. The system prototype is demonstrated with the aid of a small 4-wheeled vehicle imitating an indoor warehouse robot. This robot can deliver parcels from sources to various destinations by mapping and finding the best path in a warehouse and is chosen for demonstration as it is one the major applications of the used technologies. There are various systems that are based on GPS and facilitate autonomous robots and vehicles for accurate positioning when used outdoors. However, these systems are unavailable to perform the same tasks indoors. For an instance, consider moving packets in a warehouse or floor-cleaning robots require real-time accurate mapping of the environment they are working in. The implementation process follows - Laser scanning, implementation of Hector SLAM, robot control, autonomous navigation.

The paper is further organized as follows. Section II describes the system design and architecture; Section III demonstrates the experimental setup and results. Section IV discusses the possibilities for future work and the paper is finally concluded.

II. SYSTEM DESIGN AND ARCHITECTURE

A. System Architecture

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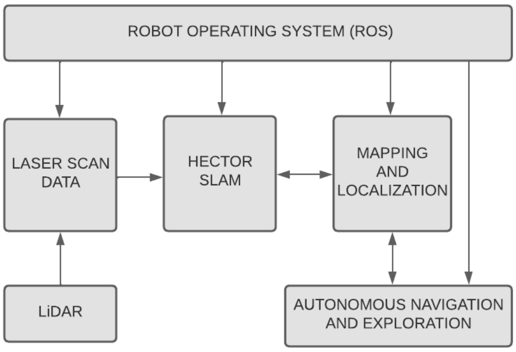


Figure 1. System Architecture

The system uses Robot Operating System for integrating and implementing all the different robotic operations requires for the project like Hector SLAM and LiDAR. The laser data from the LiDAR is used to generate a map of the environment and show the location of the robot on the map. Hector SLAM is responsible for localization and mapping. During the mapping process, the robot autonomously navigates around the area to create a more accurate map. This navigation is also done with respect to the obstacles that are identified using the LiDAR. Fig.1 demonstrates the complete system structure.

B. Software Development

ROS is the most important software used for controlling all the robotic operations. It is run on Raspbian OS for this demonstration but it can run on Ubuntu desktop or Linux OS as well. Hector SLAM is implemented on ROS and the RPLidar libraries are also integrated in ROS.

The recorded map is displayed on RViz application in real-time. Refer fig. 2.

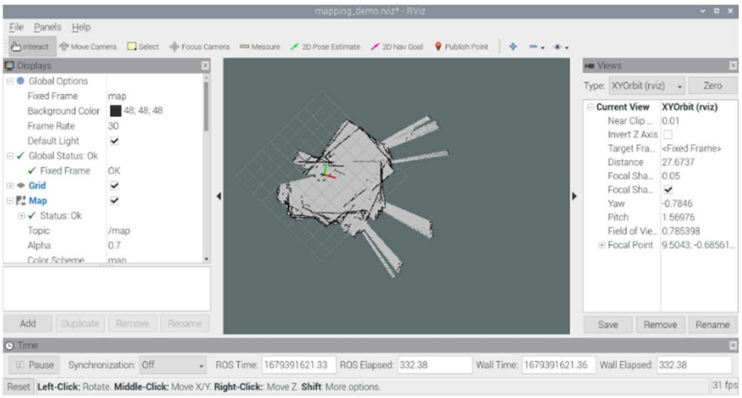


Figure 2. RViz

1. Hector SLAM

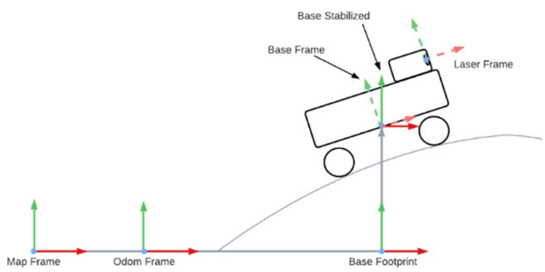


Figure 3. Hector SLAM

Hector SLAM algorithm is used since it gives reliable and accurate navigation.[1] Other grid-based SLAM algorithms like TinySLAM and GMapping require odometer information whereas Hector SLAM uses only laser scan data and previous map data (scan matching technique) to estimate the movement and location of the robot. This means that this algorithm reduces the need for extra sensors cameras and ultrasonic. Odometer information can be used to improve efficiency and reduce sensor error.
Fig. 3 demonstrates the system frames of interest for a robot with roll and pitch motion.
Hector SLAM uses scan matching technique. The map frame is the previous map data. Odometer frame is used to improve accuracy of 2D mapping. If there is no use of odometer, the map frame can be directly transformed to base frame. Base footprint and and base stabilized frames are solely used to represent robot location and height respectively. These frame values are equal with no roll and pitch. The laser frame is the current map data. All the previous frame data is evaluated and matched with the laser frame.[2]
The robot's position and velocity are estimated by this approach using the Gauss-Newton iteration formula and the robot's body transformation from previous map. The previous map data and scan data is matched.

$$RobotPose : Q = \left(P_x, P_y, \Psi\right)T \qquad (1)$$

$$Q^* = argmin_Q \sum_{i-1}^{n}\left[1 - M\left(S_i(Q)\right)\right]^2 \qquad (2)$$

where function S_i represents the coordinates of the i^{th} scan when the pose is i. M represents Map values at coordinates given by S.
With the initial value of Q, an updated value $(Q + \Delta Q)$ is evaluated from $M\left(S_i(Q)\right)$ using Taylor Expansion which gives,

$$\Delta Q^* = H^{-1} \sum_{i-1}^{n}[\nabla M(S_i(Q) \frac{\partial(S_i(Q))}{\partial Q}] \qquad (3)$$

where H is the Hessian matrix.[3]

2. Autonomous Navigation

The software development also involves autonomous navigation. This uses the Lidar data to avoid obstacles and allows efficient mapping of the area. Fig. 4 shows the architecture for autonomous navigation.
The robot uses hector_navigation package of autonomous navigation and exploration. Here the elevation data (height map) is taken along with the 2D map created by the LiDAR and combined to develop an combined 2D map or cost map of the surroundings. The cost map is then utilized by the exploration planner which analyses the map and uses exploration transform approach discussed in [4], to make decisions and plan a path for the robot. Finally, it computes the robot's linear and angular velocities required to follow the planned path and sends it to the base/exploration controller. The controller receives the robot's velocities and converts these velocities into individual wheel velocity commands.[5]

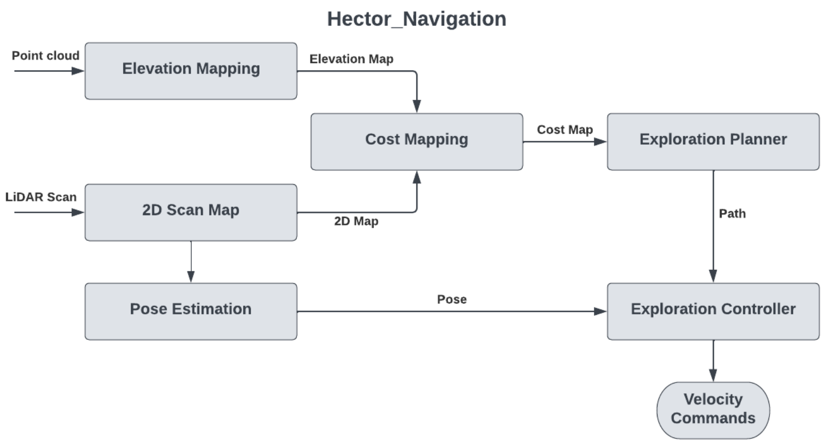


Figure 4. Robot Navigation Architecture

The kinematics of differential drive robot defines how the individual wheel velocities are calculated. Let the robot's linear velocity be V and angular velocity be ω. Then the velocities of left and right wheel, v_l and v_r are given by,

$$v_l = \frac{2v - wL}{2R} \qquad (4)$$

$$v_r = \frac{2v + wL}{2R} \qquad (5)$$

where L and R are the wheel separation length and wheel radius respectively.

3. Hardware Development

The whole system is run on 8GB Raspberry Pi 4 Model B microprocessor. The features and specifications of this board allows the smooth working of all the operations with efficiency. The LiDAR module used is RPLidar with a range of 6m radius. The drive mechanism used is a simple 4-by-4 differential wheel drive. Fig.4 shows all the hardware used for building the project.

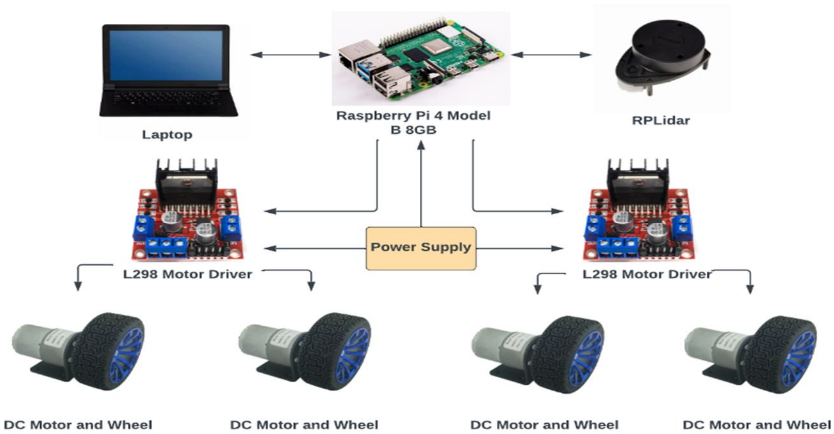
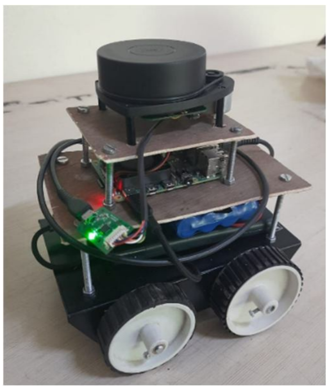


Figure 5. Hardware Components

III. Experimental Setup and Results



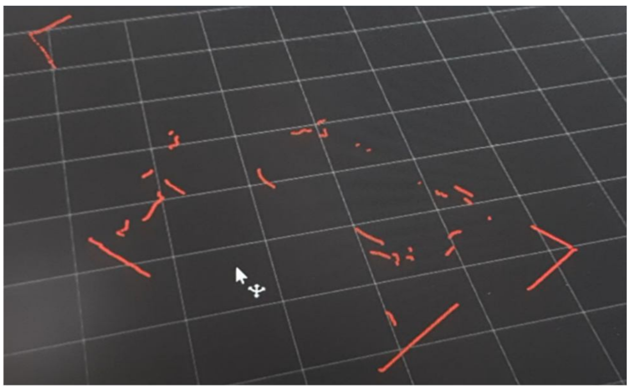


Figure 6. Robot Setup

Figure 7. Laser Scan

The project robot setup is demonstrated in fig. 6. The robot is self-designed and consists of an additional ultrasonic sensor for more efficient evaluation. The laser scan generated by lidar in a crowded room is shown in fig. 7. Generally Hector SLAM does not require an odometry device for localization but one can be used to generate more accurate maps. Hector SLAM is implemented after using the laser scan. The robot is tested in a small self-built area. The arena is shown in fig. 8 while the results on RViz i.e. map generated in the arena with and without the obstacles is demonstrated in fig. 9 and fig. 10.

Figure 8. Arena

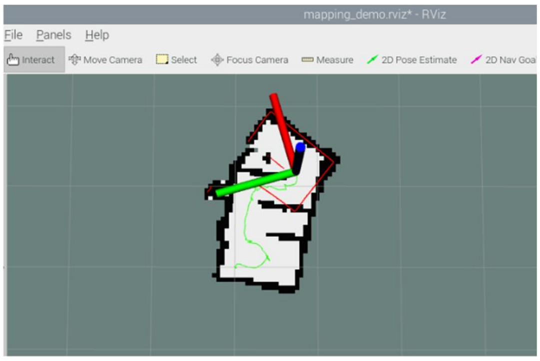


Figure 9. With Obstacles

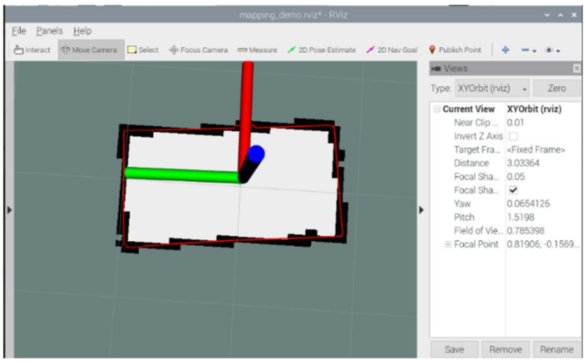


Figure 10. Without Obstacles

The map is demonstrated in RViz. The terminals green, red and blue refer to the front, right and top direction of the robot respectively. The curved green line on the map gives the path that the robot has taken from the start. On getting a closer look, red lines can be seen along the edges of the arena. These lines are the laser scan generated by the Lidar.

From the images, one can easily identify the arena. The arena used for testing is small (nearly 8x4 feet) and since the range of the lidar is 12m, the map is generated quickly without the obstacle. Hence, the robot did not move from it's original position.

IV. Conclusion And Future Work

A. Conclusion

While different GPS-based maps enable autonomous robots and vehicles for precise localization when they are outside, they cannot do the same when they are inside. Without an accurate mapping of rooms and buildings that is updated in real-time, robots that are responsible for tasks like moving packages in a warehouse or cleaning floors cannot do their jobs effectively.

This technology addresses that issue by coming up with a low-cost method for making indoor environment maps in real-time. This enables a robot to move without running into anything and to navigate by dodging obstacles. Additionally, this enhances performance and cuts down on navigation time.

B. Future Work

Path optimization algorithms play a crucial role in finding optimal paths in various domains, including robotics, logistics, transportation, and more. These algorithms aim to determine the most efficient or optimal path between a given start and goal location, considering factors such as distance, time, cost, or other specified objectives.

Path optimization algorithms refer to a class of computational algorithms used to find the best possible path or route between two or more points in a given environment, subject to certain constraints or objectives. The goal of path optimization algorithms is to minimize or maximize a given objective function, such as distance, time, cost, or energy, while taking into account the constraints of the environment, such as obstacles, terrain, or traffic. Path optimization algorithms can be used in various applications, including indoor and outdoor navigation, logistics and transportation, and robotics and automation. These algorithms can be based on a variety of mathematical techniques, including graph theory, optimization theory, and machine learning, and can be implemented using various programming languages and platforms.

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Design and Implementation of Modified Bidirectional Converter

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***Abstract*— In recent days, the need for highly power efficient methods are required to create an environment that is sustainable and eco-friendly. Therefore, the usage of converters has increased exponentially. DC-DC converter is widely used in electronic devices powered by batteries to regulate the battery voltage to a suitable level. These converters convert the battery voltage to a different level, either higher or lower, depending on the device requirements. For instance, a boost converter can be used to increase the voltage for a device that requires a higher voltage than the battery can provide. Conversely, a buck converter can be used to reduce the voltage for a device that needs a lower voltage than the battery provides. This paper involves designing a new model of the SEPIC converter i.e., modified SEPIC converter that can operate bidirectionally by replacing the output diode of the conventional SEPIC converter with a switch. The converter is designed to increase the power efficiency and to reduce the need for using huge battery packs that is used to reduce the size and cost of the batteries to be used. The designed converter is connected to battery at source end and it performs boosting operation when connected to load and it operates in bucking mode when the battery is to be charged. The efficiency of the designed converter is around 95%.**

***Index Terms*— DC – DC converter, bidirectional converter, SEPIC converter, modified SEPIC converter.**

I. INTRODUCTION

Converters can have a positive impact on the environment by promoting integrating renewable energy sources, enhancing energy efficiency, and mitigating greenhouse gas emissions. These devices can be used to create microgrids that operate independently of the main power grid, combining renewable energy sources, energy storage solutions, and converters to build a more resilient and sustainable energy infrastructure. Using converters to regulate power supply can harness renewable energy sources such as solar, wind, or hydro power and optimizing their utilization, reducing greenhouse gas emissions. Moreover, converters can help improve energy efficiency, particularly in industrial settings, by converting high voltage to low voltage, reducing energy waste and improving efficiency. By regulating power supply through converters, energy consumption can be optimized and energy losses minimized, leading to substantial energy conservation and decreased emissions of greenhouse gases. Using of converters can promote sustainable energy infrastructure, reduce greenhouse gas emissions, and improve energy efficiency, making them a crucial component of the worldwide endeavor to tackle climate change and advance sustainable development involves enhancing efficiency through voltage and current conversion to reach the

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device's ideal levels. Converters offer more flexibility as they can be used to convert voltage and current to a variety of different levels and also can be used with different power sources, such as batteries, solar panels, and generators, making them useful in a wide range of applications [10][14]. The existing buck boost converter has two stage processes to reach the required voltage, ultimately consuming a lot of space. It also has a low switching frequency, which leads to a low voltage conversion ratio. In the proposed system we use two MOSFET switches to increase the switching frequency. The converter uses a single boosting process to attain the required voltage, reducing the space occupied by the converter. MOSFET switches have high-switching frequency whose voltage conversion ratio is high. Two switches work in a NOT pulse method.

II. OBJECTIVE

- The goal of utilizing a modified SEPIC converter in battery-based electrical appliances is to effectively transform the battery voltage to a voltage level that is appropriate for the appliance's operation.
- The modified SEPIC converter can offer a regulated voltage at the output that is separated from the voltage at the input, which is crucial for ensuring the appliance operates at a consistent voltage level despite changes in the battery voltage.
- Compared to other DC-DC converters, the modified SEPIC converter boasts several advantages, such as its ability to handle a broad range of input voltages, making it suitable for use with various battery types and configurations.
- Furthermore, the modified SEPIC converter is highly efficient, a crucial factor in battery-based applications where power consumption is critical.
- In essence, the primary aim of using a modified SEPIC converter in battery-based electrical appliances is to deliver a dependable and efficient power source that caters to the appliance's specific requirements.
- Achieving this objective can help prolong battery life and enhance the performance of battery-based electrical appliances.

III. EXISTING SYSTEM

DC-DC converter is an electronic device that converts DC voltage at the input to a different DC voltage at the output. It is widely used in various electronic devices and systems, including power supplies, battery chargers, motor drives, and LED lighting. DC-DC converter are of three main types, buck converter (step-down), boost converter (step-up), and buck-boost converter[9]. Buck converters lower the voltage at input to a desired voltage at the output by turning the input voltage on and off and storing energy in an inductor. In contrast, boost converter increases voltage at the input to a desired voltage at the output by storing energy in an inductor and releases to output load. Buck-boost converter can step down or step up the voltage at input to produce a desired voltage at output and can operate in four different modes. DC-DC converters have several advantages over traditional linear regulators, including improved efficiency, smaller size, and lower cost [15] [16]. They also offer better power density, higher reliability, and improved transient response.

DC-DC converters find utility in portable electronic gadgets striving for extended battery longevity and in renewable energy setups like solar panels and wind turbines. Isolated DC-DC converters are extensively employed in various applications that require protection against electrical noise, including medical equipment, industrial control systems, and telecommunications. One main challenge of buck-boost converter is its tendency to generate significant output and input current ripple. This can create noise and electromagnetic interference (EMI) issues, and may require additional filtering to smooth out the current waveforms. Another drawback of the buck-boost converter is its intricate control circuitry[16]. Because it is a bidirectional converter, its feedback loop must be designed to handle both step-up and step-down operation, which can make closed-loop control more challenging [2] [3].

This added complexity can increase the overall cost and design effort required for buck-boost converter-based system. In efficiency terms, buck-boost converter may not be the best choice for applications where power efficiency is critical. Compared to unidirectional converters such as buck converter and boost converter, buck-boost converter typically has lower efficiency due to the additional circuitry required for bidirectional operation [4][7]. The buck-boost converter, like other unidirectional converters, does not provide separation between output and input. This may be disadvantageous in certain applications that require isolation for safety or performance reasons [6].

IV. Proposed System

In a modified SEPIC (Single - Ended Primary Inductor Converter) converter that uses a switch instead of a diode, the basic circuit topology remains the same as a regular SEPIC converter. However, instead of using a diode to rectify the output voltage, a switch such as a MOSFET or a BJT is used. The main advantage of using a switch instead of a diode is that it can offer higher efficiency, especially in high - power applications. The voltage drop across a diode can result in significant power losses, which can reduce the overall efficiency of the converter. By using a switch instead of a diode, the power loss can be reduced, leading to higher efficiency. In this modified topology, the switch is controlled using pulse width modulation (PWM) signal, produced by the control circuit of the converter, is employed to switch the device on and off rapidly at a high frequency, typically ranging from several hundred kilohertz to several megahertz. This modulation is used for the purpose of regulating the output voltage[1].

When the switch is turned on, the inductor in the circuit stores energy, when the switch is in the off position, energy is discharged into the output capacitor[12]. By adjusting the duty cycle of the PWM signal, the output voltage can be regulated. One important consideration when using a switch instead of a diode is the issue of reverse recovery time. When a diode turns off, it takes a certain amount of time for the stored charge to dissipate. This is known as the reverse recovery time. If a switch is used instead of a diode, the reverse recovery time is not an issue, but the switch must be carefully selected to ensure that it can handle the voltage and current levels of the application. Not Pulse Method – In this method the MOSFET switches SW1 and SW2 are ON & OFF alternatively based upon the Not Pulse. i.e., when the switch SW1 is ON the switch SW2 is OFF at that particular instant of time and when switch SW2 is ON, switch SW1 is OFF. The On and OFF duration the switches SW1 and SW2 can be controlled by driver circuit which receives the signal from the PIC microcontroller and the switching operation can be varied by modifying the code present in the PIC controller.

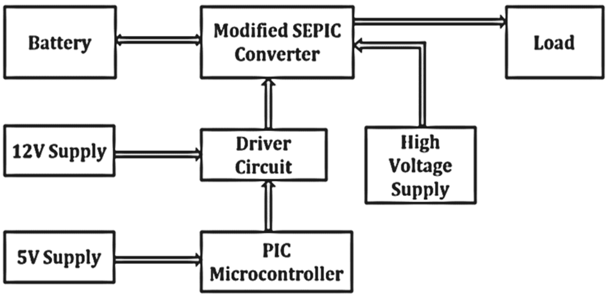

Fig.1 Block Diagram of the Proposed Converter

The above block diagram in Fig.1 is the pictorial representation hardware setup of the SEPIC converter that is modified. It represents connections of components required for operation of the "modified SEPIC converter". The rechargeable battery is always connected to the terminal near the inductor L1 and it is shown in the Fig.2 and the load is connected to the terminal near the capacitor C2. The PIC microcontroller is powered by an external 5 volt supply.

The PIC microcontroller controls the MOSFET switches present in the modified SEPIC converter. The driver circuit is also externally powered by a 12 volt supply. The driver circuit is used to power the MOSFET switch since PIC microcontroller operates at 5 volts whereas minimum voltage required to activate the gate in MOSFET is 12 volts, so to send the signal to the MOSFET, a driver circuit is required. When the PIC micro - controller sends signal to the driver circuit, MOSFET switch required voltage is supplied by the driver circuit[5]. During the charging of the battery, battery acts as load and load is disabled. From the load side a high voltage source is provides to charge the battery varied by modifying the code present in the PIC controller and the voltage is reduced to the required voltage level to charge the battery.

V. Operation

The SEPIC (Single-Ended Primary-Inductor Converter) topology comprises several key components, including power MOSFET switches, a diode, two inductors (L1, L2), and two capacitors (C1, C2). Initially, this configuration operates as a unidirectional converter. However, it's possible to transform this unidirectional SEPIC converter into a bidirectional version by substituting the unidirectional diode with a bidirectional MOSFET switch, as depicted in Figure 2[11][13].

In the context of continuous conduction mode (CCM), this converter serves as both a buck and a boost converter. The operational sequence involves the low-voltage battery voltage (Vin) being directed to an inductor. During the phase where MOSFET SW_1 is closed and MOSFET SW_2 is open, inductors L1, L2, and capacitor C1 are connected to the power supply. Once these components are charged, MOSFET SW_1 is opened while SW_2 is closed. The MOSFET switches toggle at a notably high frequency, leading to voltage spikes that elevate the voltage to the desired level, a characteristic of the boost conversion process. Importantly, when the battery requires recharging, the high voltage is effectively reduced to match the level of the low-voltage battery, thereby preventing any potential damage.
The converter is powered by a dc supply and it charges the inductor L1. Initially the capacitor C1 is assumed to be fully charged. The MOSFET switch SW_1 is initially ON while the switch SW_2 is OFF simultaneously. The MOSFET switch SW_1 now acts as short circuit and thus the capacitor C1 discharges through that and it charges the inductor L2.

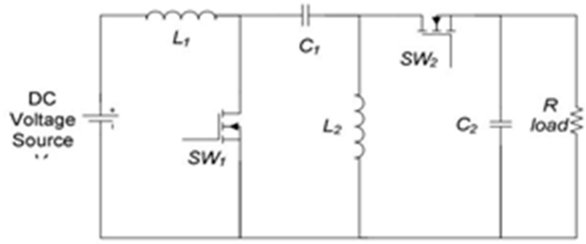

Fig. 2 Circuit Diagram of the Converter that is proposed

Mode - 1 is depiction of state of the MOSFET switches SW_1 and SW_2. In mode - 1 during the boosting process of the Modified SEPIC converter switch SW_1 is ON and the switch SW_2 is OFF.
Now when the MOSFET switch SW_1 is OFF and the MOSFET switch SW_2 is ON as simultaneously due to the NOT pulse control method. From Lenz law it is determined that the inductor opposes the change in current direction and thus changes polarity. Therefore, inductor L1 also follows the same law and now the capacitor C1 is charged, the L2 inductor also opposes the change in current and changes its polarity. By changing the polarity, the current flows through those MOSFET switch SW_2 to the capacitor C2 and charges it. When capacitor C2 charges fully ,the current starts dissipating to load and it can be visualized.

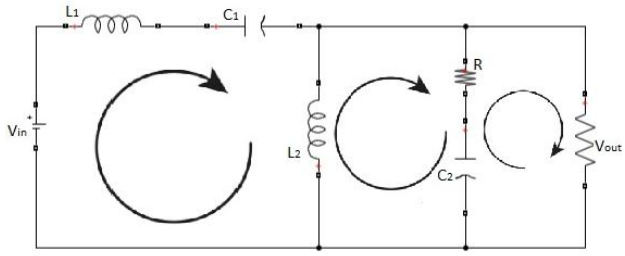

Fig. 3 Mode - II in Boosting Process

Mode - 2 is depiction of state of the MOSFET switches SW_1 and SW_2. In mode - 2 during the boosting process of the Modified SEPIC converter switch SW_2 is ON and the switch SW_1 is OFF. Switching of MOSFET switches at high frequency boosts the voltage to the higher amount. When the MOSFET switches SW_1 and SW_2 are OFF and ON respectively, the current from the inductor L2, capacitors C1 and C2 flows to the load. This process provides the required power to load while increasing the voltage to high level. The flow of current in different loops during the switching process.
During the bucking process in the modified SEPIC converter, load is replaced by a power source and the battery which is to be recharged acts as a load. The battery cannot be directly recharged from high voltage source, so the SEPIC converter that is modified performs the process required by converting the high voltage to required voltage level for safe charging of the rechargeable battery.
Mode - I is depiction of state of the MOSFET switches SW_1 and SW_2. In mode - 1 during the bucking process of the Modified SEPIC converter switch SW_1 is ON and the switch SW_2 is OFF

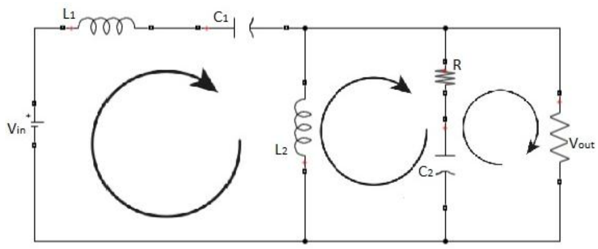

Fig.4 Mode – I in Bucking Process

Initially during the bucking process when the MOSFET switch SW1 is ON and the MOSFET switch SW2 is OFF by the NOT pulse control method. During this. The capacitor C_2 is charged, the capacitor C_1 discharges the current to the inductor L_2 and it stores the energy in it. The inductor L_1 discharges the current to the battery acting as load. Mode - II is depiction of state of the MOSFET switches SW1 and SW2. In mode - 2 during the bucking process of the Modified SEPIC converter switch SW2 is ON and the switch SW1 is OFF. When the MOSFET Switch SW1 and SW2 are OFF and ON respectively, the capacitor C2 discharges the current to capacitor C1. The inductor L2 now discharges and also charges the capacitor C1, inductor L1 discharges the current to the load.

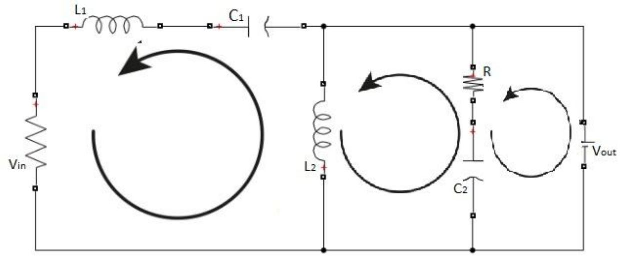

Fig.5 Mode -II in Bucking Process

Now again when the MOSFET switches SW1 and SW2 are ON and OFF respectively, the capacitor C2 works in the same way as the first cycle whereas the inductor L_2 discharges the current to charge the capacitor C1, which opposes the current direction of inductor L1. This reduces the voltage supplied the battery that is in the suitable voltage level to charge the battery. The circuit diagram with the current paths.

VI. Design Considerations

Here are the design formulas for a modified bidirectional SEPIC converter:
The inductance of the inductor L1 and L2 can be determined from the given equation:

$$L = (V_{in\_min} \text{ x } D \text{ x } (1 - D)) / (f_{sw} \text{ x } \Delta IL)$$

In this context, V_{in_min} represents the minimum input voltage, D stands for the duty cycle, f_{sw} indicates the switching frequency, and ΔIL signifies the peak-to-peak inductor current ripple.
Capacitance of the output capacitor C_1 and C_2 is calculated with the equation:

$$C = (1 - D) \text{ x } (V_{out} \text{ x } \Delta IL) / (f_{sw} \text{ x } \Delta V_c)$$

Where the output voltage is V_{out}, ΔV_c is the allowable output voltage ripple, and ΔIL is the peak to peak inductor current ripple.
The output voltage can be controlled by adjusting the duty cycle D as follows:

$$D = (Vout - Vin\_min) / (Vin\_max - Vin\_min)$$

Where V_{in_max} is the maximum input voltage.
The efficiency of the converter can be determined by the following equation: $\eta = (Pout / Pin) * 100\%$
P_{out} represents the power at the output, while P_{in} signifies the power at the input.
The input power can be calculated as: $Pi_n = V_{in} * I_{in}$
Where V_{in} represents the input voltage, and I_{in} denotes the input current.
The output power can be calculated as: $P_{out} = V_{out} * I_{out}$
Here, V_{out} represents the resultant voltage, and I_{out} stands for the resulting current.

TABLE I: PARAMETERS DURING BOOSTING

Circuit Parameters	Rating
Input Voltage V_{in} during boosting	14V
Switching Frequency (f_{sw})	100 kHz
Output Voltage V_{out} during boosting	89V
Inductors L_1 L_2	 10 mH 10 mH
Capacitors C_1 C_2	 2000 μF 1000 μF
Resistive Load Ro	100Ω

VII. SIMULATION AND PERFORMANCE ANALYSIS

The output response of Modified SEPIC during the boosting process is illustrated in Fig.2 are as follows. The input voltage, Vs, is specified as 12 - 14 volts, and the supply current is 5.9A. The converter produced an 89.05v output voltage and a 0.89A output current. The voltage conversion ratio for the boosting process is 6.35. The converter has an efficiency rate of 95%.

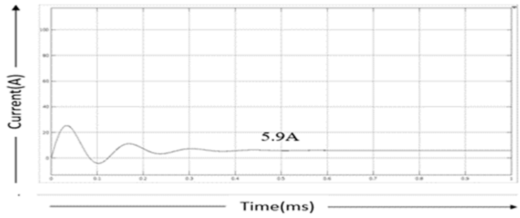

Fig.6 Input Current during Boosting Process

The waveform of the input current supplied to modified SEPIC converter during the boosting process was shown in the fig.6. The horizontal axis is labeled in milliseconds (ms) to denote time, while the vertical axis is used to depict current in amperes (A).

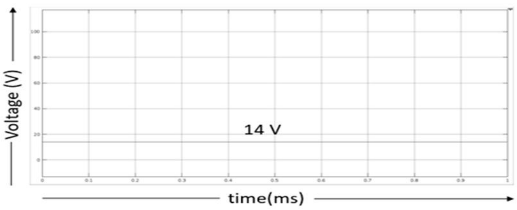

Fig.7 Input Voltage during Boosting Process

The waveform of the input voltage supplied to modified SEPIC converter during the boosting process was given in the fig.7. The horizontal axis is labeled in milliseconds (ms) to denote time, while the vertical axis is used to depict voltage in volts (V).

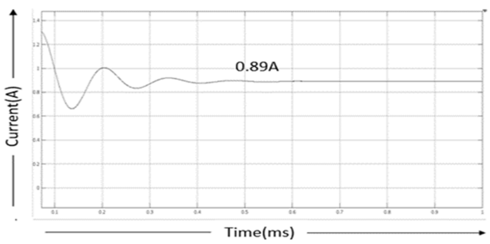

Fig.8 Output Current during Boosting Process

The waveform of the output current that is supplied to modified SEPIC converter from the battery during the boosting process is shown in the fig.8. The horizontal axis is labeled in milliseconds (ms) to denote time, while the vertical axis is used to depict current in amperes (A).

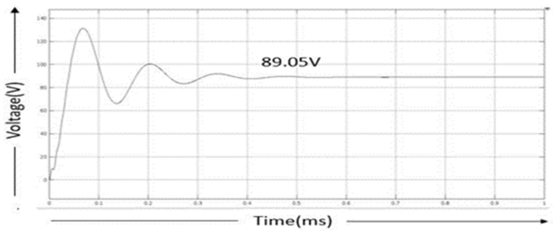

Fig.9 Output Voltage during Boosting Process

The waveform of the output voltage supplied to modified SEPIC converter during the boosting process is given in the fig.9. The horizontal axis is labeled in milliseconds (ms) to denote time, while the vertical axis is used to depict voltage in volts (V).

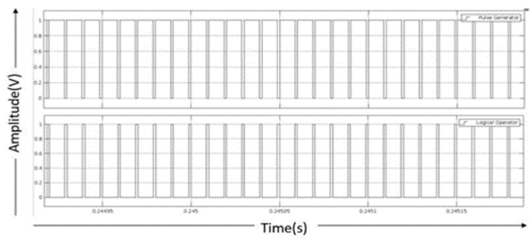

Fig.10 NOT Pulse

Fig. 10 illustrates the waveform of the NOT pulse governing the operation of the two MOSFET switches in both the boosting and bucking processes. On the horizontal axis, time is measured in seconds, while the vertical axis portrays voltage.

VIII. Hardware Specification

A DC - to - DC bidirectional converter is an electronic circuit that allows power to flow bi directionally between two DC sources, such as a battery and a power grid. The converter consists of several components, as shown in Fig. 11.

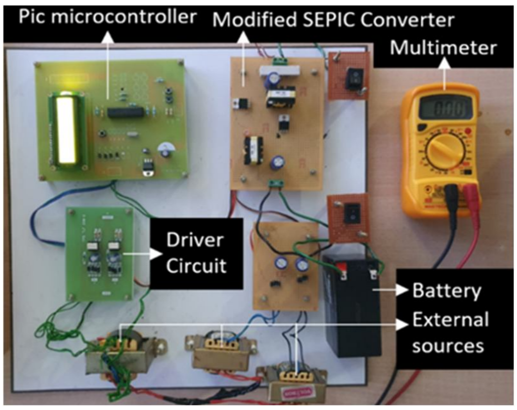

Fig.11 Hardware Setup

1. *Switches*: Both switches SW1 - SW2 were IRF840, a standard n channel MOSFET switches.
2. *Inductor*: Standard inductor L1 and L2 of through type of rating 10mH
3. Capacitors: Capacitors C1 is ceramic capacitor with 2000 μF and C2 is electrolytic capacitor with rating of 1000μF.
4. *Driver circuit*: The custom circuit contains TPL350 driver power by isolated power supplies to drive them based on PIC Controller to drive the MOSFETs.

5. *Controller*: The dsPIC30F2010 is a 16-bit DSC with a 30 MHz clock speed and various features, including timers, PWM modules, CAN 2.0B module etc. designed for high-speed signal processing. It is used to send control signals to the MOSFET through driver circuit to enable switching operation in the converter.

IX. Conclusion

A modified SEPIC converter has been successfully implemented and tested, which is capable of delivering a stable output voltage over a wide range of input voltages. MATLAB Simulink has been used to simulate and design the converter circuit, and its hardware prototype was constructed and subjected to testing with a range of input voltage levels. The experimental results demonstrated that the converter was able to produce an output voltage that was higher than the existing system. The converter's small size and reliability make it suitable for use in a variety of applications, such as battery charging, autonomous battery-operated vehicles, drones, and other electronic devices. This bidirectional SEPIC converter has achieved its project objectives and offers an excellent alternative for renewable energy applications.

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Farming Tool Leverage System and Expert Chat

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***Abstract*— The average annual income of farmers in India is well below the poverty line, primarily due to off-season agriculture and a lack of awareness about optimal farming techniques and crop management. This research paper presents an AI-based web application designed to address these challenges and improve farmers' financial and mental well-being. Our solution, comprised of a farming tools leverage system and a collaborative farming forum, empowers farmers with the knowledge and tools needed to make informed decisions and increase their income. The system leverages MongoDB, asynchronous calling, and Fast API for efficient data management and real-time interactions. AI/ML services assist with crop recommendations, crop disease detection, and price predictions. Load balancing ensures optimal performance, and Pusher JS enables real-time communication. Billing services and a dashboard provide income insights, while geographic data enhances machine learning recommendations.**
In conclusion, this research contributes to alleviating poverty and enhancing the livelihoods of farmers in India by providing a comprehensive solution to the challenges they face.

***Index Terms*— Machine learning models, leverage system, expert chat, Trending crops, widget, Tool price prediction, Crop disease detection.**

I. INTRODUCTION

Food security and sustainable development depend heavily on the agricultural industry, so it is crucial to assist and equip farmers with the right equipment, supplies, and professional guidance. Agriculture has not been exempt from the changes brought about by artificial intelligence (AI) in recent years.
This study intends to showcase an AI-based web application created to offer farmers a comprehensive platform where they can access tools, resources, and mentors' professional guidance. The key features of our proposed solution include:
Farming Tools Leverage System: This system assists farmers in various tasks such as crop management, irrigation, pest control, and harvesting. It offers real-time support through a forum for query resolution, a marketplace for renting and purchasing equipment, and an AI-powered chat bot for common issues. Additionally, it provides insights into crop trends and predicts selling prices for both new and used products.
Collaborative Farming Forum: A platform designed for farmers and enthusiasts to exchange knowledge, ask questions, and discuss farming-related topics. Users can create posts, comment on posts, and share valuable resources such as articles and videos.
AI and ML will be used to suggest Farmers which tools be best to rent according to climate, location, crop & purchasing power. It will be used to provide Real time interaction with Farmer. Predict pricing of tools to provide best possible rates for both parties based on time period, demand, profits and type of farming. The System provides

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Question & Answer platform to get solutions to farmer's query, different sales and rent stores to leverage unused products, FAQ chat bot for simple issues, Crop trend section for knowing demand and supply of crops, Selling Price prediction for used/new products.

II. LITERATURE REVIEW

In [1], the authors have built a deep-learning model for crop disease detection. Analyzing pictures of leafs and then properties to classify them as disease but no mentorship is given and used just for detection purposes.
In [2], the authors have proposed a Farming Guru app with weather prediction, crop analysis, farm equipment rental service to earn additional income for farmers. Limitations involve the lack of a crop disease detection service and the option of buying or selling farming equipment. This project has overcome this limitation by providing crop disease detection, market demand for crops, and the buying and selling of farming equipment.
In [3], the authors have used the spatial-temporal clustering model clusters farmlands with the same time window and working requirements and optimizes the intra-cluster routes. The limitations include the need to consider uncertainties during the working process. This project solved this problem by considering weather conditions.
In [4], the authors have used mobile application that the farmers can use to hire tractors as well as other mechanizations at a nominal amount. This paper doesn't focus on the recommendation of the crop and doesn't provide services such as crop disease detection and mentor advice.
In [5], the authors have provided a prediction on soil requirements to increase productivity and gain profit from such a technique. Limitations include that model learning depends only on soil conditions. This project solved this problem by using other factors to train the model.
In [6], the authors have built a web-based application for farmers to rent equipment for agriculture. The farmers are provisioned to list their equipment's on the website and other farmers can pay to rent-out the equipment's they need. Website for farming tool renting purpose No scope for crop disease detection or expert advice
In [7], the authors have developed a system that tells the farmers the type of crop disease from an image and instantly give a solution for the same. The limitations found is mentor advice is not provided. This project solved the above limitation by providing service of mentor advice
In [8], the authors have proposed a Farm Log Rental Service Platform Agri-Brilliance with Farm Equipment Rental Service, Crop Prediction, Plant Disease Prediction and view soil testing centers. Limitations involve the lack of the option of buying and selling farming equipment through the platform alongside the rental service of farming equipment.
The authors of this research [9] have suggested machine learning-based crop recommendation system strategies. They used machine learning algorithms which includes KNN, Decision Tree, and Random Forest. Limitations involve the lack of the option of buying and selling farming equipment, crop disease detection, expert advice, social forum.
The authors of this study [10], concentrated on deep learning methods for image-based plant disease identification. Limitations include the absence of the ability to buy and sell farming equipment, a crop recommendation system, a resale check value, expert guidance, a social forum, and a service that displays the most popular crops at the moment.
In [11], the author addressed the complexity of agriculture due to extensive data and variables. They explored using artificial neural networks (ANNs) to predict crop production, considering multiple indicators. The challenge lies in the complexity of the agricultural system, impacting crop yield. Our project addresses this by applying non-linear methods like random forests to improve crop yield prediction.
The author of this study [12] provides a thorough literature review on the use of artificial intelligence methods in agriculture. Agriculture diseases cause significant crop losses and environmental risks as a result of the overuse of chemicals. Hybrid systems, like neuro-fuzzy or image processing combined with artificial neural networks, are being used today. It progresses towards more accurate, automated, and real-time systems.
Described in [13] Disease outbreaks pose a persistent threat to agriculture and substantially harm the national economy. Early detection can therefore lessen the severity of illnesses and safeguard crops.
The purpose of this effort [14], according to the paper's author, is to create a software system that can mechanically locate and categorize diseases. Images of the leaves are used to identify plant illnesses. One of the paper's limitations is that it only examines specific diseases only.
In [15], the author focuses on a method for identifying plant diseases that uses image processing and machine learning. In this paper, they suggested an Android app that aids farmers in spotting plant diseases by submitting a photo of a leaf to the database. Authors inferred from the statistics above that convolutional neural networks (CNN) offer a remarkable degree of accuracy in identifying diseases.

III. PROPOSED WORK

A Farming tools leverage system is a software solution that aims to make the process of farming more efficient by leveraging technology. The system can be designed to help farmers in various tasks, such as crop management, irrigation, pest control, and harvesting.
A Forum for farming is a platform designed for farmers and farming enthusiasts to share knowledge, ask questions, and discuss farming-related topics. The platform can be designed to allow users to create posts, comment on posts, and share resources such as articles and videos.
This project also provide an admin panel to list products as from a single source of truth. The website also provides features such as Crop recommendation based on current soil stats, rain, temperature and other farmland specs . With Crop disease detection which suggests disease with other useful information when a user uploads a picture of crop.
The detailed workflow for the proposed system is delineated below:

- The solution mainly starts from registration and login with use of MongoDB Database to handle queries related to forum and order placed for rent and purchase.
- Farmers can use forum to get their queries resolved by expert and fellow farmers. Features such as share and comments can be utilized.
- Farmers can utilize Marketplace for renting and purchasing equipments. User can use billing service powered by Razor Pay to purchase and rent the items.
- This project utilized AI/ML services to accurately provide crop produce recommendation, crop disease detection by monitoring images and query resolution in real time .This project utilized FastApi server to optimize Machine Learning tasks.
- This project studied data for Used and new farmer tools to predict about the probable price for an equipment.
- Farmer can utilize trained FAQ bot to get normal queries resolved. This project provided solution to farmers , where they can analyze current demand and supply ratio for crops , such that they don't grow crops with less profit margin , refer Fig 3.1

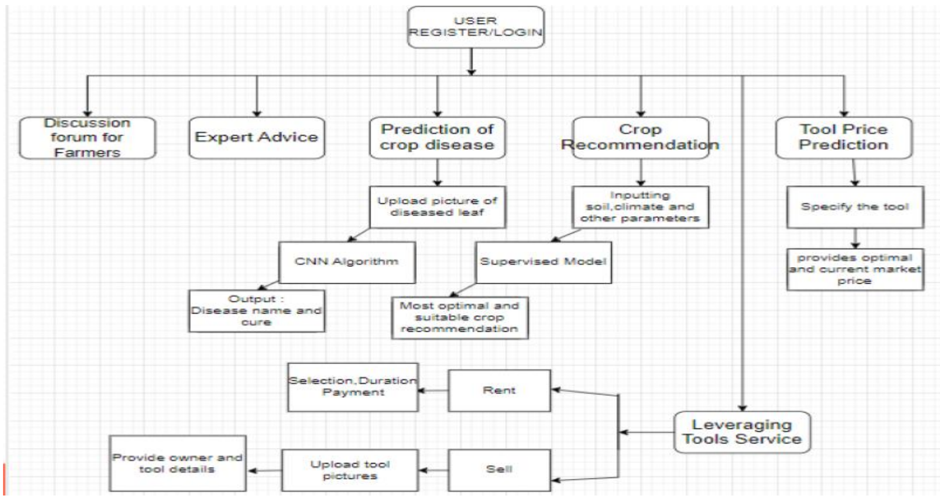

Fig. 3.1 Workflow of System

The Architecture Design of software system can be described as,

- The clients access the proposed system; the client requests go through a load balancer first.
- The Load balancer basically manages api calls and services to maintain balance between each service being used. Load balancer is used to avoid performance bottlenecks and to create a distributed architecture.
- The clients can post questions or queries in the forum and access previously answered queries for more information, fetched from the Database.
- Pusher JS is like a web socket which maintains real time interaction between services. Pusher JS is used for maintaining a synchronous connection to allow servers to push new data to clients instantly.
- Billing service and Dashboard are for reporting service to clients to check income generated and other details.

- Products can be searched or chosen by clients through a list of products fetched from the Database for leverage of farming equipment. Geographic details such as soil and climate information are used for training the Machine Learning Service.
- The Machine Learning Service is used for making product recommendations based on the crop details and crop recommendations based on geographic details provided by the clients.
- The Pricing Service is used to predict and suggest an appropriate price for the product recommended by the Machine Learning Service.
- The Database stores previously posted questions and queries of the clients and the list of products and their corresponding relevant details. The Database also includes Crop details for recommending Crops based on the Client's requirements as shown in Fig 3.2.

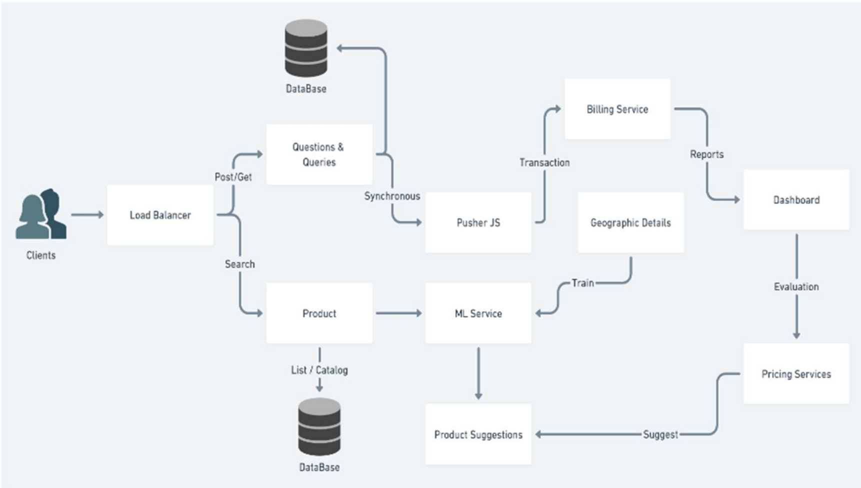

Fig. 3.2 Architecture Design Model

Implementation Details of Leverage system is as follows,
Algorithm 3.1 begins with pre-processing of dataset by normalizing the price field to gain more insight values, next split dataset into test and train sets, and feed into Random Forest Regressor. Performed testing and observations and saved model for future use in pickle.
Algorithm 3.1: Used Price Prediction of farming equipment
Input:
• Majority training Data
• Normalized Price Data
Output: Predicted Price, Ptool.

- Pre-process Dataset to obtain final Dataset & Split into train and Test tests
- Load Normalized data into Random Forest Regressor & dump trained model into pickle file for loading into server
- To Predict tool price

Algorithm 3.2 begins loading of Image Dataset, applying image processing techniques to normalize the dataset , and applying CNN model to classify images . Then testing and observations using Torch.
Algorithm 3.2: Farmer's provided crop image disease detection
Input:
• Majority training Image Data
Output: Classified diseases and supporting Information, image.

1. Normalize Image Dataset to obtain final Dataset
2. Transform Images into enhanced version by using Image processing techniques
3. Load Normalized data into CNN module and also perform more computation
4. Perform batch training for some epochs & Predict Disease information and supplements etc.

Algorithm 3.3 begins by analyzing customer care call records and analyzing them. Next build intents from them and feed into chatbot.
Algorithm 3.3: Farmer's query Resolution chat Bot
Input:

Question and Answers customer care data

Output: Probable Answer to Query, Answer Query.

1. Preprocess queries and call records of Customer care & process query answers into Intents using DialogFlow
2. Train chatbot & receive answers to normal query

Algorithm 3.4 begins with processing Dataset and normalizing temperature, soil and rainfall values .Next this project applies some techniques such as Decision tree, Bayes algorithm, Random Forest, SVM etc. and train model.
Algorithm 3.4: Based on farmer input, recommend profitable crop choice to grow Input:

- Major dataset, with classes

Output: Recommend Choices of crop, C1, C2, C3.

1. Preprocess dataset with crops and other parameters
2. Split into train and test classes
3. Train model with ensembling technique with supporting algorithms such as Naive Baye's , SVM , Decision Tree and Random Forest
4. Metrics and load into pickle

Details about working web application can be described as,

1. Question Answer Portal and Discussion

This Feature provides a space where the user can post his query with a picture to get better results and solutions from Farm experts and fellow farmers. This feature is intended to provide much needed guidance to farmers. A farmer can put their advice and solutions into the Solutions tab provided. He can share the question and solution via external share such as twitter or whatsApp.

2. Sales and Rent stores

This feature is intended to solve the no-income state of farmers in off-season, and make them independent from one source of income. This helps farmers by making them leverage their systems / tools in off-season thereby providing an extra source of income to them.
Similarly users of these products get to use tools which they can't afford at lower prices and improve productivity of their farm.

3. FAQ Chatbot

In the website users can use a floating action button or separate section to interact with this. This basically provides simple and fast resolutions to general queries of farmers. The chatbot has been trained on a dataset provided by the Government of India, which consists of interactions between Krisihi Sahyog expert and farmer. This is implemented by converting interactions into Intents and with use of DialogFlow.

4. Recommendation to grow Crops

This project provides this feature, by using which farmer by providing various major factors of his geological location such as Minerals contents of soil, moisture, temperature etc., can know the best crop to grow to yield maximum returns and a good quality product after harvest. Built using ML models such as Naive Bayes, SVM and Random Forest and FastApi as backend server handling running of Model and providing data to React.

5. Selling Price Prediction

Using this tool, a farmer, by letting us know the condition of his tool which he wants to list on the website for sale / rent, can estimate its final selling and rent price on the go. The parameters involve details such as Manufacture year, Manufacturing company, Modal number, used days, working Condition etc.

6. Trending Crops

This feature is intended to provide approximate insight to farmers about demand and supply based on Government Data. This is intended to tell farmers which crops will be more profitable for them to grow and thereby reduce instances of wasting crops and milk etc. by farmers in protests.

7. Crop Disease Detection

To use this feature shown in farmers upload their crop pictures and using CNN with a gradient model and a dataset of 54,000 images this project tries to detect the disease for the crop. This project also provide details such as explanations about disease, supplements to cure these diseases, the experts suggestions and suggested product image and buy link.

IV. Results And Discussions

The solution is able to provide a different way and one stop solution to farmers to earn extra side income and tools to help their everyday work and make it easy. This project used MERN stack to develop core architecture of web application and utilized FastAPI as AI/ML Backend server with python . Majorly this project used Convolutional Neural Network to analyze large datasets of disease crop images and to build models which can provide accuracy of 98 percent as in Table 4.1 .To use this feature , farmers upload their crop pictures and using CNN with a gradient. model and a dataset of 54,000 images , this project try to detect the disease for the crop .This project also provide details such as explanations about disease , supplements to cure these diseases , the experts suggestions and suggested product image and buy link .

TABLE IV.1: ACCURACY FOR CROP DISEASE DETECTION

Method	Accuracy
CNN	98 %

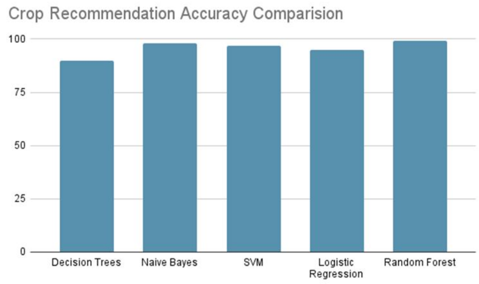

Figure 4.1: Crop grow Recommendation Plot

For Crop recommendation, this project implied Decision tree, Gaussian Naive Bayes , SVM ,Logistic Regression and Random Forest . Applied Random forest to achieve Accuracy of 99.09 percent , refer Table 4.2 . Provided this feature, by using which farmer by providing various major factors of his geological location such as Minerals contents of soil , moisture , temperature etc. , can know the best crop to grow to yield maximum returns .This project applied algorithms such as Linear Regression , SVM , Naive Bayes and Random Forest to predict resale value and optimal price for tools . Due to lack of dataset availability , built over own dataset ,refer Table 4.3 To use this tool , a farmer, by letting us know the condition of his tool which he wants to list on the website for sale / rent , can estimate its final selling and rent price on the go, refer Fig 4.1 & 4.2

TABLE IV.2: ACCURACY FOR CROP RECOMMENDATION SYSTEM

Method	Accuracy
Decision tree	90 %
Gaussian Naive Bayes	98.04 %
Support Vector Machine	97.75 %
Logistic Regression	95.2 %
Random Forest	99.02 %

TABLE 4.3: ACCURACY FOR PREDICTION

Method	Accuracy
Linear Regression	52.08 %
Support Vector Machine	54.257 %
Naive Bayes	57.445 %
Random Forest	65.564 %

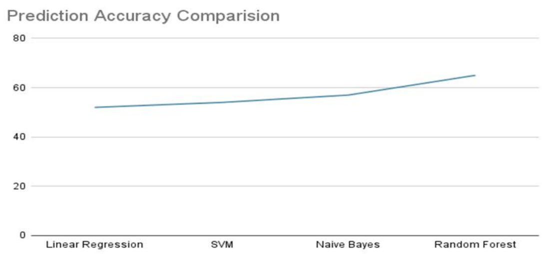

Figure 4.2: Tool price Prediction Plot

V. Conclusion And Future Work

The AI-based web application provides a variety of services to help farmers in India overcome the obstacles they confront in order to enhance their income and quality of life. A question and answer portal, rental and sales locations for farming equipment, a chatbot for frequently asked questions, data on popular crops, suggestions for optimum crop growth, selling price forecasts, crop disease detection, news updates, and an admin panel are among the services offered. By providing these services, the proposed application aims to give farmers the tools, resources, and professional guidance they need to enhance their farming methods, boost crop yields, and eventually enhance their financial well-being. By providing creative AI-based solutions to the issues encountered by farmers in India, the programme has the potential to revolutionize the sector.

There are few potential future scope areas for this Farming tool levarage system Integration with precision agriculture technologies, such as GPS mapping and soil sensors, to provide more accurate and data-driven insights for farmers. Development of a mobile application version of the farming tool leverage system to enable farmers to manage their operations from anywhere. Incorporation of weather forecasting technology to provide real-time insights on weather patterns and help farmers plan their operations accordingly.

Compliance With Ethical Standards

The authors declare that there is no competing interest or conflict of interest in this paper

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SSR Mitigation in Power System by LQR Control of nearby DFIG

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***Abstract*— This study examines the influence of a direct-power control technique for a DFIG (Doubly-Fed Induction Generator)-based wind generator on sub-synchronous resonance (SSR). A series capacitor of a transmission line will exchange power with the synchronous generator when it runs via an SSR. DFIG includes power converters built into its rotor circuit, allowing for quick control of both the active and reactive power of the device. This is made possible by the rotor converter circuit's fast IGBT switching. Examining the ability of the LQR (Linear Quadratic Regulator) on the DFIG to provide the required active power and reactive power during SSR is the primary goal of this work. Additional DFIG is added to the test system in addition to the original test system, and during SSR its performance is evaluated using an additional control signal that is obtained from the synchronous generator and supplied to DFIG through LQR. The analysis of SSR was completed based on eigenvalue analysis utilizing the D-Q model test system and transient simulation using MATLAB Simulink. Independent model control is used to control the DFIG rotor converter that dampens multimodal SSR oscillations. The test system was developed using the IEEE first benchmark model's adopted system.**

***Index Terms*— Subsynchronous resonance, Linear Quadratic Regulator, DFIG, IEEE First Benchmark Model, Eigenvalue Analysis, Rotor side converter control.**

I. INTRODUCTION

In order to combat the line reactance effect on scarcely accessible transmission lines, utilities are forced to employ series capacitors due to the rapidly exponentially increasing development of electrical power consumption. Due to negative damping, however, this series of capacitors will be crucial in causing subsynchronous oscillation in the mass-spring system of the generator and turbine [1], [2]. The shaft torque may be magnified as a result of brief disruptions. Two consecutive shaft failures caused by torsional SSR oscillations happened in 1970 and 1971 at the Mohave power plant in the US, according to reports of this kind of incidence [3, 4]. Numerous solutions, including the employment of FACTS devices TCSC [5], SSSC [6], and SVC [7], excitation voltage control [8], modified power system stabilizers [9], and interplant power-flow controllers [10], have been suggested to prevent these types of accidents. It has also been noted in [11] that power control over additional DFIG can reduce SSR. Many of the recommended solutions can successfully reduce one oscillation mode but fall short in their ability to suppress additional oscillation modes that develop as a result of various levels of series compensation. As a result, one's thoughts should be directed toward finding a source that is appropriate and capable of providing the necessary level of power. Numerous academic works propose direct power regulation of the DFIG, which provides excellent transient responsiveness. With one modification, the IEEE FBM, the first benchmark modal, is employed here as

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the test system. To enable the mitigation of SSR in the test system, one additional DFIG with LQR is added into the test system provided in IEEE FBM. The power converter's quick control features and LQR control make the DFIG the best option for providing the necessary power to suppress SSR. According to the diverse publications, a stator flux-oriented vector control is the most widely used technique. [12]- [14]. Variations between the system's actual parameters and their actual values have an impact on the system's performance. Even when parameters are changed, the direct power control method in the absence of rotor current [15] provides a stable response. The work's main goal is to evaluate how well the DFIG's new direct active and reactive power control along with LQR works to reduce subsynchronous oscillations. The synchronous generator load angle was used to generate one input signal that was provided to the DFIG control circuit and LQR.
The paper is structured as follows: Section II provides a description of the test system. Section III provides a mathematical model of the improved IEEE FBM test system for SSR in the D-Q frame. The controller design description, the IEEE FBM test system for SSR, and the DFIG power control scheme are provided in Section IV. Simulation results and their discussion are reported in Section V, and conclusions are presented in Section VI.

II. TEST SYSTEM

Figure 1 shows the single-line diagram of the test system. With the exception of the DFIG, the test system in the aforementioned picture follows the IEEE's first benchmark model for SSR research. Since we will be controlling the power of the DFIG, which has a total of three masses in the test system, it is regarded as a single-mass model. Due to its modeling approach, DFIG will only take part in network mode. The resonance probabilities observed in this case are consistent with those of the original IEEE FBM (First Benchmark Model) system. The generator may be conceptualized as an assemblage of generators that have a common mechanical design. The DFIG seen in Fig. 1 might perhaps originate from a nearby wind power facility or have been recently installed in close proximity to the original producing station. The system's loading is chosen to prevent the transformer from becoming overloaded.

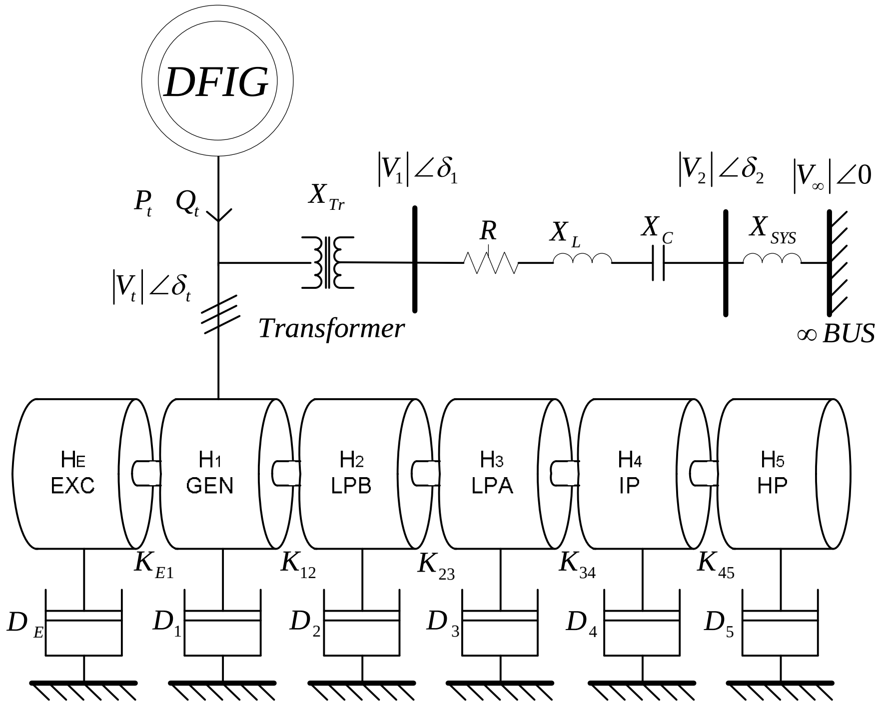

Figure 1. System designed for SSR Study Adopted with Multi-mass Configuration

The controller and the Doubly Fed Induction Generator (DFIG) are evaluated for their performance by connecting them to a busbar of the synchronous generator. Fig. 2 illustrates the converters located on both the grid-side and rotor-side of the Doubly Fed Induction Generator (DFIG). The transformer is supplied with regulated electricity prior to being supplied to the power system. During subsynchronous oscillations, the LQR control strategy for DFIG rotor converters is designed to prevent the mechanical mass system of the synchronous generator from experiencing subsynchronous resonance with the series capacitor of the transmission line.

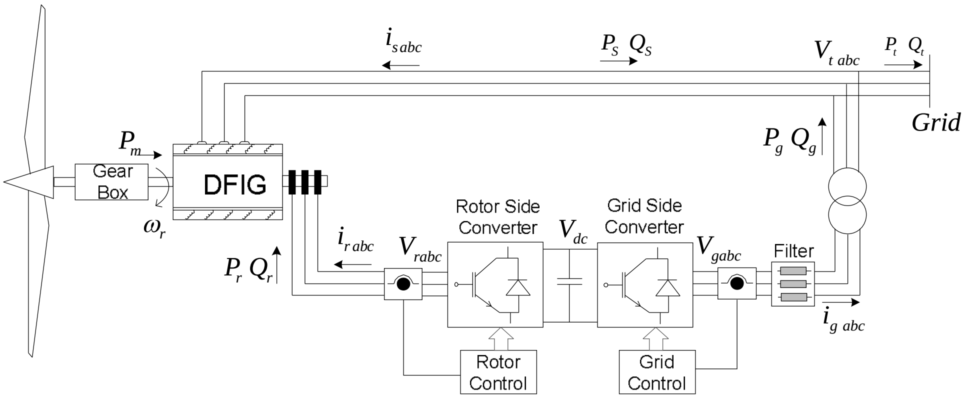

Figure 2. Wind Energy Conservation System by DFIG

III. MODELING OF TEST SYSTEM

A. Modeling of DFIG for SSR Control

The Doubly Fed Induction Generator (DFIG) has resemblance to a wound rotor induction generator. It incorporates a direct current (DC) connection between the back-to-back converters, which are sustained by a capacitor bank. Additionally, the rotor circuit is linked to the grid through the converters. The quick-acting IGBTs allow for quick output power regulation in both directions via the rotor circuit. As a result, control over SSR can be performed by operating the DFIG at either subsynchronous or super-synchronous speed. The voltage and flux equations for DFIG in both D-Q form and in any reference frame are,

$$\left.\begin{aligned} v_{ds} &= p\psi_{ds} - \omega\psi_{qs} + R_s i_{ds} \\ v_{qs} &= p\psi_{qs} + \omega\psi_{ds} + R_s i_{qs} \end{aligned}\right\} \quad (1)$$

$$\left.\begin{aligned} v_{dr} &= p\psi_{dr} - (\omega - \omega_r)\psi_{qr} + R_s i_{dr} \\ v_{qr} &= p\psi_{qr} + (\omega - \omega_r)\psi_{dr} + R_s i_{qr} \end{aligned}\right\} \quad (2)$$

$$\left.\begin{aligned} \psi_{ds} &= L_m i_{dr} + L_s i_{ds} \\ \psi_{qs} &= L_m i_{qr} + L_s i_{qs} \end{aligned}\right\} \quad (3)$$

$$\left.\begin{aligned} \psi_{dr} &= L_r i_{dr} + L_m i_{ds} \\ \psi_{qr} &= L_r i_{qr} + L_m i_{qs} \end{aligned}\right\} \quad (4)$$

Where the currents flowing in stator and rotor are , the flux linkages are , the speed of DFIG is , the resistance of stator winding and the resistance of rotor winding are Rs and Rr respectively.
The matrix form of the aforementioned equations under the synchronous reference frame will be as follows:

$$\begin{bmatrix} v_{ds}^e \\ v_{qs}^e \end{bmatrix} = \begin{bmatrix} L_s p & -\omega_s L_s \\ \omega_s L_s & L_s p \end{bmatrix} \begin{bmatrix} i_{ds}^e \\ i_{qs}^e \end{bmatrix} + L_m \begin{bmatrix} p & -\omega_s \\ \omega_s & p \end{bmatrix} \begin{bmatrix} i_{dr}^e \\ i_{qr}^e \end{bmatrix} \quad (5)$$

$$\begin{bmatrix} v_{dr}^e \\ v_{qr}^e \end{bmatrix} = \begin{bmatrix} R_r + L_r p & -s\omega_s L_r \\ s\omega_s L_r & R_r + L_s p \end{bmatrix} \begin{bmatrix} i_{dr}^e \\ i_{qr}^e \end{bmatrix} + L_m \begin{bmatrix} p & -s\omega_s \\ s\omega_s & p \end{bmatrix} \begin{bmatrix} i_{ds}^e \\ i_{qs}^e \end{bmatrix} \quad (6)$$

Where e stands for the synchronous reference frame and s for the slip. Next, using “(5)”,

$$\begin{bmatrix} i_{ds}^e \\ i_{qs}^e \end{bmatrix} = \frac{1}{L_s\left(p^2 + \omega_s^2\right)} \begin{bmatrix} p & \omega_s \\ -\omega_s & p \end{bmatrix} \left\{ \begin{bmatrix} v_{ds}^e \\ v_{qs}^e \end{bmatrix} - L_m \begin{bmatrix} p & -\omega_s \\ \omega_s & p \end{bmatrix} \begin{bmatrix} i_{dr}^e \\ i_{qr}^e \end{bmatrix} \right\} \quad (7)$$

The equation of the transients in rotor voltages in synchronous reference frame for the DFIG can be obtained using “(6)” and “(7)”,

$$\begin{bmatrix} v_{dr}^{e} \\ v_{qr}^{e} \end{bmatrix} = \begin{bmatrix} R_r + L_r^{'} p & -s\omega_s L_r^{'} \\ s\omega_s L_r^{'} & R_r + L_r^{'} p \end{bmatrix} \begin{bmatrix} i_{dr}^{e} \\ i_{qr}^{e} \end{bmatrix} + D \cdot \begin{bmatrix} v_{ds}^{e} \\ v_{qs}^{e} \end{bmatrix} \quad (8)$$

The rotor transient inductance is denoted by $L_r^{'}$, $L_r^{'} = \sigma L_r$ where $\sigma = 1 - L_m^2 / (l_s L_r)$ and

$$D = \frac{L_m}{L_s} \frac{1}{p^2 + \omega_s^2} \begin{bmatrix} p^2 + s\omega_s^2 & (1-s)\omega_s p \\ (s-1)\omega_s p & p^2 + s\omega_s^2 \end{bmatrix} \quad (9)$$

The active and reactive powers of DFIG are found as under,

$$P_s = \frac{3}{2}(v_{ds} i_{ds} + v_{qs} i_{qs}) = -\frac{3}{2} \frac{L_m}{L_s} v_{qs} i_{qr} \quad (10)$$

$$Q_s = \frac{3}{2}(v_{qs} i_{ds} - v_{ds} i_{qs}) = \frac{3}{2} v_{qs} \left(\frac{L_m}{L_s} i_{dr} - \frac{v_{qs}}{\omega_s L_s} \right) \quad (11)$$

By installing an SVC-type device, the terminal voltage may be maintained constant, and rotor currents can be used to manage the stator's active and reactive power.

B. Modeling of Synchronous Machine

Here, the state-space equations developed from the test system's D-Q modeling are used [16]. Linearized equations around the operating point are generated in order to do eigenvalue analysis. The state-space matrix is created together with the linearized equations for the turbine-generator mass system with a series capacitor. Fig. 1 depicts the generator's rotor model.

The synchronous generator is a type 2.2 model of the synchronous machine. Three-phase winding is on the stator; the rotor is wound with a field winding and the position of damper winding is on the D axis, and other two damper windings are located on the Q axis, whereas the stator has three phases of winding. This approach uses detailed models to accurately depict the rotor's motions. The following fundamental equations can be used to obtain the space-state equations for each generator.

$$\psi_S = [L_{ss}] i_s + [L_{sr}] i_r \quad (12)$$

$$\psi_r = [L_{rs}] i_s + [L_{rr}] i_r \quad (13)$$

The matrices of rotor and stator self as well as mutual inductance are used in the aforementioned equations. The aforementioned equations are changed to a D-Q reference frame, and after that, linearized.

C. Modeling of Multi-Mass Turbine-Generator Set

One generator mass stage, one exciter stage, and four turbine mass stages are used to illustrate the mechanical turbine-generator system in Fig. 1. Five soft steel shafts connect the six turbo generator masses, each of which has a different inertia. The following shaft torque equations are provided.

$$[2H] p^2 \underline{\delta} + [D] p \underline{\delta} + [K] \underline{\delta} + \underline{T} = 0 \quad (14)$$

The shaft stiffness matrix is indicated by [K], while [H] is representing the diagonal matrix of inertia and [D] represents the diagonal matrix of the damping coefficients. The resulting angular position vector is produced by the torque vector T operating on the shaft end. Damping is not considered in this paper. The speed and angular displacement from the reference line of each mass are the state variables taken into account.
The state matrix A for both generators may be obtained from “(14)”, and the eigenvalues are obtained as solution of the A matrix. With the help of the eigenvalues, the natural frequencies of the multi-mass model can be determined and are shown in table 1 below.

TABLE I. MODES OF SYSTEM AND THEIR CORRESPONDING FREQUENCY

Mode	0	1	2	3	4	5
Natural frequency (Hz)	1.66	15.73	20.23	25.50	32.37	47.31

D. Modeling of Electric Network

Fig. 3 illustrates the analogous electrical circuit used in the Institute of Electrical and Electronics Engineers (IEEE) Frequency-Based Method (FBM) for the purpose of investigating Sub-Synchronous Resonance (SSR). The connection between the generator, which has a constant voltage source (Eg) and terminal voltage (Vt), and an infinite bus is established through a series-compensated transmission line. The state equations for the d-q components of the electrical network are shown in "(15)" and "(16)".

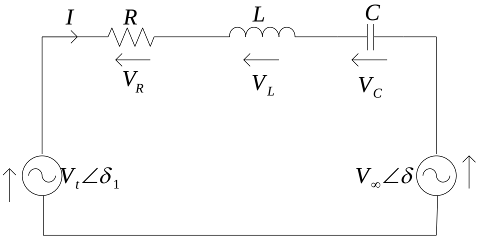

Figure 3. Electric Network Test System Model

$$\left.\begin{aligned} V_{td} &= Ri_d + \frac{X_L}{\omega_0} pi_d - \frac{\omega}{\omega_0} X_L i_q + v_{cd} + V_\infty \sin\delta \\ V_{tq} &= Ri_q + \frac{X_L}{\omega_0} pi_q + \frac{\omega}{\omega_0} X_L i_d + v_{cq} + V_\infty \cos\delta \end{aligned}\right\} \qquad (15)$$

$$\left.\begin{aligned} pv_{cd} &= \omega v_{cq} + \omega_0 X_C i_d \\ pv_{cq} &= -\omega v_{cd} + \omega_0 X_C i_q \end{aligned}\right\} \qquad (16)$$

IV. CONTROLLER DESIGN

A. Feedback Signal Selection

Optimal damping during the SSR state following a significant event, such as loss of a crucial line or a fault, is the goal of building an LQR. By permitting a larger range of operation, a properly built damping controller allows the synchronous generator and DFIG combination in the system to transmit power at an expanded limit.

With reference signals which can modify the active and reactive power of DFIG, which is situated at the generator terminal, it is first important to evaluate the modal controllability. We'll concentrate on the modes where DFIG exhibits strong controllability. The modes of interest should be easily observable in the chosen feedback output signal. In order to sort the available signals, the analysis of modal observability is evaluated. For the sake of simplicity, this analysis solely considers the generator speed deviations as available signals.

B. Power Control Scheme of DFIG

In the proposed control methodology, the direct axis of the synchronous reference frame remains stationary with respect to the stator flux. The stator resistance's influence may be disregarded and the stator flux can be kept at a constant level due to the direct connection of the stator to the grid. The stator voltage vector for a synchronous frame is given by "(1)" as,

$$v_{qs} = \omega_s \psi_{ds} \qquad (17)$$

Equations (10) and (11) can be used to calculate the stator active and reactive power because the coefficient of power for a wind turbine is always kept at its ideal value.

$$\left.\begin{aligned} P_s &= -k_\sigma \omega_s \psi_{ds}^{\omega} \psi_{qr}^{\omega} \\ Q_s &= k_\sigma \omega_s \psi_{ds}^{\omega} \left(\frac{L_r}{L_m} \psi_{ds}^{\omega} - \psi_{dr}^{\omega} \right) \end{aligned}\right\} \qquad (18)$$

where $k_\sigma = 1.5 L_m / \left(\sigma L_s L_r\right)$

The pair of equations shown below represents the necessary adjustments in the active power P and the reactive power Q to effectively control the oscillations of the rotor in a synchronous generator within a short timeframe, assuming that the stator flux stays constant.

$$\left.\begin{aligned} \Delta P_s &= -k_\sigma \omega_s \psi_{ds}^{\omega} \Delta \psi_{qr}^{\omega} \\ \Delta Q_s &= -k_\sigma \omega_s \psi_{ds}^{\omega} \Delta \psi_{dr}^{\omega} \end{aligned}\right\} \qquad (19)$$

The rotor voltage needed to control power is obtained by solving “(8)”, “(18)”, and “(19)” and ignoring the rotor resistance.

$$\left.\begin{aligned} v_{dr}^{\omega} &= \left(K_{P_Q} + \frac{K_{I_Q}}{s}\right)\left(Q_s - Q_s^{*}\right) + \omega_{sl}\frac{P_s}{k_\sigma \omega_s \psi_{ds}^{\omega}} \\ v_{qr}^{\omega} &= \left(K_{P_P} + \frac{K_{I_P}}{s}\right)\left(P_s - P_s^{*}\right) + \omega_{sl}\left(\frac{L_r}{L_S}\psi_{ds}^{\omega} - \frac{Q_s}{k_\sigma \omega_s \psi_{ds}^{\omega}}\right) \end{aligned}\right\} \qquad (20)$$

Fig. 4 depicts the schematic control diagram, in which the signal from the synchronous generator is used. The DFIG will use a signal to make up for the power exchanged by the synchronous generator during subsynchronous resonance. Only when the signal is in subsynchronous resonance will it become active.

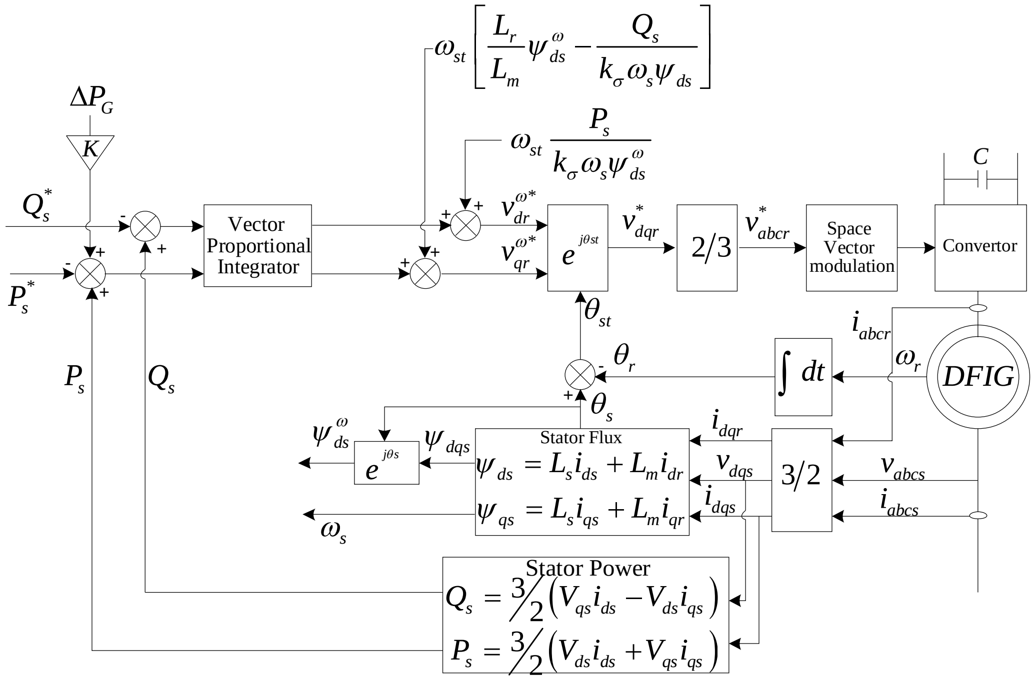

Figure 4. Block diagram of the control scheme for DFIG

C. Control Design Based on LQR

The representation of the state space linearized model of power system can be done in the following form:

$$\dot{x} = Ax + Bu + \Gamma w$$

$$y = Cx + v$$

where u is an input vector of m dimensions, y is an output vector of q dimensions, and x is an n-dimensional state vector. A stringent correct, linear, time-invariant, controlled, and observable plant is what is presumptively assumed. Additionally, w and v are the presumed uncorrelated white Gaussian noise and sensor error-noise inputs, respectively, with known covariance matrices V and W [15]. Fig. 5 illustrates the LQR control configuration.
The following quadratic cost function J can be minimized by selecting an optimal control input u, that is obtained using the LQR control method:

$$J = \lim_{T \to \infty} \frac{1}{T} E \int_0^T \left(z^T Q z + u^T R u \right) dT \qquad (21)$$

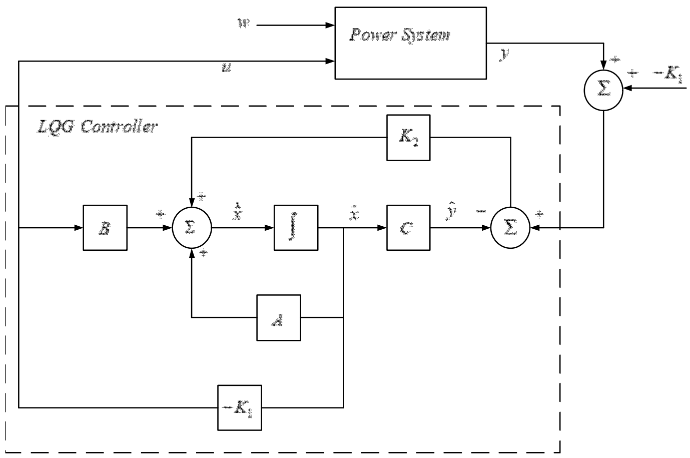

Figure 5. LQR Controller diagram

where either x or linear mixture of the states can be represented by z. $R^T = R \geq 0$ and $Q^T = Q \geq 0$ are achieved by carefully selecting the weighting parameters for the matrices Q and R. Both are often diagonal matrices. The best state feedback control law given by is computed using the reduced order system by:

$$u = -K_1 x \qquad (22)$$

Where $K_1 = R^{-1} B^T S$ and Ricatti equation's solution is obtained in form of S which is a unique symmetric semidefinite solution:

$$A^T S + SA + Q - SR^{-1} B^T S = 0 \qquad (23)$$

subject to [A] and [B] being stabilizable, R > 0, and [A], [Q] has no unobservable modes on the imaginary axis. Since it is impossible to measure every state of a plant, an estimator (Kalman filter) is used to extract the necessary estimations of the states from the accessible or measured outputs. The Kalman filter has the same structure as a standard state estimator, including:

$$\dot{\hat{x}} = A\hat{x} + Bu + K_2 \left(y - C\hat{x} \right) \qquad (24)$$

where K2 is the Kalman filter gain which minimizes $J_f = E\left\{ \left[x - \hat{x} \right]^T \left[x - \hat{x} \right] \right\}$, and is represented by:

$$K_2 = P_f C^T V^{-1} \qquad (25)$$

and the solution to the algebraic Ricatti equation is denoted as Pf, which is a unique symmetric positive semidefinite matrix.:

$$P_f A^T + AP_f - P_f C^T V^{-1} C P_f + \Gamma W \Gamma^T = 0 \qquad (26)$$

subject to [C] and [A] being detectable, $W \geq 0$, V > 0 and for $\left(A, \Gamma W \Gamma^T \right)$, there are no unmanageable modes present along the imaginary axis. Finally, the optimum control rule inside the Linear Quadratic Regulator (LQR) formulation is obtained as:

$$u = -K_1 \hat{x} \qquad (27)$$

Figure 6 depicts the suggested Linear Quadratic Regulator-based Power Oscillation Damping Controller (LQR-POD), which makes use of synchronous generator oscillations that have been measured.

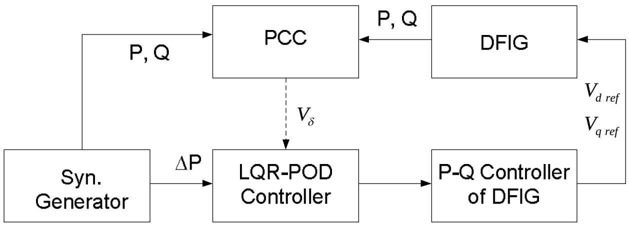

Figure 6. Proposed LQR-SSR controller for DFIG-Synchronous Generator

V. Simulation Results And Discussion

In this paper, the following cases has been examined which have a compensation of 50% and 60%.
Case A: The overall base system with DFIG.
Case B: The system in Case A is provided with a control signal derived from the synchronous generator.
Case C: The system in Case A is provided with a control signal derived from the synchronous generator, which is regulated by a LQR controller.
Two subcases with series compensation levels of 60% and 50% are tested for each of the cases. Utilising this specific level of compensation is necessary to activate various synchronous generator torsional modes. The work's goals are to do eigenvalue analyses for each of the aforementioned instances and to look into how the DFIG active and reactive power control technique with series compensation affects SSR. The evaluations of eigenvalues for the first scenario are shown in Table 2 in order to pinpoint the torsional modes with oscillation frequencies in the sub-synchronous range.
The positive real portion of a few torsional modes that are responsible for the system's subsynchronous resonance is highlighted. In contrast to the base system, the use of a Doubly Fed Induction Generator (DFIG) in conjunction with a transient active power regulation technique, using derived control signals from synchronous generators, has the potential to improve a specific torsional mode. However, it is important to note that this approach does not achieve total suppression of Subsynchronous Resonance (SSR). Although the torsional mode can be improved with the adoption of the DFIG power control method, the system's damping was insufficient.
The use of derived control signals from synchronous generators with LQR has been investigated as a way to lessen the effects of SSR and to achieve system stabilisation via the use of series compensation. Table 3 shows that using generator power deviation with LQR as an additional signal can effectively mitigate all torsional modes and stabilise the system. Even with a 60% or 50% degree of correction, all eigenvalues have negative real portions and lead to increased damping.

TABLE II. Results of Eigen Value Analysis For Case A

Series compensation level =60%	Series compensation level =50%	Oscillation Modes
0.000± 296.97i	-0.09± 293.97i	Torsional mode of synchronous generator
-0.007 ± 202.564i	-0.152 ± 203.16i	
-0.019 ± 156.74i	-0.153 ± 161.23i	
0.143 ± 126.798i	**0.186 ± 127.01i**	
0.398 ± 99.000i	-0.05 ± 98.85i	

TABLE III. Results of Eigen Value Analysis For Case B and Case C

CASE B		CASE C		Oscillations Modes
Percentage of Series Compensation		Percentage of Series Compensation		
60%	50%	60%	50%	
-0.001± 296.14i	-0.001± 298.74i	-0.008± 298.45i	-0.014± 295.47i	Torsional mechanical mode of synchronous generator
-0.007 ± 199.55i	-0.009 ± 201.51i	-0.032 ± 203.06i	-0.045 ± 201.87i	
-0.015 ± 162.52i	-0.021 ± 160.02i	-0.055 ± 165.15i	-0.078 ± 160.64i	
0.120 ± 125.97i	-0.023 ± 126.21i	-0.056 ± 122.16i	-0.049 ± 126.81i	
0.000 ± 99.510i	**0.124 ± 99.510i**	-0.009 ± 96.37i	-0.045 ± 98.81i	

Using derived equations, simulations in the time domain are also performed for cases B and C at a compensation level of 60% in MATLAB-Simulink. Figs. 7 and 8 demonstrate the time domain responses of the torque provided by the shaft between the LPA and LPB turbines of generator 1 and the mass oscillations for cases B and C, respectively, when the disturbance is delivered at t = 6 seconds. Time domain simulation findings confirm the outcomes of the analysis done of eigenvalues.

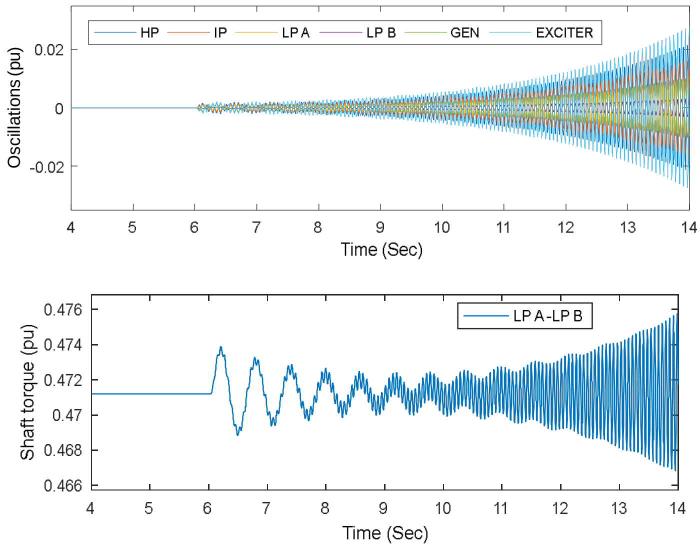

Figure 7. Oscillations Exhibited by Various Masses and Resulting Torque Exerted on LPA-LPB Shaft of a Generator, For Case B.

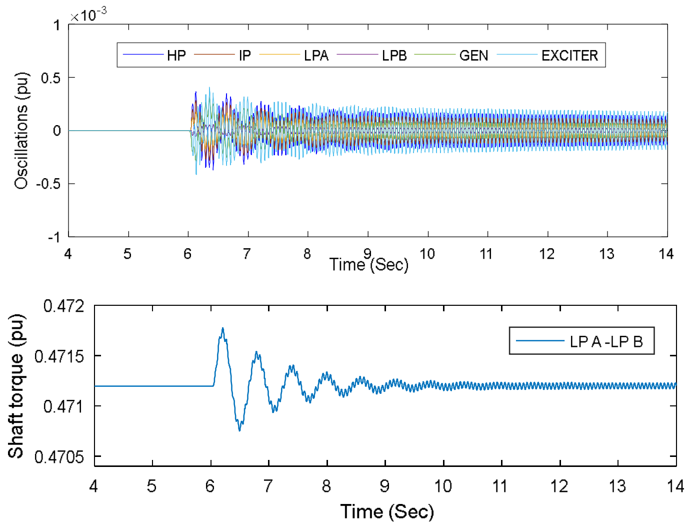

Figure 8. Oscillations Exhibited by Various Masses and Resulting Torque Exerted on LPA-LPB Shaft of a Generator, For Case C.

VI. Conclusion

This work uses state space modeling of different electrical components collected from IEEE FBM to investigate the impact of a power flow controller with LQR on subsynchronous resonance (SSR) in the selected test system. The occurrence of subsynchronous resonance (SSR) may be attributed to the presence of a series capacitor in a transmission network that is equipped with a certain amount of compensation. This study presents a systematic method to transient modeling of Doubly Fed Induction Generators (DFIG) with variations in the active and reactive power control loop. The modeling process incorporates varied component models to accurately represent the system dynamics. Two alternative compensation levels, 50% and 60%, are regarded as the most exciting modes for the turbo generator. According to eigenvalue analysis and time domain simulation, the DFIG cannot successfully dampen all of the generator's torsional oscillations when it is used with only its power control loop and a supplementary signal from the synchronous generator. When the Doubly Fed Induction Generator (DFIG) is used in combination with Linear Quadratic Regulator (LQR) and an extra signal derived from the power oscillation of the turbo generator, it is possible to dampen all torsional modes. This holds true even when the compensation level matches the natural frequency of the turbine-generator system.

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Smart Parking System using IOT

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***Abstract*— Due to the growing number of automobiles on the road, there is a significant increase in demand for parking spots in metropolitan areas. Therefore, motorists constantly struggle to find good parking spots. Moreover, the existing parking system is ineffective, and also long lines and traffic jams are caused due to manual issuing of parking fees. In order to address these issues and offer a hassle-free parking experience, there is an urgent need of an automated parking system. Therefore we came up with an idea of creating an Internet of Things (IoT)-based smart parking system that makes use of an Arduino, PIR sensors, and stepper motors for the barrier in order to address these issues. This type of parking system would rather enhance a user's parking experience, thus saving them time and effort. The barrier system will be automated through the use of PIR sensors and stepper motors, enabling automation of gate entry and exit, thus minimizing the need for manual intervention. The proposed system intends to offer hassle-free parking for car owners while providing parking lot owners with a dependable and effective parking management system.**

***Index Terms*— Smart parking system, IoT, Automation, Arduino, Vehicles.**

I. INTRODUCTION

Due to an exponential increase in automobiles in the world, parking has become a significant problem. It is tough to find parking places, which causes gridlock and wastes time. Moreover, the current traditional parking systems cannot manage the expanding number of vehicles. An IoT-based parking system can help tackle this problem. Electronic items like Arduino, PIR sensors, and a stepper motor can be used in the system. Both parking lot managers and car owners will benefit from the seamless and effective parking experience offered by the IoT-based parking system

A. Motivation

The current traditional parking system is marked by inefficiency, leading to traffic jams, time and fuel wastage. Consequently, it serves as a primary driver for the development of an Internet of Things (IoT) based parking solution. These concerns can be addressed, and the overall parking experience can be enhanced through the implementation of an automated parking system. Our proposed system aims to give vehicle drivers a piece of real-time information on parking availability, enabling them to rapidly discover an empty parking spot. This will improve the overall parking experience for drivers and enhance the efficiency and cost-effectiveness of parking lot management.

B. Objectives

The following are our project goals:

- To create a system that utilizes PIR motion sensors to reliably and accurately sense the presence of

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automobiles while entering or exiting or while present in a parking lot.

- To use a stepper motor-based barrier system that can be remotely controlled via IoT to regulate entrance to the parking lot.
- To design a user-friendly dashboard for regulating entry and keeping an eye on the parking lot.
- To advise consumers in real-time about parking availability in order to maximize the usage of available parking spaces.
- To make manual parking lot administration and monitoring less time- and labor-intensive.
- To offer a scalable, affordable solution that is simple to use in various parking facilities.
- Increasing the security of the parking lot by spotting and reporting any unauthorized activity.

C. Contribution

Our system proposal makes the following contributions:

- Supplying useful information to municipal planners and decision-makers will help them plan infrastructure and parking rules more effectively.
- Lowering the time spent looking for parking spots which will improve traffic flow, ease congestion, and reduce carbon emissions.
- Establishing a practical and economical parking management system.

II. LITERATURE SURVEY

A smart parking system prototype is developed in the paper with the aim to find empty parking slots without manual efforts which can save time and effort. A wireless sensing network is made that can sense the availability of slots and the collected data can be stored on cloud which can be further analyzed and the information can be accessed from it using the mobile app. Also from the sensory data collected, some informative data is also evaluated. Ref. [1] As population is increasing day by day so to find parking slots is becoming a serious issue in big cities. Ref. [2] With the advancement of IoT, the above addressed issue can be solved. The review on various papers in recent year is presented in order to investigate about different models, sensors and technology which can be integrated and used so as to build a system which can manage the parking slots and can save time, energy, fuel and subsequently carbon footprint.

Ref. [3] With the increase of issues arising like global warming, parking problems, etc. because of growing transportation, the paper presents the system capable of finding the vacant spaces for parking which will in turn reduce the effort of searching the whole area. The prototype is created using IoT which can detect the presence of vehicles and on that basis can update the application for the user to get information for the same. Also some drawbacks are mentioned considering the modern world. Ref. [4] With the challenge of parking of vehicles faced by all smart cities due to which their valuable time, effort and energy is wasted and also fuel consumption increases in order to find the slots for parking, the paper represents a parking system SCPMS that is based on sensors. Basically, the system identifies the available space for parking and updates it at the display counter of main parking. So, this functionality is useful for users to find the slots easily and book the parking. As a conclusion, manual effort gets reduced and in less time the parking slot is identified which in turn helps to save fuel and avoid traffic.

Ref. [5] In order to address issues like traffic congestion, inadequate automobile parking facilities, and road safety, urban towns are continuously seeking solutions that are as dependable and productive as possible. This work thus describes an IoT-based smart parking system which also integrates cloud, which entails the deployment of an IoT eco-system on-site to trace and signalize the vacancy of each parking space. Additionally, an application on the smartphone is made available, which enables the users to reserve a spot by checking the availability of parking spaces. Ref. [6] A system is proposed in the given paper which tells the user about the parking space, verifies them using the mobile technologies and according to the length of the vehicle the slot is given which is then daily analyzed on the basis of the data collected of leaving and coming of vehicle. For the purpose of deciding the slot availability, IR sensor is used. Using Wi-Fi module and microcontroller, data is accessed and send to the server where it is analyzed. RFID label is used to validate an individual and the Mobile App id designed to give a good user experience.

Ref. [7] The process to find the parking slot is very time consumable in big cities. If parking is unavailable, then it may lead to traffic and can create problems. So to have a reliable, secure and accurate solution to this issue, a system is designed which can solve the problem faced in today’s time. The proposed system is the combination of IoT and android applications which can help to meet its requirements of finding the parking spaces in short span of time and thus saving the energy, fuel, time and efforts. The system also gives the feature of prebooking the slot

so that the time is saved. From the results it was analyzed that the system is 70% accurate and more efficient than other existing solutions. Ref. [8] Adaption to Internet of Things (IoT) can be helpful in finding the place for parking with ease. In the work, a Smart Car Parking System (SCPS) is designed using IR sensor and a database that also permits the driver for parking and shows the slots available.
Ref. [9] The inconvenience of finding a parking space is becoming a major issue for people in the cities. The traditional method of physically searching for spaces is time and effort consuming which also leads to traffic jam. To overcome this problem, a system is designed using Raspberry Pi 3, an ultrasonic sensor, a Pi Camera, and Python IDE for software. The system detects presence of vehicle and also make the payment method easy through mobile app. Ref. [10] Typically, the Internet of Things is utilized to construct a smart parking system which makes use of web-based technology, a map-view application for parking lot availability, wireless sensor network controllers, and car presence sensors.

III. METHODOLOGY

As part of our process, we first determine the requirements for the smart parking management system using an iterative development approach. Following that, the system architecture was developed together with the selection of the hardware and software components. The technique was then tested with a prototype before being put into use. Following system improvements based on test results, the process was repeated until the desired results were attained. Fig. 1-shows a brief idea about our system.

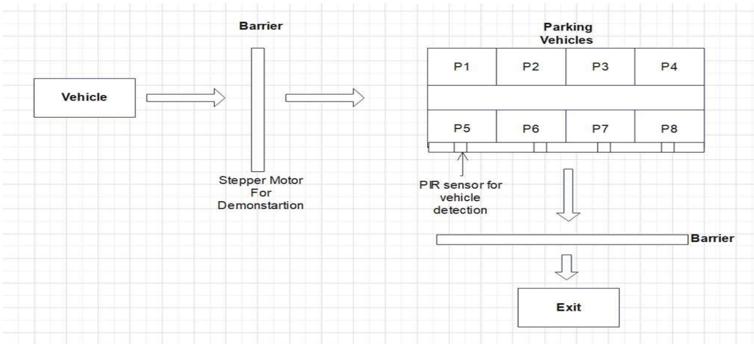

Figure. 1. High level design for the smart parking system

IV. PROBLEM DESCRIPTION

To ensure that parking is managed more efficiently in light of the growing count of vehicles on the road, better parking solutions are required. With the use of IoT, the suggested solution seeks to offer a smarter parking management system. When a vehicle is present in a parking place, the PIR sensors will detect it, and it will then use the internet to send the information to the central server. Drivers can then access the availability of parking space through a mobile app or it can be displayed on a board after the server has processed the data. The barrier will also be powered by a stepper motor that is managed by the central server in the system. Whenever a car wants to enter a parking spot, the barrier will automatically open, and it will close when the car pulls out. This will ensure that only authorized vehicles are using the parking area and stop unauthorized access. In conclusion, the suggested approach intends to address the shortcomings of conventional parking systems by supplying real-time parking availability information, decreasing the time wasted on looking for parking spots, and preventing unauthorized access to parking spaces.

V. MODELLING APPROACH

A. Assumptions

Our system makes the assumption that every part will work together seamlessly. The model also assumes that the component has no internal resistance, which means that its voltage does not decrease with use. Additionally, it is assumed that the system will function flawlessly and that all connected devices will appropriately reflect the slot availability.

B. Justification

There are many reasons to use Internet of Things (IoT)-based smart parking systems, including:

Effective utilization of space: By directing cars to available parking spots and saving them the time required and fuel consumed for driving around searching for a parking place, smart parking systems can maximize the utilization of parking space.
Real-time data: Smart parking systems can give drivers real-time information on the vacancy of parking places, easing their stress and aggravation. Real-time parking spot availability can be checked by drivers using a smartphone app or other device, and if a spot is available, it can be reserved.
Reduced traffic: Smart parking systems can aid in reducing traffic congestion in congested regions by directing drivers to available parking spaces. As a result, air quality may be enhanced and greenhouse gas emissions may be decreased.

VI. Implementation

The following components are utilized in the parking slot management system:
Arduino: Arduino is an open-source electronics platform with straightforward hardware and software. Users can build software for the board and upload it to the board using these components, which come with a microcontroller board and a programming environment. The system for detecting spots, transmitting information to the user, and managing the operation of barriers is programmed using an Arduino board (as shown in Figure 2) in our project.

Figure. 2. Arduino UNO

Figure. 3. Passive Infrared Sensor

Passive Infrared Sensor(PIR): PIR sensors (as shown in Figure 3), are machines that continuously scan their range of view for variations in infrared radiation. To detect the infrared radiation emitted by moving objects and living organisms, PIR sensors are often used in motion detection systems. They are utilised in the system because, thanks to the heat produced by the vehicles, which the sensor can detect, they can quickly identify both the presence and absence of automobiles.
Servo Motor(as shown in Figure 4): Automation, robotics, and control applications typically use an electric motor known as a servo motor. Servo motors provide for exact control of the position, speed, and acceleration of a shaft or other mechanical parts. A servo motor consists of a rotor, stator, and feedback control system. It is used in the system to manage the barriers and to verify vehicle entry and exit.
LCD: An LCD (as shown in Figure 5) 16x2 display has two rows of 16 characters each and is a type of alphanumeric display. The Liquid Crystal Display (LCD) technology is used to display characters, which is often used in electrical items like calculators, digital watches, and other consumer gadgets. These displays will be employed in the system to alert users of the presence and absence of vehicles, making it simple for them to identify an empty slot.
Potentiometer: A potentiometer (as shown in Figure 6) is an electrical device that controls the resistance of a circuit. It consists of a moveable contact attached to it and a wiper that moves over the resistive element when it is spun. Potentiometers are widely employed in systems to control a display's brightness or contrast.

Figure. 4. Servo motor

Figure. 5. Liquid Crystal Display

Figure. 6. Potentiometer

Here's how a smart parking system utilizing a PIR sensor and Arduino Uno works:

- PIR sensors are installed in each parking spot. These sensors sense the heat emitted by the car in order to detect the presence of a vehicle.
- Further the data is transmitted to a central server to be processed and analyzed, which is collected by the sensors. The server uses the data to identify which parking spots are vacant and which are not.
- This information is then displayed on a digital sign at the entrance of parking lot, indicating the number of available spots. And then we can choose the parking slot if available.
- When a vehicle enters a parking spot, the PIR sensor detects the change in infrared radiation and updates the server accordingly indicating that the space is now not available. And when the vehicle leaves, PIR sensor detects the absence of heat and updates the server that the space is now available.

VII. Analysis And Discussion

A network of interconnected devices and sensors that collaborate to optimize parking space utilization and make parking for drivers easier is an IoT-based smart parking system. This ecosystem may gather data on parking occupancy, vehicle movement, and other relevant variables, and utilize this data to guide drivers about parking spaces that are available in real-time. The following elements make up the analysis of an IoT-based smart parking system:

Hardware: Sensors, cameras, gateways, and controllers are frequently found in smart parking systems. While the cameras can take pictures of the vehicles and their license plates, the sensors can identify the presence of cars in parking places. Data from the sensors and cameras can be processed by the gateways and controllers before being sent to a centralized server. Additionally, there were certain difficulties with the system's algorithm and sensor integration. But overall, it can be concluded that the system is dependable, effective, and valuable for reducing the amount of traffic in cities.

VIII. Simulations And Validations

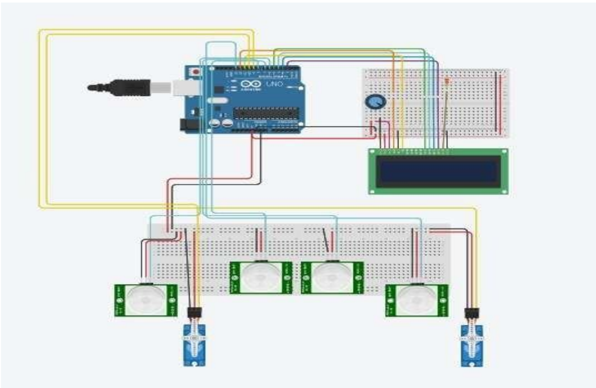

Figure 7. The system design on Tinkercad.

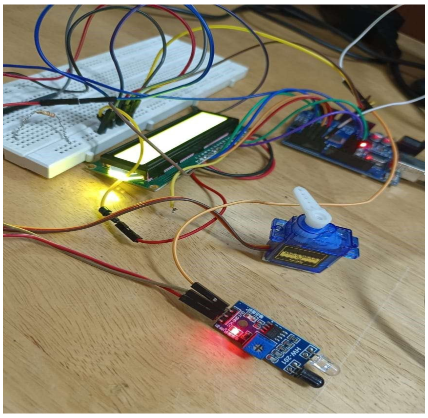

Fig 8. Implementation using all components as mentioned.

IX. Contributions And Implications

The implementation section's smart parking system using IoT project has various important consequences and contributions. First, the initiative advances the development of autonomous parking space identification, making it easier for vehicle drivers to locate parking spots. One can quickly and efficiently identify the free space without losing time or effort by integrating various technologies such verifying algorithms, sensors, and motors. This can be advantageous at a variety of locations, including campuses, malls, markets, etc., reducing transportation congestion and the rise in global warming in major cities.

Overall, the contributions and implications of the parking system using IoT are significant. The project demonstrates the potential of system to search for free spaces efficiently in dynamic environments, and it highlights the accessibility and affordability of technology. These contributions and implications have the potential to impact various fields and pave the way for the development of new and innovative applications. The results show that the system accurately and efficiently detects the absence and presence of vehicle and displays it on the LCD. Figure 3 – Shows the simulation of the system.

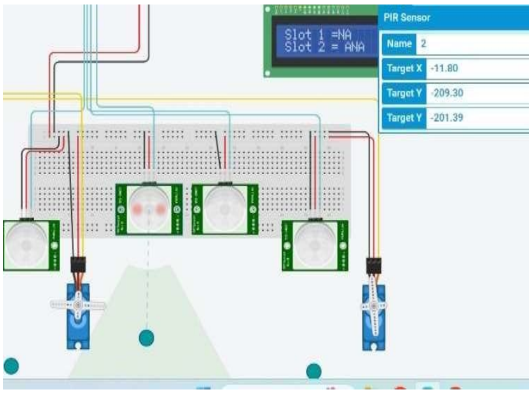

Figure 9. The output for the project on Tinkercad.

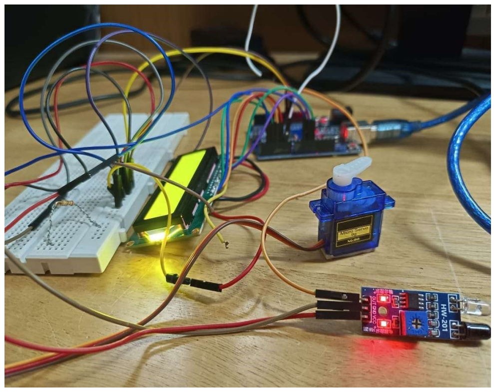

Fig. 10. The output for the project shows the presence of the car.

X. Conclusions

As a result, we have created a parking management system using Arduino and PIR sensors which is a useful and efficient solution for managing parking spaces. The system is capable of detecting the presence of a car or a bike in parking slots and thus provides information regarding the parking spaces in real time. The system is very easy to install and can be adapted to suit the specific requirements of different parking areas. Other technologies such as mobile apps and other cloud-based systems can also be integrated for remote monitoring and management.

Overall, the system is an economical and reliable solution for maximizing parking spaces and improving the parking experience of users.

Limitations And Future Scope

There exist a few issues with our work which can be resolved in later iterations. The work initially focuses only on managing slot availability. The addition of a pre-booking system and mobile application-based payment can further improve it. Moreover, adding a camera that can capture the motion of cars and update the system with AI/ML can also be implemented. Future studies can also examine the security benefits of user and vehicle authentication by QR scanning or number plate detection.

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Stability Analysis of Multi-Source Power Generation Systems with Automatic Generation Control using Fuzzy Logic Control and I Controller under Load Variation

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***Abstract*— High Penetration of renewable energy with conventional power system increases the system instability problem during recent year. Load frequency control (LFC) is a valuable part in controlling the smart power system. In this paper create a model for automatic generation control with wind power system using fuzzy logic controller (FLC) in single area power system. It is very important to control the integral load frequency while generating thermal and wind. In this paper integral controller is used to obtain the value of FLC. All FLC controllers are to be analyzed and ultimately compared with existing controllers. And finally, it is proved that the calculation done on the basis of FLC is much better than the existing control schemes.**

***Index Terms*— Wind power generation, AGC, Fuzzy logic controller, I Controller, Stability Analysis.**

I. INTRODUCTION

Controlling the power output by changing the system frequency when the load changes is called Load Frequency Control (LFC). LFC is a part of automatic power control (AGC) used in power generation and control [1]. It is very useful in power systems to activate the original output from the generating units which are intrinsically linked after variation in the frequency of the system and equal power replacement.

By implementing specific control methods that are employed in the design of LFC, the dynamic performance of the system is developed. Among many other kinds of LFC, straightforward conventional controllers are frequently utilized [2]. Because of their ease of realization, inherent qualities, low cost, and simplicity, these straightforward controllers are well-known in industries. In order to obtain the Area Control Error (ACE), which is a combined version of errors in frequency exchange of net as the signal for controlling purpose, the integral scheme for controlling in conjunction with conventional scheme are primarily used in the power industries. The traditional approach using the proportional integral controller typically results in bigger overshoots in the transient frequency deviation. Additionally, fixing the frequency deviation takes a lengthy period [3]. Although conventional controlling schemes are frequently employed as secondary schemes and are well recognized for their simplicity, they cannot be guaranteed to provide a superior response that is dynamic in some circumstances [4].

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Mishra and Nanda described the AGC computation, which uses both traditional integrals and fuzzy controllers. A location addresses a cohesive group of generators, meaning that their f-frequency deviations are equivalent. Automatic load frequency control (ALFC) refers to the problems with the output power of electrical generators at a specific location due to variations in the tie-line and frequency to ensure the maintenance of interchange and scheduled frequency between other locations.

In remote and rural places where installing electric lines is challenging due to price, right of way restrictions, or environmental considerations, wind power resources are the most cost-effective source of electrical energy [6]. Diesel generators are typically used to create wind resources since they are unpredictable or fluctuate in nature. High reliability is provided by the wind-diesel power generation to increase power to the isolated load. Nevertheless, because the active power requirements of the isolated community vary often, the huge and severe variation of frequency is brought on by the disparity between the generation and load. System device will be disrupted if the deviation could not be controlled and kept within the permissible range. Additionally, the system can become unstable [7].

In AVR and AGC, fuzzy logic controllers are used. Analysed are a large number of triangle-shaped membership functions (MFs) that provide a good response. Fuzzy PI controller has the following benefits: (i) it provides a better approach to copy with incorrect information; (ii) it allows for flexibility in decision-making; and (iii) it provides a good machine/human interface by adopting a human rule for extracting information and by following a logic for the explanation's conclusion [8].

In section (2) explain single area system in thermal, wind briefly with problem formulation. Optimization technique (Fuzzy logic controller) explain in section (3). Finally result analysis and conclusion briefly explain in section (4) and section (5).

II. SINGLE AREA SYSTEM

A. Thermal power system

The steam produced in the boiler flows to the turbine blades, where it is converted into mechanical energy, in the thermal model that is being discussed here [1]. This model was chosen for ease of comparison and execution. This energy is changed into electrical energy by employing a generator. Thus, the steam turbine is the focus of the thermal power plant concept. Open loop systems are not employed because the power supply exhibits frequency variations and an erratic nature without a controller. The proper controller gains are used with closed loop systems. single area thermal system is perturbed by 1% steps. Without a controller, the thermal system's reaction is unstable, thus an integral controller value is computed (K_i=0.047) through trial and error. After the influence of the controller, the controller significantly increases the system's stability, and the system is approximately stable at 19s, with a pear over shoot of -0.043.

B. Wind power system

In ref, the transfer functions of wind power system operations with and without pitch controls are primarily investigated. Without the pitch controller, there will be greater variations in a typical step disruption. The fluid coupling serves as the tie line foundation in this arrangement. The change in power is the result of fluid coupling and frequency variation. This is seen as a feedback reaction that links the two systems. The thermal system receives 1% of the step disturbance for each individual reaction. The specifics of a wind system's architecture have already been covered in ref. [9]. The response of a wind system without a pitch and I controller is examined there as well [10]. Changes in wind speed create steady-state errors of 0.052 magnitudes and oscillatory responses from the wind system for both disturbance signals. In order to maintain system stability and prevent wind system components from being harmed by excessive wind speed variation, the steady state error must be under control. There are no matches between the load and generation under standard processing circumstances. The production as a whole is given by Equation (1)

$$P_G=P_{Gth}+P_{GW} \tag{1}$$

Where: $P_{Gth} = K_{th}\, P_G$, $P_{GW}= K_w\, P_G$ K_{th} and k_w stand for the proportions of thermal and wind power generation to total power generation, respectively. The total load dispatch affects the values of Kw and Kth. Equation (7.1), for small perturbation, can be written as:

$$\Delta P_G=\Delta P_{Gth}+\Delta P_{GW} \tag{2}$$

From equation (7.2), under normal operating condition and loading $P_G=P_L$=1.0 P.U, we have

$$K_{th}+K_w= 1.0 \tag{3}$$

By adjusting the speed-varying signals, the ungoverned system becomes governed. It is believed that the automatic manipulation of P_{Cth} and P_{CW} by thermal and wind power plants helps to control load frequency. The thermal system and the wind system were initially investigated individually in this paper, both with and without a controller. The performance of the system was also examined, even when the system loads and parameters were changed.

III. FUZZY LOGIC CONTROLLER

The FLC architecture can be broken down into three categories: allocating inputs to certain regions, figuring out the rules associated with inputs, and defuzzing output to its original value [11]. Determining the process states and control output: The initial stage focuses on choosing the appropriate input signal for the fuzzy logic controller. The content of the rule base antecedent is represented by a selection of process state variables for this controller.

- ACE and ACE change. ACE versus ΔACE
- ACE and change in frequency (ACE Vs Δf)

ACE and change in ACE are selected for the controller created for automatic generation control.
Fuzzy rules: The guidelines used when employing fuzzy controllers are listed in the table 1. The following examples show how the rules work: if ACE is NLa and ACE is NLa, ACE-out is NLa; if ACE is NSm and ACE is NLa, ACE out is NLa; etc. The "Mid-max" rule for "and" and "or" was implemented in the formula as a result. The challenges resulting from measurements and time are reduced to a minimum with this method. Since they differ from the norms, ACE is given far more attention than ACE. As a result, the ACE location with greater influence in this region is allowed to have a dead band on a variation basis.

TABLE 1: RULE BASE FOR THERMAL, WIND AND THERMAL+WIND SYSTEM

DEL ACE \ ACE	**NLa**	**NSm**	**ZEr**	**PSm**	**PLa**
NLa	NLa	NLa	NSm	NSm	ZEr
NSm	NLa	NLa	NSm	ZEr	ZEr
ZEr	NSm	NSm	ZEr	PSm	PSm
PSm	ZEr	PSm	PSm	PLa	PLa
PLa	ZEr	ZEr	PSm	PLa	PLa

Numerous membership function types, including triangle, bell, trapezoidal, and Gaussian, are available in fuzzy logic inference systems. The rule base and membership operations are tightly related. In Automatic generation control (AGC), the FLC must react more quickly to every change in the ACE. Flow Chart for the Proposed FLC in Thermal+Wind generation system as shown fig. 1

IV. RESULT ANALYSIS

The effectiveness of a single area has been discussed how to use a traditional I controller, a fuzzy logic controller, and a MATLAB SIMULINK model for a thermal, wind, and thermal+wind system. A controller for fuzzy logic with input, output, and feedback gain. FLC analysis demonstrates that it enables quick and effective dynamic reactions. The optimal gain K_t for the thermal area of the 5-membership function is 0.07, while the optimal feedback gain K_t for the wind area is 0.01, respectively. The FLC is superior, as can be seen from the comparison of the traditional I controller in the following figure 2, 3, and 4. The FLC requires less time for settling than the traditional I controller.

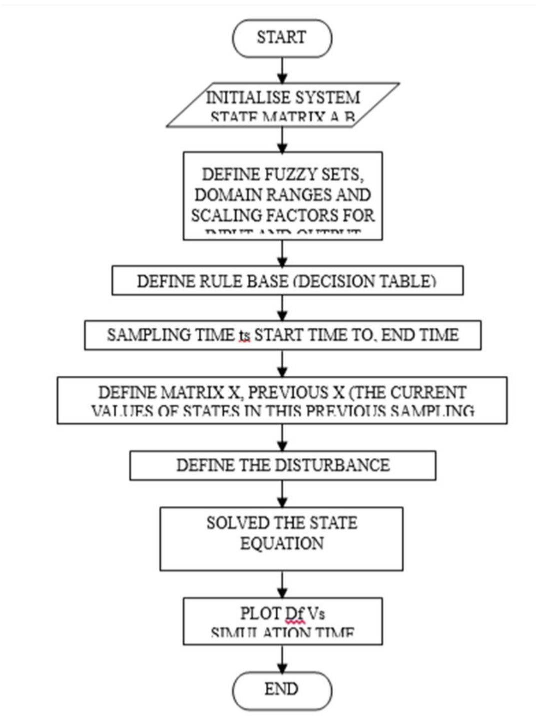

Figure 1 Proposed Flow chard for FLC in Thermal+Wind system

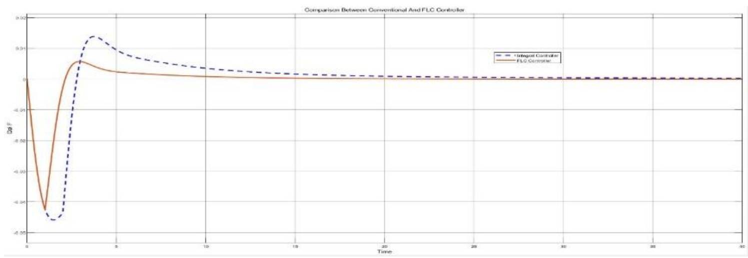

Figure 2 Performance comparison for a single area thermal system using conventional and FLC controllers

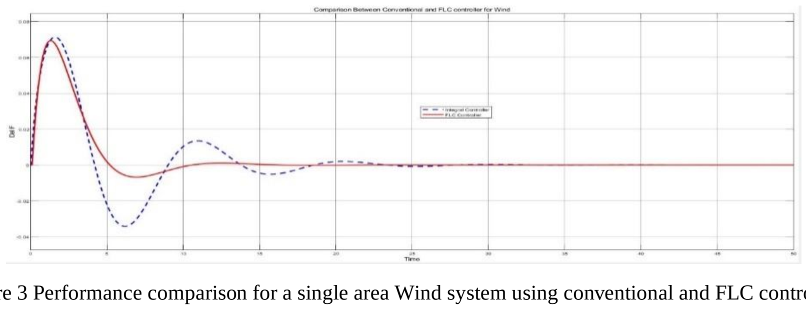

Figure 3 Performance comparison for a single area Wind system using conventional and FLC controllers

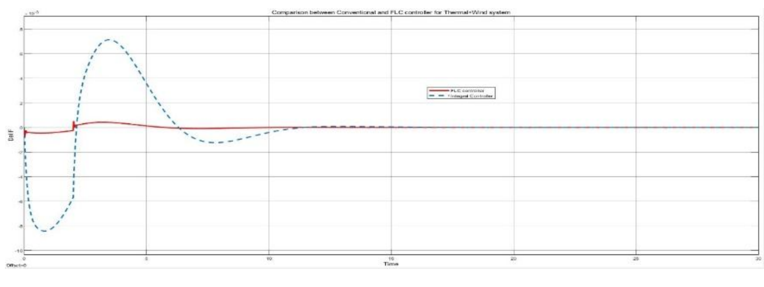

Figure 4 Performance comparison for a single area Thermal +Wind system using conventional and FLC controllers

Table 2 clearly proves that an FLC-based integral controller performs better when compared to a traditional controller by displaying the time required for peak settling and overshoot in a thermal, wind and thermal+wind system located at a specific location.

TABLE II: ANALYSIS BETWEEN CONVENTIONAL I CONTROLLER AND FUZZY LOGIC CONTROLLER

S. No.	Systems	Parameters	Conventional I Controller	Fuzzy logic Controller
1	Thermal power system	Settling Time (Ts)	24 Sec	13 Sec
		Peak overshoot (Ms)	0.044	0.04
2	Wind power system	Settling Time (Ts)	23 Sec	11 Sec
		Peak overshoot (Ms)	0.078	0.064
3	Thermal+Wind power system	Settling Time (Ts)	13 Sec	10 Sec
		Peak overshoot (Ms)	0.009	0.004

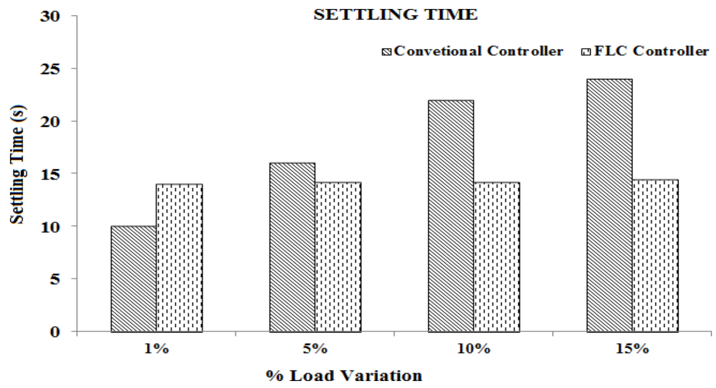

FIGURE 5: Performance comparison of a single area, multigenerational system using conventional and FLC controllers for settling time

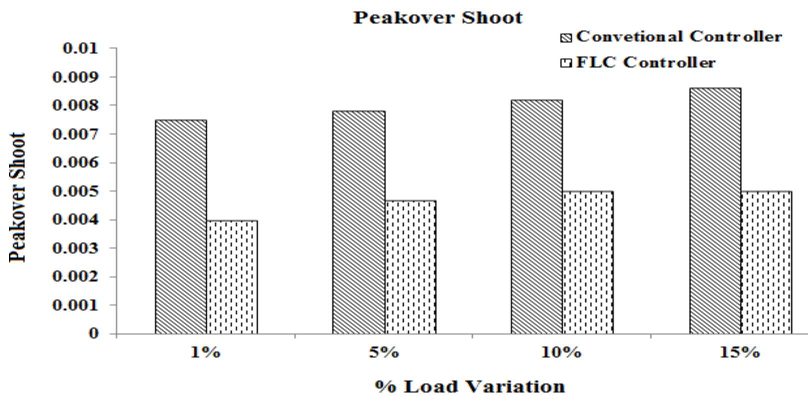

FIGURE 6: Performance comparison of a single area multigenerational system with conventional and FLC controllers for Peak Over Shoot

Simulated integral controller gains for the suggested systems are obtained from the FLC, and the outcome demonstrates the time-domain evolution gradually. It has been demonstrated that the FLC governor in use is more effective than a traditional controller controlled by a Ziegler mechanism. Furthermore, because more system tool knowledge is not required, the suggested controller is simpler and easier to build. The typical area multi-source has been processed for various future generations for a variety of loads with a difference of ±15% and ±15% from the assigned value in both locations, and the scheduled power production from Thermal+Wind system are regulated to adapt with the typical operating load as shown in Fig. 5 and 6.

V. CONCLUSION

The FLC dependent load control of a specific location with thermal and wind resources is examined individually in this study, and the two systems are then combined into a single generator made up of implemented and existing governors. Due to differences in the loads, the controller's traditional integral components need to be adjusted. The transient computation will grow if the wind and thermal productions are higher. The system should be designed to inhibit the dynamics of the power resources in order to determine the gain of the controllers. Results obtained fuzzy logic control structure used for load frequency control for the single area power system its supremacy over the conventional controller.

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Smart Mobility Assistive Device for Paretic People

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***Abstract*— For individuals who are physically challenged, there are currently plenty of smart gadgets available. Existing technology does have several significant disadvantages, such as the cost and accessibility to an average person. The wheelchairs of today are also heavy and challenging to physically transport from one place to another. The efficacy of contemporary wheelchairs equipped with advanced robotic technology in improving the overall well-being of those with disabilities is hindered by their exorbitant price, technical constraints, and safety concerns. To address the aforementioned issue, the present research study proposes the implementation of a technologically advanced wheelchair controlled using smart gestures. For the elderly and the disabled to move around, wheelchairs and similar assistive devices are required. However, because it requires help from others to move, hand gesture-controlled wheelchairs can help individuals with physical disabilities by enabling them to move the chair on their own with a few simple gestures. The suggested prototype would be highly beneficial to them since it will allow them to operate the wheelchair with their hand gestures, through which the wheelchair's directions may be changed and be used to navigate. This system can be controlled by a microcontroller (Arduino). It is clear from the findings that the proposed research has designed a wheelchair prototype that is affordable, and gesture controlled.**

***Index Terms*— Assistive device, microcontroller, modern wheelchair, paretic patients, smart gesture control.**

I. INTRODUCTION

About 2.68 million persons, or 2.21% of the population, in India as of the 2011 census are disabled. The WHO estimates that 75 million individuals in the year 2019 regularly use wheelchairs. This is equivalent to 1% of the entire global population. Every rural and urban area of India has seen an increase in the percentage of people with disabilities. A medical condition or accident could have resulted in the handicap, or it could have been inherited. Since they must rely on others for their mobility, it is quite challenging for disabled people to independently fulfil their everyday tasks [1].

Every human life deserves the opportunity to live normally. But due to impairments or various unanticipated circumstances, many of us cannot independently perform everyday duties or move about securely. The inability to do any task or difficulty in performing the same is referred to as a disability. The number of physically impaired individuals is unfortunately increasing. A wheelchair or any assistive device is necessary for people who are

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paralyzed, have fatal leg injuries or hemiplegia, or have different sorts of neurological and brain injuries, or have lost their ability to walk or move independently. [2].

By combining this gesture technology with the typical wheelchair, individuals with disabilities can be assisted in a variety of ways to carry out their routine daily duties. The development of an affordable, user-friendly smart wheelchair is essential for assisting paretic individuals from disadvantaged backgrounds. The primary impetus for our research is from our commitment to enhancing the quality of life for those with physical impairments and socio-economic disadvantages. Our proposed solution is simple and cost-effective.

This study describes a smart, affordable wheelchair system that may be operated with simple finger signals and movements. To operate a wheelchair, all users need to do is move their fingers and show the gesture. It has straightforward operations and uses less energy. The suggested solution does not require joystick use or external sensor wire because it detects motion and gestures using an external camera.

The five gestures that are considered in this study are STOP, LEFT, RIGHT, BACKWARD, and FORWARD.

The final section of this work is outlined as follows: a literature review has been conducted to assess the status of research on smart wheelchair, which is described in section II, to identify the research gaps between the existing work. We have outlined our suggested methodology in section III. Requirement and utilization of Hardware and Software is presented in Sections IV, and V, respectively. Section VI contains the results and discussions of the analysis. Section VII contains the features of the proposed model. Section VIII presents conclusion and future scope of the work.

II. Literature Review

The features and safety of smart wheelchair technology continue to be improved by researchers and engineers. Recent years have seen development of several intelligent mobility systems which use different control methods [2]. For the current research article review of several relevant publications are being referred to provide an efficient and better response. By pointing out a lack of research, this part helped to propose an alternative solution for the existing objective.

Rajeshree Khande et al. have designed the Smart Voice and Gesture Controlled Wheelchair [1]. The proposed model in this study will have improved accuracy because they used The Voice Recognition Module-V3, which can recognize any seven vocal commands at once from a collection of 80 instructions. Muhammad Sheikh Sadi et al. have designed the Finger-Gesture Controlled Wheelchair with Enabling IoT [2]. In this study, a clever, reasonably priced wheelchair system is described. It may be controlled using basic finger signals and motions. Therefore, there is no need to use joysticks or any additional sensor circuits in the proposed system for detecting movement and gestures using a simple RGB camera of 1 mega pixel with 30 fps at USB cable connection. Sarnali Basak et al. have designed the Gesture-based Smart Wheelchair for Physically Challenged People [3]. The proposed research work is about a gesture-based smart wheelchair system that can recognize hand movement using gestures or 3D hand movement detection technologies.

Amar Paljeet Cheema et al. proposed a fully wireless electric wheelchair with quadriplegia individuals and home automation using IoT. To simulate the motion of full handsfree electric wheelchair, an accelerometer sensor, a cell phone RF transceiver, a Handoff module, and an Arduino microcontroller are integrated [4]. The three main parts of the proposed framework are the speed increase sensor, the RF (radio recurrence) transmitter, and the RF (radio recurrence) collector. A literature review on smart wheelchair has presented by Kedar Sukerkar et al. in [5]. The fact that an electric wheelchair contains a computer and multiple sensors is the only distinction between a smart wheelchair and one without. Intelligent wheelchairs are easy to use and provide the user with outstanding safety. The current state of the art and possible research directions are covered in this essay. Muzhal Ghaffar et al. has developed an Assistive Smart Home Environment using Head Gestures and EEG Eye Blink Control Systems [6]. To develop a system to allow users to operate room lighting, air circulation, security lock management and wheelchair navigation, the study uses an approach based on head tilt movement and sets of blinking eyes. R.R. Bhambare et al. have presented smart wheelchair control using voice and gesture control. The authors have developed an intelligent wheelchair control system that can detect hand gestures and voice commands for the purpose of helping people with disabilities. It is a wheelchair that just requires simple hands and verbal gestures to operate [7].

Mubdi-Ul Alam Sajid et al have designed an intelligent wheelchair for handicapped people that functions based on body movement. The semi-autonomous wheelchair that allows the user to maneuver it however they see fit is the main topic of this study. With the help of this wheelchair, a crippled person with limited mobility and freedom can move around [8]. Advances in Smart Wheelchair Technology and the brief history of wheelchair prototype designs and the most recent advancements in intelligent wheelchair technology are presented in [9]. A Smart

Autonomous Wheelchair was developed to enhance self-driving wheelchair utilizes computer vision technology to facilitate forward movement and perhaps replace conventional control mechanisms such as head joysticks, sip-and-puff controls, chin joysticks, and thought-controlled wheelchairs [10].

III. PROPOSED METHODOLOGY

By designing the motion control wheelchair with the use of hand gestures, the authors of this paper put forth a useful and affordable solution. The chair can be controlled by hand gestures such as the thumbs up for the FRONT, the palm hand to STOP, the peace sign for the LEFT, the OK hand for the RIGHT, and the thumbs down for the BACK. Additionally, these inputs can be modified based on the user's preferences. Fig 1 represents schematic of hand gesture unit. Fig 2 shows the hand-gestures integrated to the chassis. Fig 3 illustrates the block diagram of smart wheelchair. The aim was to create a wheelchair that was both inexpensive and equipped with all the features required for individuals with disabilities to use it and go about their everyday lives without any difficulties.

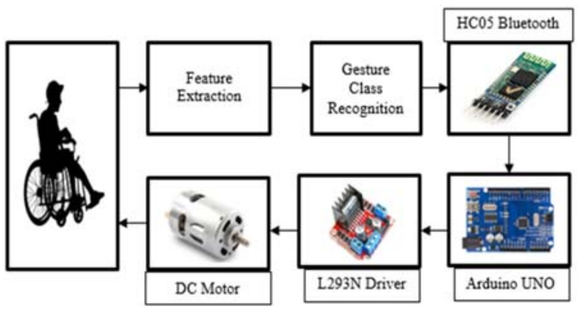

Fig. 1. Schematic Representation of the Hand Gesture Unit.

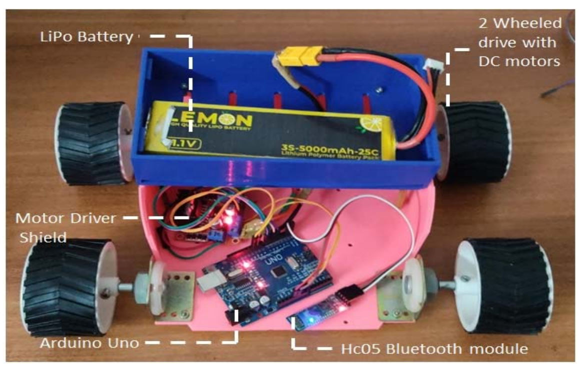

Fig. 2. Integration of Hand Gestures to Chassis.

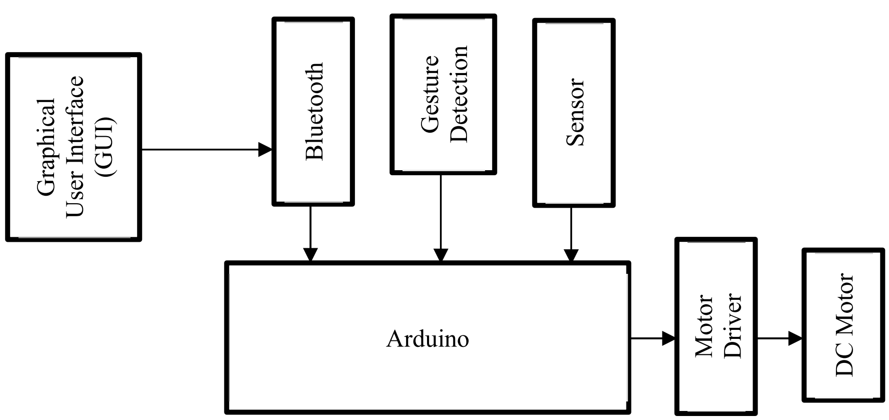

Fig. 3. Block Diagram of Smart Wheelchair

IV. HARDWARE

Gesture control allows disabled patients to control their navigation and movement. Two DC motors, a motor driver shield, a webcam (for capturing) image, rechargeable LiPo battery (12V) for power supply, and a hc05 Bluetooth module (for communication) are included in the configuration of the system to achieve the defined functionality and requirements.

The motor driver shield employs a triple high current half-H driver. The L293N motor driver shield is designed to provide bidirectional driving currents of up to 1 A.

V. SOFTWARE

For this system, Arduino Integrated Development Environment (IDE) was used for programming. It offers a range of built-in capabilities, including series menus for streamlined programming and sequential verification, among other features. The program implemented on IDE has transferred to Arduino Uno (Hardware Board).

The code is based on the following Python libraries for gesture recognition:

- *cv2 package*: The official open-source OpenCV "cv2" module for Python offers computer vision functionality.
- *NumPy package*: The package has a high degree of versatility in its ability to handle arrays. In addition to providing tools for manipulating these arrays, the software also includes a high-performance object for handling multidimensional arrays and tools for dealing with such arrays. It is an essential Python module for scientific computing.

VI. RESULT

The objective was to control wheelchair movement for paretic people through hand gestures. Fig 4 shows direction based on the gestures from the user. Table 1 shows the functionalities of the defined gesture class. The key features of the proposed system are as follows:

- The proposed paradigm is appropriate for persons with physical constraints as well as those who are unable to converse.
- The suggested solution decreases cost and complexity by utilizing Arduino uno, which requires no extra hardware support and is affordable as well as easy to program.
- Image processing is used for Hand Gesture Recognition.

VII. CONCLUSION AND FUTURE DIRECTIONS

In this research article, a cost-effective gesture-controlled smart wheelchair system is suggested. For wheelchair users with physical limitations, this system guarantees safe travel and easy navigation. Basic safety features like obstacle detection and fall detection can be added, along with an emergency messaging system that notifies both the user and the caregiver. It is still difficult to detect the hand region in dimly lit rooms and with varying colour schemes, particularly for skin tones that don't change is still challenging. This study's scope can be expanded in the future to address this issue. In order to enhance the efficacy of the model, additional research must be conducted. The smart wheelchair will become an indispensable necessity in the future. There is considerable opportunity to develop sensors and mobile robots in smart wheelchairs. The evolution of these things may have a significant effect on the cost factor. The success of smart wheelchair systems also depends on the development of hardware and software. To improve current problems with wheelchair systems, the work on feedback and evaluations could also provide useful new ideas.

TABLE 1: FUNCTIONAL TABLE.

HAND/PALM MOVEMENT	FUNCTION	ACTION
Thumbs-up	front ()	Chassis moves forward
Thumbs-down	back ()	Chassis moves backward
Raised Hand	stop ()	Chassis stops
Peace sign	left ()	Chassis moves left
OK sign	right ()	Chassis moves right

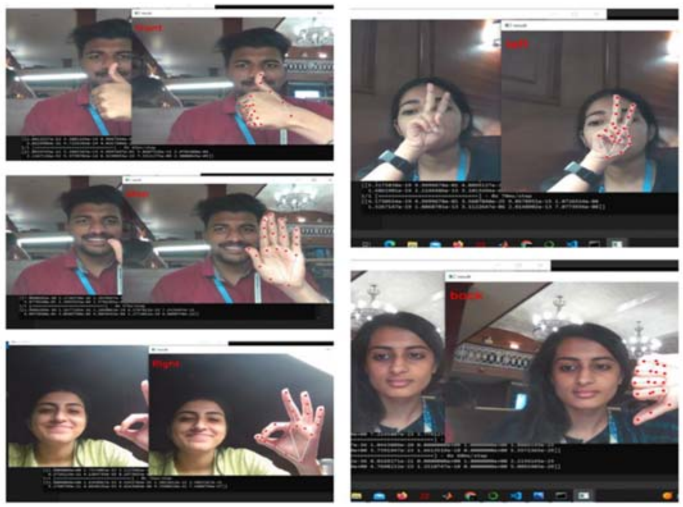

Fig. 4. Directions by Hand Gesture for the Wheelchair.

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Performance Evaluation of a Sliding Mode Controlled DC to DC Converter for EV Charging System

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***Abstract*— Due to environmental concerns, electric vehicles (EVs) are becoming more and more common in automobiles. Since electrical vehicles rely on rechargeable batteries to manage their power supply, therefore, it's important to have a reliable, efficient, and affordable battery charger that can consistently deliver the required output for the specific EV's battery. A DC-DC converter with a pulse width modulation (PWM) based Sliding-Mode Voltage controller is presented in this paper to help reduce charging time by achieving the required output voltage, high current density, and negligible overshoot for the specified lithium-ion battery system. Both ideal and non-ideal conditions are used to analyse the proposed converter. The performance of dc and ac side inductors has been designed and analysed to ensure their efficiency and affordability. According to the findings, the proposed converter is able to maintain a power factor of approximately 90% with less total harmonic distortion both of which are ideal for the high-current density load.**

***Index Terms*— Buck, lithium-ion battery charger, electric vehicle battery charger, ac-dc converter, MOSFET, Pulse Width Modulation (PWM), Sliding-Mode (SM)**

I. INTRODUCTION

The rechargeable battery is one of the crucial and complex systems that provides electricity to drive electric vehicles (EVs). Therefore, having an effective, affordable, and efficient battery charger is essential for EVs. To completely meet the requirement, an AC-DC converter is required [1],[2],[3][4]. An AC-DC converter can be isolated or non-isolated. In this paper conventional diode based AC -DC converter is used along with proper designed LCL filter in order to reduce unwanted harmonic distortion and to increase overall power factor of system [5],[6],[7][8].
Afterward, depending on the state of the lithium-ion battery, the voltage may need to be adjusted. A closed-loop DC-DC converter can be utilized to do this operation. The life cycle of the entire system may be shortened by the considerable power loss that the traditional closed-loop DC-DC converter dissipates in the active switches [9],[10]. Conduction, switching, and leakage power losses cause the largest power loss in typical closed-loop DC-DC converters. Additionally, the output voltage and current do exhibit overshoot, which may be harming the lithium-ion battery[11],[12].
To overcome, a Pulse Width Modulation (PWM) based Sliding-Mode Voltage controller is used. This controller

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aids in reducing conduction power loss, switching power loss, and leakage power loss in addition to the overshoot at the output voltage and current. Additionally, the present prosecution has been enhanced [13],[14]. This suggests that the overall power loss will be decreased without compromising the switching frequency, which helps to keep the size of passive components constant.
This study presents a reliable, cost-effective, and efficient AC-DC converter for lithium-ion battery charging in electric vehicles. Distinct situations are used to study the converter in detail.

II. HELPFUL HINTS

A. Proposed system

The proposed system is illustrated in Fig .1. The load is supplied with electricity by the single-phase ac source. The LCL network has been allocated near the ac source for filtering reasons. The diodes D5, D6 , D7and D8 aid in controlling the ac flow to the connected primary side. The rippled waves in the DC are lessened by the RC3, C3. Afterwards, the two MOSFETs M1, M2 and then assist in adjusting the dc output voltage in response to the load. The remaining diodes, D1, D2, D3, and D4, aid in preserving the dc flow. Components like L1, L2, and C1 are responsible for storing and filtering purposes. The two fuses F1 and F2 are assigned for protection. Eventually, the Lithium-Ion battery (48V 100Ah) was used as a load.

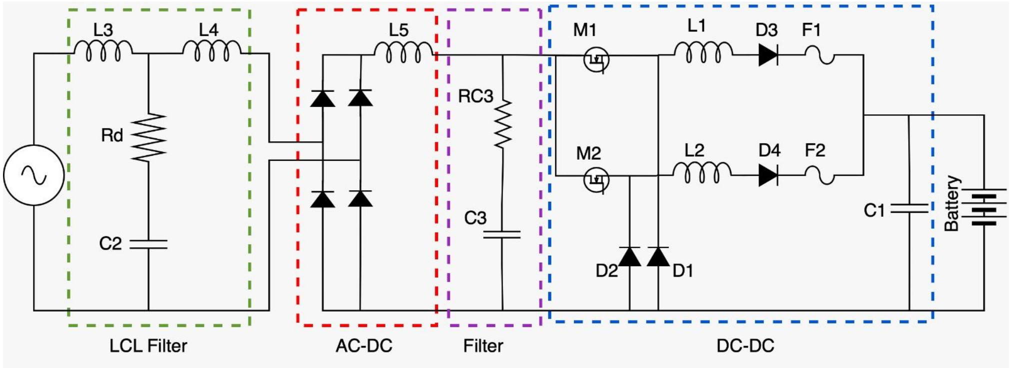


Fig.1 proposed system

B. Design and analysis of LCL filter

The grid current can be estimated based on equation 1.

$$I_{grid} = \frac{\sqrt{2} \times P_{load}}{V_{ac}} A \qquad (1)$$

The required inductance can be computed using equation 2.

$$L = \frac{X_l}{2 \times \pi \times f_{ac}} H \qquad (2)$$

where, x L = Inductor reactance = 2πf L
The L3 and L4 will be half of the inductance that has been calculated.
The ac side capacitance can be calculated as

$$C_2 = \frac{1\% \times P_{load}}{2 \times \pi \times f_{ac} \times V_{ac}^2} F \qquad (3)$$

The resonant frequency can be computed as

$$F_r = \frac{1}{2 \times \pi \times \sqrt{\frac{L_3 \times L_4}{L_3 + L_4} \times C_2}} HZ \qquad (4)$$

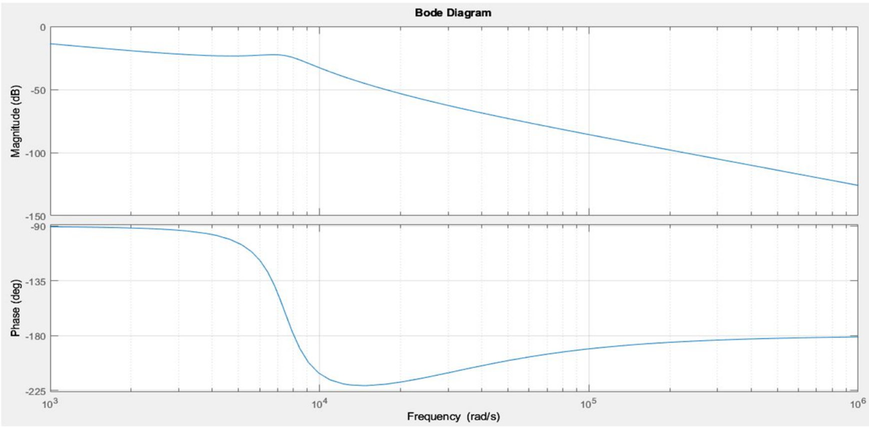
The damping resistance can be calculated as

$$R_d = \frac{1}{6 \times \pi \times F_r \times C_2} \, ohm \qquad (5)$$

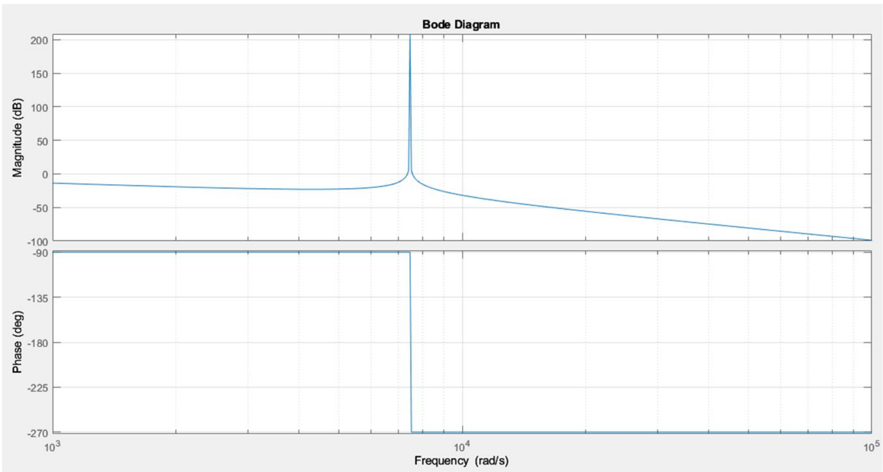
Where f_{ac} = Grid frequency, P_{load} = Filter load power. The designed filter frequency response can be analysed based on the transfer function and given herewith.

$$SYS(s) = \frac{R_d \times C_2 + 1}{L_3 \times L_4 \times C_2 s^3 + (L_3 + L_4) \times R_d \times C_2 s^2 + (L_3 + L_4) s} \qquad (6)$$

After manipulating the above equations, the bode plot has been computed and depicted in Figure 2. The Figure implicates the consequences of the designed filter frequency response and the stability. After adding the damping resistor, the overall response smooth and minimizes the spike that is associated with the system besides when the damping resistor was not concerned spikes do take place. Thus we can conclude from bode plots , that the designed filter exhibits more stability while the damping resistor is integrated .



(a)



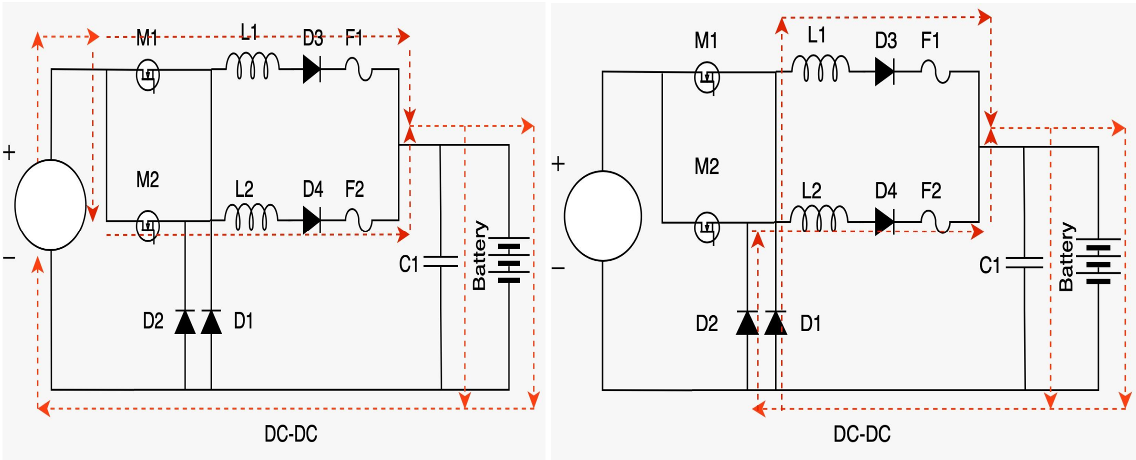
(b)

Fig 2. Bode plot of the designed LCL filter (a) with effect of R_d (b) without R_d

C. Steady state analysis of the proposed DC-DC system

a. *Ideal condition*

For the sake of this study, all the components are considered perfect. In addition, fixed switching frequency and duty cycle have been examined. A continuous open-loop analysis of the system is being conducted. The four modes of the suggested DC-DC converter have been explored here.



Mode One Mode Two

Fig.3 Working modes of the proposed DC-DC converter: (a) Mode One (b) Mode Two

1. Mode one

The converter has performed an analysis at the time 0 t DTs. MOSFETs one and two are now operating in conduction mode, whereas MOSFETs three and four as well as diodes one and two are operating in non-conduction mode. As seen in Figure 2(a), the input source is now linked to the left side of inductors one and two. In this approach, the crucial equations are.

$$V_{L1} = V_g - V_0 \tag{7}$$

$$V_{L2} = V_g - V_0 \tag{8}$$

$$\frac{d_{iL1}}{dt} = \frac{V_g - V_0}{L_1} \tag{9}$$

$$\frac{d_{iL2}}{dt} = \frac{V_g - V_0}{L_2} \tag{10}$$

$$i_{C1} = I_{L12} - I_0 \tag{11}$$

2. Mode two

Now that the converter has been examined during the DTs to Ts timeframe. Four MOSFETs are currently operating in non-conduction mode. The first and second diodes are now conducting. Inductors one and two's left sides are now connected to the ground, and the circuit is now shown in Figure 2(b). In this approach, the key equations are.

$$V_{L1} = -V_0 \tag{12}$$

$$V_{L2} = -V_0 \tag{13}$$

$$\frac{d_{iL1}}{dt} = \frac{-V_0}{L_1} \tag{14}$$

$$\frac{d_{iL2}}{dt} = \frac{-V_0}{L_2} \tag{15}$$

$$i_{C1} = I_{L12} - I_0 \qquad (16)$$

b. Non Ideal Conditions

For the sake of this investigation, the MOSFET has been chosen with the assumption that all of the components are not perfect. The system has been examined in continuous conduction mode with the frequency and duty cycle being presumptively constant. The preceding section described the two modes of the proposed DC-DC system.

1. Mode one

The important equations of this mode are.

$$V_{L1} = V_g - V_{M1} - I_{RL1}R_{M1} - I_{RL1}R_{L1} - V_{D3} - I_{RL1}R_{D3} - I_{RL1}R_{F1} - V_0 \qquad (17)$$

$$V_{L2} = V_g - V_{M2} - I_{RL2}R_{M2} - I_{RL2}R_{L2} - V_{D4} - I_{RL2}R_{D4} - I_{RL2}R_{F2} - V_0 \qquad (18)$$

$$\frac{d_{iL1}}{dt} = \frac{(V_g - V_{M1} - I_{RL1}R_{M1} - I_{RL1}R_{L1} - V_{D3} - I_{RL1}R_{D3} - I_{RL1}R_{F1} - V_0)}{L1} \qquad (19)$$

$$\frac{d_{iL2}}{dt} = \frac{\left(V_g - V_{M2} - I_{RL2}R_{M2} - I_{RL2}R_{L2} - V_{D4} - I_{RL2}R_{D4} - I_{RL2}R_{F2} - V_0\right)}{L_2} \qquad (20)$$

$$i_{C1} = I_{L12} - I_0 \qquad (21)$$

2. Mode two

The important equations of this mode are.

$$V_{L1} = -I_{RL1}R_{L1} - V_{D3} - I_{RL1}R_{D3} - I_{RL1}R_{F1} - V_0 - I_{RL1}R_{D1} - V_{D1} \qquad (22)$$

$$V_{L2} = -I_{RL2}R_{L2} - V_{D4} - I_{RL2}R_{D4} - I_{RL2}R_{F2} - V_0 - I_{RL2}R_{D2} - V_{D2} \qquad (23)$$

$$\frac{d_{iL1}}{dt} = \frac{(-I_{RL1}R_{L1} - V_{D3} - I_{RL1}R_{D3} - I_{RL1}R_{F1} - V_0 - I_{RL1}R_{D1} - V_{D1})}{L1} \qquad (24)$$

$$\frac{d_{iL2}}{dt} = \frac{(-I_{RL2}R_{L2} - V_{D4} - I_{RL2}R_{D4} - I_{RL2}R_{F2} - V_0 - I_{RL2}R_{D2} - V_{D2})}{L_2} \qquad (25)$$

$$i_{C1} = I_{L12} - I_0 \qquad (26)$$

At 0 < t < Ts the dc conversion ratio for L1 and L2 would be

$$L_1 = G_1 = D_{on} \times \left(\frac{2 \times \left(1 - \frac{V_{M1}}{V_g} - \frac{V_{D3}}{DV_g} - \frac{D_{off}V_{D1}}{DV_g}\right)}{\frac{DR_{M1} + R_{L1} + R_{D3} + R_{F1} + 2R + D_{off}R_{D1}}{R}} \right) \qquad (27)$$

$$L_2 = G_2 = D_{on} \times \left(\frac{2 \times \left(1 - \frac{V_{M2}}{V_g} - \frac{V_{D4}}{DV_g} - \frac{D_{off}V_{D2}}{DV_g}\right)}{\frac{DR_{M2} + R_{L2} + R_{D4} + R_{F2} + 2R + D_{off}R_{D2}}{R}} \right) \qquad (28)$$

D. Design of proposed Sliding-Mode Voltage Controller

SM (SLIDING-MODE) controllers are renowned for their dependability and stability. In order to achieve the necessary steady-state functioning, SM controllers should ideally operate at infinite, variable, and self-oscillating switching frequencies that allow the controlled variables to follow a certain reference route. However, the viability of using SM controllers in power converters is hampered by the fluctuating and high switching frequency. The controller's modelling includes the state-space averaging method. By doing this, the implementation of SM controllers may directly benefit from PWM duty cycle control. .

So, in this paper, we provide a unified approach to the design of PWM-based SM voltage controllers for fundamental dc-dc buck converter based on the work of [13]. Similar to [13], our goal is to give straightforward, immediately implementable control equations for the PWM-based SM voltage controller.

Creating a state-space description of the converter model in terms of the required control variables (such as voltage and/or current, etc.) is the first step in designing an SM controller. This research focuses on the use of SM control for converters that operate in CCM. It incorporates an extra voltage error integral term into the control computation, unlike the majority of other previously suggested SM voltage controllers, in order to lower the steady-state dc error of the actual SM controlled system.

fig. 4 shows the schematic diagrams of the PID SMVC dc–dc converters to be discussed in this paper . Here, C , L, and r_l denote the capacitance, inductance, and instantaneous load resistance of the converters respectively; i_c ,i_L and i_T denote the instantaneous capacitor, inductor, and load currents, respectively ;V_{ref} , v_i and v_0 denote the reference, instantaneous input, and instantaneous output voltages, respectively; β denotes the feedback network ratio; and $u = 0$ or1 is the switching state of power switch .

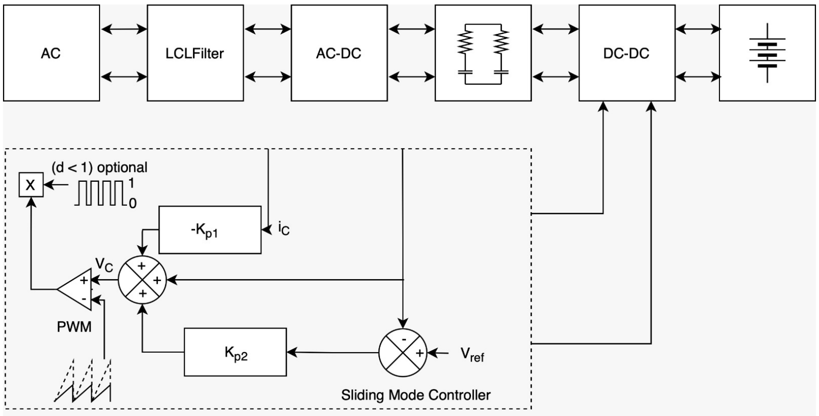


Fig .4 Schematic diagram of the PWM based SMVC buck converter.

The control equations required for the implementation of the respective buck converter are
The instantaneous state variable's trajectory is described as

$$S = \lambda_1 x_1 + \lambda_2 x_2 + \lambda_3 x_3$$

Where $\lambda_1, \lambda_2, and \lambda_3$ representing the control parameters termed as sliding coefficients.

Next, we look at how the converters' SM control operation's existence conditions are determined. The local reachability criterion is necessary to guarantee the presence of SM operation.

$$\lim_{s \to 0} S.\dot{S} < 0$$

For buck converter simplified existence condition is

$$0 < -\beta L_1 \left(\frac{\lambda_1}{\lambda_2} - \frac{1}{r_L C_1}\right) i_c + L_1 C_1 \frac{\lambda_3}{\lambda_2}\left(V_{ref} - \beta V_o\right) + \beta V_o < \beta V_i$$

$$-K_{p1} i_c + K_{p2}\left(V_{ref} - \beta V_o\right) + \beta V_o = V_c$$

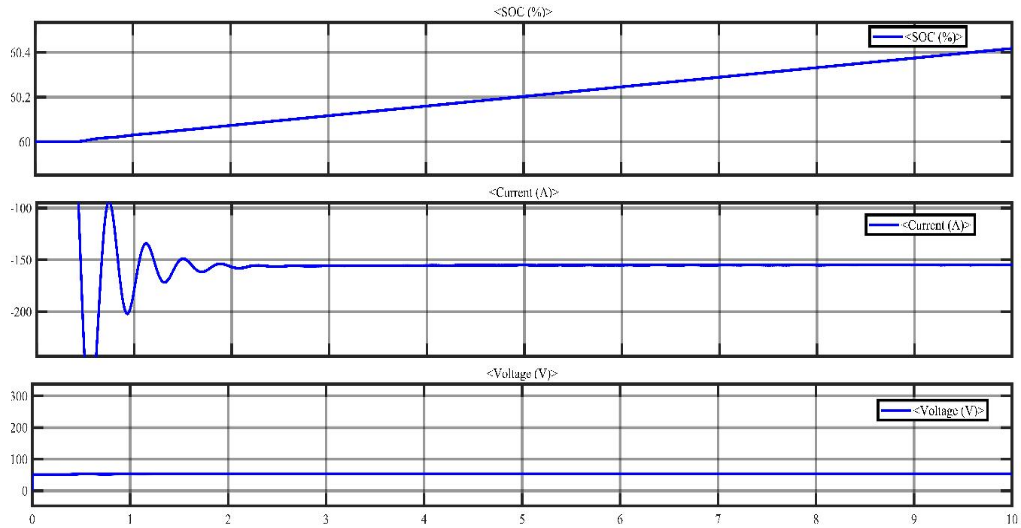
$$\hat{V}_{ramp} = \beta v_i$$

Where K_{P1} and K_{P2} are the constant gain parameters for the feedback signals i_c and ($V_{ref} - \beta V_0$). The values of K_{P1} and K_{P2} can be found in terms of converters parameters L_1, C_1.

E .Parameters of the system

parameters	values
source	240 V
Output voltage	52V
Output current	151A
Switching frequency	35KHz
AC inductor (L3,L4)	2.5mH
Output capacitor(C1)	333uF
Input capacitor(C2)	14.8uF

F. Expected Results



III. CONCLUSIONS

This paper proposes PWM-Based Sliding-Mode voltage controlled DC-DC converter for EV charging applications. The proposed converter's steady-state study demonstrates the relationship between input voltage, output voltage, and the prosecution in both ideal and non-ideal circumstances. For effective and economical operation, the DC and AC side inductors have been designed properly. The system may charge the lithium-ion battery with 152.1A while maintaining overshoot and other parameters with the suggested converter and prosecution. The suggested system will be more operationally, dependable and efficient by maintaining high power factor with low harmonic distortions.

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Empathy of Diabetics through Supervised Machine Learning Models

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***Abstract*— Present-era diabetes is the most dangerous problem for the majority of people. It will be affected irrespective of age fact. In this case, a person's lifestyle can estimate the next stage of affected by comparing it with diabetic patients' reports for future prediction on his diabetic affected stage is one of the approaches. This automation can be done using machine learning approaches with good prediction methodologies. We proposed a study to compare all classification models in machine learning for diabetes prediction using lifestyle data. Based on lifestyle-related and demographic characteristics variables predicting diabetes, all classification models in supervised machine learning. Models are evaluated performance metrics for all models to produce a result as accuracy, sensitivity, specificity, precision, F1 score, and ROC curve with time complexity. These machine-learning models assist medical institutions in identifying diabetes patients.**

***Index Terms*— Supervised Machine Learning, Classification, accuracy, sensitivity, specificity, precision, F1 score, and ROC.**

I. INTRODUCTION

Machine Learning (ML) is one of the sub-parts of computerised reasoning AI (artificial intelligence) that arrangements with the manners by which machines gain as a matter of fact [1], [2], [9]. In any case, some researchers are of the assessment that the terms man-made intelligence and ML are indistinguishable due to the chance of gaining, which is the principal component of the element called keen framework [4], [7]. A nitty gritty meaning of the term machine learning was given as "a framework is said to have gained for a fact E as for a few classes of undertakings T and execution measure P, in the event that its presentation at task in T, as estimated by P, improves with experience E" [17], [23]. For a long time, the machine has tackled many refined and complex true issues in application regions, for example, promoting, business and retail applications, normal language handling, medical care, independent vehicle frameworks, wise robots, environmental change, picture handling, voice, and gaming, among others [10], [32]. Machine learning procedures have been utilized for the expectation and analysis of numerous illnesses like the Coronavirus pandemic, jungle fever, typhoid, coronary conduit infections, and diabetes mellitus, among others [2], [10], [19]. Machine Learning calculations are normally founded on the experimentation approach which is very inverse to traditional calculations that adhere to the programming directions in view of if-else choice explanations [6], [13]. Machine learning undertakings are ordered into four general classifications, in particular administered learning, unaided learning, dynamic learning and support learning [23], [34] [22]. Managed gaining deduces a capability from the named preparation information,

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unaided gaining induces a capability from unlabelled preparation information, and dynamic learning gathers a capability by picking the most useful example for marking to prepare the model. In contrast, support learning connects with a unique climate [20], [31]. The flowchart of the preparation interaction of machine learning errands incorporates directed learning, solo learning and dynamic realizing, while preparing information is named, the preparation cycle is called administered while in any case it is called an unaided preparation process [3]. Conversely, when both named and unlabelled information are utilized for the preparation handling, this preparation system is called semi-directed [21], [28], [16]. In any case, the errand of administered machine learning is the one most ordinarily utilized in genuine applications, particularly for the conclusion and expectation of sicknesses [18], [35]. In this review, the directed machine models were created involving managed machine learning calculations for the expectation of diabetes mellitus [5], [33]. Diabetes mellitus (DM), usually alluded to as diabetes, is a gathering of metabolic problems of carb digestion in which glucose is underutilized, delivering hyperglycaemia (expanded glucose focus in the blood) [12], [22], [24]. The significant side effects of DM incorporate incessant peeing, expanded thirst, and yearning. Whenever left untreated, diabetes can cause numerous confusions, like diabetic ketoacidosis and non-ketoacidosis hyperosmolar unconsciousness [25], [36]. The drawn-out inconveniences brought about by DM incorporate cardiovascular illnesses, strokes, persistent kidney disappointments, foot ulcers, and harm to the eyes and nerves [21]9. Diabetes happens because of either the pancreas not creating sufficient insulin or the cells of the body not answering as expected to the insulin delivered [5]. DM is perhaps one of the deadliest sicknesses on the planet, particularly in created countries [14]. It is, notwithstanding, turning out to be more widespread in emerging countries like Nigeria, while presenting a larger number of dangers to people in the last option than those in the previous [15], [37]. More than 415 million individuals were experiencing diabetes mellitus overall starting around 2015, 8.3% being essential for the grown-up populace, with equivalent rates in all kinds of people [21]. DM type 2 comprises roughly 90% of the cases. DM is assessed to have brought about 1.5-5.0 million passings every year in the time of 2012-2015 and it duplicates an individual's gamble of biting the dust [29], [30]. The quantity of individuals with diabetes is supposed to ascend to 592 million by 2035. DM is one of the developing general well-being worries in Nigeria [8], [24]. A long time back, South Africa and Ethiopia had a bigger number of instances of diabetes than Nigeria, yet presently Nigeria has the most noteworthy frequency of diabetes in sub-Saharan Africa [16]. In this review, the analytic dataset of DM type 2 was gathered from the Murtala Mohammed Medical clinic, Kano-Nigeria and used to foster the prescient managed machine model in light of calculated relapse, support vector machine, K-closest neighbour, arbitrary woods, guileless Bayes, and slope helping calculations [26] [33].

II. Literature Review

Many works have been done utilizing regulated machine learning to construct prescient models in the medical care area to supplement and enhance crafted by well-being labourers throughout diagnosing numerous sicknesses. In crafted by, Coronavirus forecast models that utilization directed machine learning (ML) were created. The model was created in view of direct relapse (LR), support vector machine (SVM), least outright shrinkage and determination (Rope), and remarkable smoothing (ES) calculations [2], [9]. The review exhibited the ability of the administered machine learning calculations to foresee the quantity of impending Coronavirus patients that were impacted. A directed machine learning approach, which consolidated the conventional calculation and weighted K-closest neighbour (WKNN) calculations to foresee and group DM type 2 as per the presence or nonappearance of coronary conduit illness difficulties, was created in crafted [16], [32]. The managed machine learning prescient model for intense ischemic stroke post intra-blood vessel treatment was created in crafted by

. The model showed a promising exactness of the expectation and the concentrate additionally proposed a powerful learning model that might possibly streamline the choice cycle for clinical treatment and endovascular action in the administration of intense strokes [8]. In the work, the prescient-managed machine learning model for the expectation of post-acceptance hypotension was created [23], [37]. The consequence of the review showed that the achievement kept in expectation post-enlistment hypotension exhibits the capacity of administered machine learning models for prescient examination in the area of anesthesiology [21], [29]. The prescient model for hospitalization because of coronary illness was created involving administered machine learning calculations in the work. The dataset utilized for the improvement of the model was gathered from a metropolitan clinic in Boston and five models were created utilizing SVM, AdaBoost, LR, Gullible Bayes, and probability proportion test calculations [20]. A directed machine learning model for the fast location of intensity rate discontinuity and cardiovascular arrhythmias was created in the review [21]. An irregular woodland calculation and a dataset of 300 examples of arrhythmic, non-arrhythmic coronary conduit sickness, and people with next to no restoratively huge cardiovascular circumstances were utilized to foster a prescient model. The model was assessed with 104 autonomous cases and ended up being exceptionally proficient [7], [22]. In the work, directed machine learning was utilized to create a sub-atomic mark that can characterize metastatic hepatocellular carcinoma patients and distinguish qualities that were pertinent to the metastatic and endurance of the patients [30]. In the work, a survey of regulated AI for populace hereditary qualities was completed and the survey investigation discovered that there is a promising heading nearby [17]. The investigation further discovered that directed AI is a significant and underutilized procedure that has extensive potential for transformative genomics. A regulated machine-learning model for distinguishing proof of mosquitoes from the backscattered optical sign was created in the review [35], [16]. The review showed that the optical sensor combined with directed machine learning can be a reasonable elective means for observing the mosquito populace [8]. The prescient managed machine learning approach for the assessment of the gamble repeat in the beginning phases of oral tongue squamous cell carcinoma has been created in the work [19]. The review's consequence showed regulated ML's capacity to anticipate locoregional repeats [26], [27] [34]. Regulated machine learning calculations which incorporate help vector machines, straight discriminant examination, and K-closest neighbour calculations were utilized to distinguish dementia in the work [13]. The consequence of the review showed that the calculations are fit for anticipating dementia [14], [37].

III. Proposed Model

One more mixture method of learning called semi-regulated learning includes a mix of both managed and solo learning over a dataset that comprises of little part of marked preparing models with residual larger part of the models being un-named. It unites the exceptionally productive and exact speculation capacity of directed calculations with sensible guesses given by solo ones. This approach is relevant in the event of datasets containing a huge number of preparing models with many elements where speculation over such information is typically undeniably challenging. In such a setting, managed learning is applied over the little part of the named preparing information and solo learning is utilized to bunch the un-marked preparing information into groups of comparable models. At last, the information acquired during managed learning is used to sum up over-grouped information. The new patterns of always expanding scale and intricacy of information have led to one more profoundly refined learning worldview called as profound learning. A famous sub-space of ML models along with creating better improvements of the forecasts. The idea driving profound learning calculations is to copy the abilities to learn of the human cerebrum which includes datasets and has picked up a ton of speed.

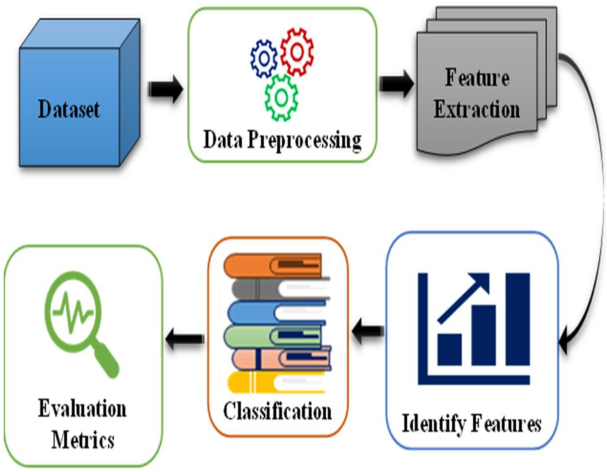

Figure 1. The Architecture of ML-based Diabetics Prediction

A. Data Sets

Clinical choice emotionally supportive network alludes to electronic medical care frameworks that give help/help to clinicians, clinical staff or patients themselves to improve well-being and medical care benefits, and executed through present-day advancements like artificial intelligence, ML and information mining by taking advantage of clinical information. When applied for illness anticipation and the board, clinical choice help utilizing ML includes savvy information examination and deduction to help the doctors in clinical navigation by working with individualized risk profile study, customized medicines, prognostic displaying of patient's wellbeing state and so on. The overall design of the ML framework for offering such clinical choice help with normal constituent advances is portrayed as making sense of underneath

B. Data Preprocessing

Information obtaining Assortment of medical services information from accessible sources like emergency clinic data sets, online public stores given by research associations, legislatures or researchers, medical care studies and reviews information, information given by protection organizations, drug organizations and thusly. The idea of the information relies upon the issue and the goals of the review. EHR, clinical pictures from various modalities, remedies, and information gathered by clinical sensors are exceptionally well known and profoundly take advantage of wellsprings of medical care information in research concentrates on these days. Information pre-handling This alludes to handling crude info information and applying reasonable changes to refine it further for better or ideal outcomes. Clinical datasets are especially portrayed by heaps of missing qualities, anomalies as well and class unevenness. Disposal of such commotion is achieved by different pre-handling activities.

C. Feature Extraction

Highlight determination Elements are viewed as the structure blocks of any ML calculation, overall and are fundamentally the natural properties or attributes of the dataset itself. Highlight determination is a course of extricating a pertinent subset of elements that best address the different classes in the dataset as well as expand the exactness of the learning calculation. There are three classes of component determination methods a) Channel techniques Concentrate significant highlights in light of the innate, measurable properties of the information to get an element subset that is profoundly pertinent to the objective. Connection, shared data, and fluctuation are regularly utilized to highlight significance estimates in channel strategies. b) Covering strategies Include a pursuit through the element space and an order calculation to choose a component subset that outcomes in the most extreme grouping exactness. Dissimilar to channel techniques, coverings are viewed as profoundly reliant upon the characterization calculation. c) Inserted techniques Include a blend of channels along with covering strategies where the quest for the ideal element subset is a necessary piece of classifier preparation, as opposed to a free step.

D. Identify the Feature

Expectation All the more usually called as an arrangement in ML phrasing, it contains two sub-steps in particular preparing and testing. Here, the first dataset is partitioned into preparing and testing datasets. During preparation, the preparation dataset is given as the contribution to the learning calculation, which figures out how to sum up or foresee the results through design acknowledgement. Testing includes deciding the forecast execution of the gaining calculation over beforehand concealed models from the testing dataset. The clinical choice help given by ML prescient calculations incorporates a forecast of illness risk, type, progress, treatment, complexities, etc.

E. Classification Models

Approval Alludes to the most common way of approving the classifier execution for exactness and dependability of its expectations. Frequently, it is completed on an inward test dataset, got from the first dataset known as inside approval. At the point when an outer dataset, which isn't a piece of the information dataset is utilized to approve the outcomes, it is called outside approval. Approval is a fundamental stage, particularly in symptomatic clinical choice help applications assuming it is to be embraced in clinical settings.

F. Confusion Matrix

A confusion matrix is well-defined as a table that is frequently used to define the concept of a classification model proceeding an established of test data for which the true values are known. It is enormously convenient for measuring the precision, recall, AUC-ROC curves and accuracy.

TABLE I. TYPE SIZES FOR CAMERA-READY PAPERS

		Actual Values	
		Positive (1)	*Negative (0)*
Predicted Values	*True (1)*	TP True Positive	TN True Negative
	False (0)	FP False Positive	FN False Negative

True Positive (TF): The count value of predicted positive from the cross table and its value is true
True Negative (TN): The count value of predicted negative from the cross table and its value is true.
False Positive (FP) (Type 1 Error): The count value of predicted positive from the cross table and its value is false.

False Negative (FN) (Type 2 Error): The count value of predicted negative from the cross table and its value is false.

G. Accuracy

Accuracy purely procedures how frequently the model classifier appropriately expects the prediction, and accuracy is the proportion of the count of correct expects of the values of the prediction and the total count of overall prediction values.

$$\text{Accuracy} = \frac{\text{TP+TN}}{\text{TP+TN+FP+FN}} \tag{1}$$

H. Precision

The precision value from the target is well-defined by way of the count of true positive values divided by the overall count of predicted positive values.

$$\text{Precision} = \frac{\text{TP}}{\text{TP+FP}} \tag{2}$$

I. Recall (Sensitivity)

The recall value from the target is well-defined by way of the count of true positives divided by the total count of actual positive values.

$$\text{Recall} = \frac{TP}{TP+FN} \tag{3}$$

J. F1 Score

The F1 score will give a united knowledge of recall and precision metrics. It is thoroughgoing that the minute precision is identically equal to recall.

$$\text{F1} = 2 \text{ X } \frac{\text{Precision X Recall}}{\text{Precision + Recall}} \tag{4}$$

IV. EXPERIMENT RESULT

The dataset contains information about female Pima Indians aged 21 and older. It consists of various attributes such as age, number of pregnancies, BMI (Body Mass Index), blood pressure, skin thickness, insulin level, diabetes pedigree function, and whether or not the individual developed diabetes (binary classification). The dataset was originally collected from the National Institute of Diabetes and Digestive and Kidney Diseases and is available through various machine learning repositories, including the UCI Machine Learning Repository. The primary objective of this dataset is to develop machine learning models that can predict whether an individual has diabetes based on the provided attributes. The dataset is often used to practice and demonstrate data preprocessing, feature engineering, model selection, hyper parameter tuning, and evaluation techniques. It's a common dataset for teaching and learning machine learning concepts, especially binary classification. The dataset may have missing values and outliers, which need to be handled during data preprocessing. As with real-world medical data, the dataset might have some complexities and noise, which could impact model performance.

Steps to Work with the Dataset:

*Step-01:*Load the dataset and understand its structure.

*Step-02:*Preprocess the data, handling missing values and outliers.

*Step-03:*Split the dataset into features (attributes) and targets (diabetes classification) and Perform feature selection and engineering if needed.

*Step-04:*Choose a machine learning algorithm then Split the data into training and testing sets.

*Step-05:*Train the chosen model on the training data.

*Step-06:*Evaluate the model's performance on the testing data using appropriate metrics (accuracy, precision, recall, F1-score, etc.).

The diabetes dataset is a great resource for learning and practising machine learning concepts, particularly for binary classification tasks. It's important to approach the analysis ethically and responsibly, especially when dealing with medical data.

The following table shows metrics evaluation like accuracy, balanced accuracy, ROC AUC and F1 Score for all classification models in supervised machine learning models. These values are very helpful in predicting future values.

TABLE II. METRICS FOR CLASSIFICATION MODELS

Model	Accuracy	Balanced Accuracy	ROC AUC	F1 Score
NuSVC	0.78	0.75	0.75	0.78
SVC	0.78	0.75	0.75	0.77
ExtraTreesClassifier	0.78	0.75	0.75	0.77
NearestCentroid	0.73	0.74	0.74	0.73
KNeighborsClassifier	0.75	0.74	0.74	0.75
LinearDiscriminantAnalysis	0.76	0.73	0.73	0.76
DecisionTreeClassifier	0.74	0.73	0.73	0.75
BaggingClassifier	0.76	0.73	0.73	0.75
CalibratedClassifierCV	0.76	0.73	0.73	0.76
LinearSVC	0.76	0.73	0.73	0.75
LogisticRegression	0.76	0.73	0.73	0.75
RidgeClassifierCV	0.76	0.72	0.72	0.75
RidgeClassifier	0.76	0.72	0.72	0.75
GaussianNB	0.74	0.72	0.72	0.74
AdaBoostClassifier	0.74	0.72	0.72	0.74
XGBClassifier	0.73	0.71	0.71	0.73
QuadraticDiscriminantAnalysis	0.74	0.71	0.71	0.74
RandomForestClassifier	0.74	0.71	0.71	0.73
BernoulliNB	0.7	0.7	0.7	0.7
LGBMClassifier	0.72	0.7	0.7	0.72
SGDClassifier	0.7	0.68	0.68	0.71
PassiveAggressiveClassifier	0.7	0.67	0.67	0.7
Perceptron	0.69	0.66	0.66	0.69
ExtraTreeClassifier	0.67	0.64	0.64	0.67
LabelSpreading	0.63	0.62	0.62	0.64
LabelPropagation	0.63	0.62	0.62	0.64
DummyClassifier	0.64	0.5	0.5	0.5

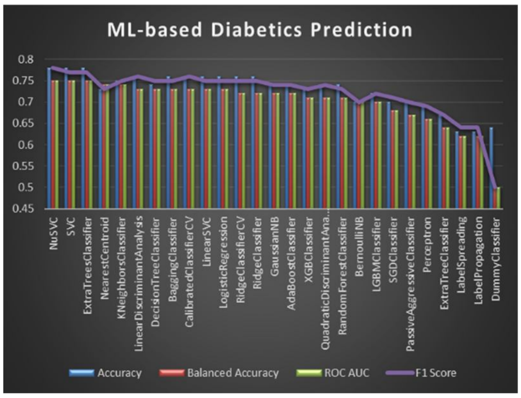

Figure 2. Evaluated the model’s performance

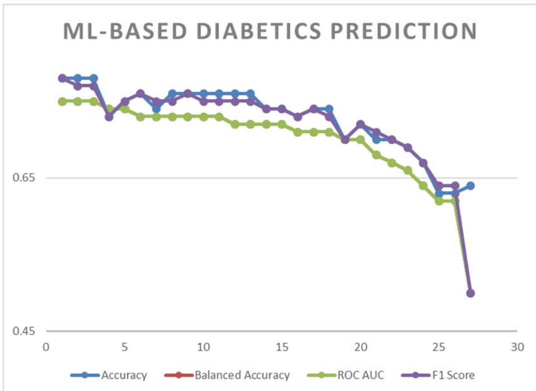

Figure 3. Comparison of evaluated the model’s performance

V. CONCLUSION

The paper focused on the automation of machine learning approaches with good prediction methodologies are compared all classification models for diabetes prediction based on lifestyle data. Finally, the models assist medical institutions in identifying diabetes patients using evaluated performance metrics for all models produced by a result as accuracy, sensitivity, specificity, precision, F1 score, and ROC curve with time complexity.

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Tomato Leaf Disease Prediction using Neural Networks

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***Abstract*— Tomatoes, which are extensively grown in Indian agricultural fields, are among the commonly cultivated vegetable crops. The tropical climate in India provides favorable conditions for tomato cultivation. However, various factors, including climatic conditions and other elements, can adversely affect the normal growth of tomato plants. Plant diseases present a significant risk to crop production and can lead to economic losses, adding to the challenges posed by climate conditions and natural disasters. Unfortunately, traditional methods of detecting diseases in tomato crops have proven to be ineffective and time-consuming. This study primarily aims to accurately identify tomato plant leaf diseases that are found using image analysis. Various methods have been applied for extracting the features that have been used to improve the accuracy of classification. Alex Net, InceptionV3, and a CNN (Conv Net) algorithm have been utilized to classify many types of tomato plant diseases. When comparing the results, it is notable that the CNN (Conv Net) classifier outperforms the other two models. The findings demonstrate the practical applicability of the model in real-life scenarios.**

***Index Terms*— CNN, Tomato Plant Diseases, Machine Learning, Deep Learning, Artificial Intelligence**

I. INTRODUCTION

Plant diseases pose a significant crisis in the agricultural sector, hindering agricultural development and resulting in substantial economic losses for farmers. Tomato, being a staple crop in India, is cultivated extensively across the country. Detecting and identifying tomato leaf diseases solely through naked-eye observation by agricultural experts is a challenging and less accurate task, which is only feasible for limited areas. Farmers and agriculturalists face difficulties in accessing agricultural experts, and the inspection of crops by these experts requires significant financial investment and consumes a considerable amount of time.[16] However, the recent advancements in the domain of technology have given rise to technologies like AI and ML. These technologies facilitate the automatic detection of tomato plant diseases detected on leaves using computerized techniques, enabling the monitoring of large-scale tomato crops in a more efficient manner. Many of the researches have proven that over 20 varieties of tomato diseases negatively impact the yield and quality of tomatoes, leading to substantial economic losses for farmers. These diseases affect various parts of the tomato plant, including leaves, roots, fruits, and stems, often resulting in abnormal growth, discoloration, damage, and ultimately plant destruction. Some common plant diseases found in tomato include early blight, spider mites, leaf Mold, target spot, yellow curl virus, and mosaic virus as depicted in Fig 1.

Timely detection of tomato diseases is crucial for minimizing the impact on plant health and maximizing crop yield. A number of methods that have been proved to be innovative have been used for the identification and the detailed classification for specific plant diseases. The main goal of this study is to provide farmers with accurate

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identification of diseases in their early stages and raise awareness about these conditions. By doing so, farmers can take proactive measures to mitigate the spread and negative results of the diseases on tomato plants, ultimately improving crop yield.[18]
Noteworthy progress has been made in the field of detection of leaf diseases in plants through the application of AI, and ongoing research continues to explore new avenues. Various techniques such as Machine Learning, Deep learning, Artificial Neural networks, Convolutional neural networks, and others have been employed to go through this topic. Machine learning, subset of AI is playing a major role in enabling systems to learn and enhance their performance over time.
Recent invention in the domain of deep learning and neural networks have led to improved classification accuracy in plant disease detection. A cutting-edge technique involves utilizing deep learning with Neural Network, which incorporates multiple stages of feature extraction automatically, resulting in enhanced classification accuracy. There are many different methods in machine learning but, C CNN has gained wide popularity and has shown notable superior performance compared to traditional classification methods.[17] The introduction of state-of-the-art meta-architectures such as VGGNet, LeNet, ResNet, AlexNet, Squeeze Net, ImageNet and others in Deep CNN has further contributed to significant improvements in predicting tomato leaf disease, achieving the high classification performance.
The results of these CNN models have inspired many researchers to adopt pre-trained models for the detection of tomato diseases detected through leaves. In the specific context of tomato plants, a growing research interest in utilizing CNN for disease detection. Convolutional layers are major part of CNN, which consist of sets of filters are applied to images to generate feature maps or images, along with additional layers such as pooling. Through the iterative process of convolution layers and other processing layers in classification of images, the feature maps are extracted, ultimately leading to the network producing a label that represents an approximate class, shown in Figure 2.

Fig 1. Instances of Tomato Leaf Diseases

II. RELATED WORKS

Alvaro Fuentes et al introduced an innovative approach for object detection, which combines the Faster R-CNN, R-FCN, and SSD algorithms with the state-of-the-art deep CNN feature extractors. Their proposed model, known as R-CNN with VGG-16, demonstrates enhanced recognition capabilities. Notably, this model effectively reduces false positives during the training phase, improving overall accuracy. Accuracy of 92%. However, one the potential improvement of this project model could have been increase in performance speed.[1]
Halil Durmas et al proposed the utilization of Deep Learning Network-based architectures, specifically squeeze Net and AlexNet, for the recognition of tomato leaf diseases. The results indicated that AlexNet achieved a higher classification accuracy of 95.65%. One advantage of using squeeze Net is its lightweight nature, which demands lower computational resources. The factors associated with squeeze Net include longer training times and the requirement of smaller batch sizes while the training process of model [2]
Melike Sardogan et al presented a novel approach that combines a CNN with the LVQ (Learning Vector Quantization) algorithm for leaf disease recognition. The proposed method resulted in classification accuracy of 86%. The key advantage of this study is the ability to achieve early and effective recognition of plant leaf diseases. However, important thing to note is that one of the potential factors to work on this method is the challenge related with the classification rate [3].
The authors of (Arnal Barbedo, 2019) segmented images into separate spots and lesions, which increased image number and data diversity as well as made it feasible to recognize numerous diseases in the same leaf, where single symptoms were being considered. About 12% accuracy was achieved, which is greater than the case when usage of raw images was done. The authors of (Arnal Barbedo, 2019) used a pretrained CNN that employed Google Net

architecture to study the use of separate spot and lesions, instead of using whole leaves and classified various plant infections. They concluded that the accuracy attained from separate lesions and spots was 94% [4].
Akshay Kumar et al put forth CNN-based architectures in their research. Among the proposed models, VGGNet exhibited exceptional performance and achieved an impressive accuracy of 99.25%. One notable advantage of this model is its ability to reach the maximum accuracy while also minimizing computational loss. However, it is worth mentioning that training VGGNet demands a significant time and necessitates a high-end hardware setup, which can be thought of as a potential improvement of the approach in future [5]
Elhassouny et al have introduced a mobile application that is built using deep CNN for identifying diseases in plant leaves. Derived from the "Mobile Net" CNN model, this application demonstrates the capability to point out the ten most common leaf diseases. The dataset used for the application consists of 7176 tomato leaf images. Notably, the proposed application achieves an impressive diagnostic accuracy of 88.4% that meets the necessary speed requirements. This mobile application provides an accessible and efficient tool for diagnosing tomato leaf diseases on the go. But small dataset used during training can be improved to make it more functional [6].
Ireri, D et al employ an RBF-SVM classifier that utilizes LAB color-space pixel values to effectively detect infected areas of tomato plants. The classifier focuses on identifying bruises on the stalk and calyx of infected tomato plants, while also categorizing tomatoes as either healthy or infected. The authors developed 4 different machine models for grading cases that have been on basis of color and texture data. Among these models, the RBF-SVM consistently outperforms the others, exhibiting an impressive accuracy of 95.15% for the healthy and infected tomato classes.
Interestingly, accuracy achieved by the classifier for identifying healthy and diseased tomatoes improves as the class number used in grading increases. This highlights the classifier's efficacy in distinguishing between various grading categories [7].

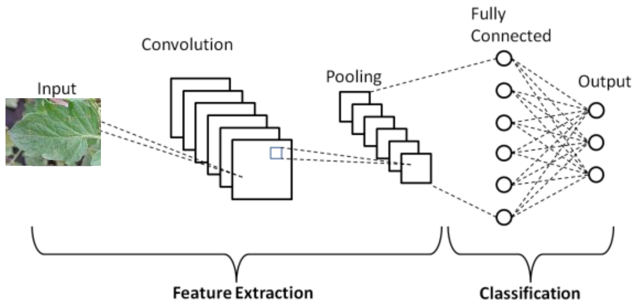

Fig 2. Convolutional Neural Network

Karthik R. et al introduced a CNN-based methodology that attained a commendable accuracy of 98%. This approach offers the advantage of a higher detection rate compared to existing methods, showcasing its efficacy in accurate classification. However, training model on a significantly large dataset can improve the thoughts on novelty of this CNN technique [8].
Surampalli Ashok et al presented a CNN-based methodology that achieved an impressive accuracy of 97%. One notable advantage of this study is its high performance in accurately classifying data. However, it is notable that the utilization of recent algorithms and classifiers may be necessary to reach optimum results, indicating a potential implementation for future of proposed methodology. It is important to explore and leverage the most up-to-date techniques for optimal performance [9]
Agarwal has et al introduced a straightforward CNN-based model for detecting nine different disease types in tomato plants. The model
comprises eight hidden layers and is evaluated using the dataset from Kaggle, which includes 18,160 leaf images categorized into ten classes. For training, 1400 images from each class are used, while 100 images are used for testing and 300 images for model validation. The model achieves an impressive accuracy of 91.2% over the Plant Village dataset.
To further enhance accuracy, the authors augment the dataset by incorporating processes such as flipping, rotation, and random variation of leaf intensities. This augmentation results in an increased accuracy of 98.4%. Notably, the proposed machine model has shown greater performance compared to classical machine learning processes and pre-trained models across various datasets [10].

Lee, J. et al introduce a system that combines AI and image techniques for processing for multi-class identification and instance-based segmentation to assess the size and mass of fruits captured in image. The conclusion of their study demonstrates a notable correlation between fruit size and mass, indicating that AI techniques can effectively capture this intricate physical relationship for predicting ultimate mass of the fruits. Alex net algorithm is used. The authors evaluate various AI methods and establish that the estimated mass aligns closely with the actual mass. The experimental findings reveal an impressive detection accuracy of 99.02%, highlighting the system's ability to accurately estimate fruit mass based on size information [11].

Rong, J et al present a two-phase approach for accurately locating the plant disease of cherry tomatoes. The first phase involves utilizing a YOLOv4-Tiny detector to quickly identify the approximate location of the tomatoes in real-time. In the second phase, the peduncle and fruit pixels are segmented using YOLACT + +. The resulting peduncle mask is then used for curve fitting, enabling the discovery of three key points that form a geometric framework for predicting the peduncle posture.

The proposed method achieves an impressive accuracy rate of 92.7%, demonstrating its effectiveness in accurately identifying and predicting the posture of cherry tomato peduncles. [12].

In their research conducted by Naresh K. Trivedi et al., study is done while making use of Google Colab and a dataset consisting of 3000 photos of tomato leaves affected by nine different diseases, along with healthy leaves. The entire procedure involved several steps. Firstly, the input photographs were pre-processed to enhance their quality, and the specific images related to the diseases of interest were identified. Subsequently, the original photos were divided into multiple regions to facilitate further processing. At this stage, the CNN model was fine-tuned, adjusting its hyperparameters to extract additional patterns from the data, such as colors, texture, and edges. The conclusion of this study demonstrated that the model achieved an accuracy of 98.49%.

This experiment serves as evidence for effectiveness of applied methodology in accurately classifying and diagnosing leaf diseases in leaves. The combination of Google Colab, a large dataset, and careful preprocessing techniques contributed to high accuracy achieved by the machine learning CNN model [13].

In a recent study conducted by H. Kibriya et al. in 2021, tomato plant disease detected on leaves classification was addressed using two CNN-based models, namely Google Net and VGG16 with 96% accuracy. The researchers employed deep learning process to handle the challenge of accurately detecting tomato plant leaf diseases. Their study aims to detect an efficient way to solve this problem. The testing of the models were done on the Kaggle dataset, which consists of 10,735 leaf samples.[14]

Study conducted by Ashqar, Abu-Naseer and Abu-Naser, et al in 2019 was done on Plant seedling dataset, they pre-processed input images by resizing them to 128x128 pixels, normalizing the pixel values to a [0,1] range and balancing dissimilar classes.

The authors selected a CNN (Conv Net-based) approach for classifying plant images with dataset containing approximately 5000 images belonging to 12 different species and achieving accuracy of 99.48%.

TABLE I MODEL ACCURACY COMPARISON

Authors	Methodology Used	Performance Metrices
Fuentes, Alvaro	Faster R-CNN, R-FCN and SSD algorithms, VGG-16	92%
Durmuş, Halil, Ece Olcay Güneş, and Mürvet Kırcı	Squeeze Net and Alex Net	95.65%
Sardogan, Melike, Adem Tuncer, and Yunus Ozen	CNN and LVQ	86%
Arnal Barbedo, J. G	CNN (Google Net)	94%
Kumar, Akshay, and M. Vani.	VGG Net	99.25%
A. Elhassouny and F. Smarandache	Mobile Net	88.4%
D. Ireri, E. Belal, C. Okinda, N. Makange, and C. Ji	RBF-SVM	95.15%
Karthik, R	CNN	98%
Ashok, Surampalli	CNN	97%
M. Agarwal, S. Kr. Gupta, and K. K. Biswas	CNN	91.2%
J. Lee, H. Nazki, J. Baek, Y. Hong, and M. Lee	Alex Net	99.02%
J. Rong, G. Dai, and P. Wang	YOLOv4	92.7%
N. K. Trivedi, V. Gautam, A. Anand, H. M. Aljahdali, S. G. Villar, D. Anand, N. Goyal, and S. Kadry	CNN	98.49%
H. Kibriya, R. Rafique, W. Ahmad and S. M. Adnan	VGG16 and CNN	96%
Ashqar, Abu-Nasser and Abu-Naser	CNN (Conv Net)	99.48%

Transfer learning means the process of reusing a pretrained model for solving a new problem that is different from scratch, which involves learning or training data from basic. [15]

In this literature survey, we have conducted a comprehensive evaluation of researches that made use of Machine Learning for tomato plant disease identification. We have compared the findings from various published models and observed that CNN demonstrates high accuracy in disease identification when trained on sufficient data. It was also found in the survey that ConvNet has shown highest accuracy performance. Our Findings and their accuracy are depicted in Table I

III. METHODOLOGY

A. Image Acquisition

Involves obtaining online images that are to be used as input data for the purpose of training and also testing machine learning models. Image acquisition involves capturing or retrieving pictures from various sources, like cameras, sensors, or databases. We acquired our images from Kaggle dataset

B. Image Pre-processing

Once the image has been acquired, if they are deemed unsatisfactory or the regions of interest are not clearly defined, image preprocessing processes can be employed to mitigate noise and enhance the quality of the picture. Image preprocessing encompasses several ways such as cleansing, integration, transformation, and reduction, all aimed at improving the overall clarity and utility of the images. These techniques to reduce noise, enhance features, adjust color or contrast, and prepare the images for subsequent analysis or processing steps are used.

Pre-processing means steps taken to prepare image data before feeding it into the neural network. The main goal of pre-processing is used for quality improvement of the input data, reduce noise, and help the neural network to better understand and extract useful features from the images. For our study, the entire dataset is divided into 80% train data and the 20% test data. Rescale is a pre-processing step where the pixel values of the input images are rescaled by dividing each pixel value by 255. This helps in normalizing the pixel values to a range between 0 and 1, which can improve in the training of the model which is performed in our research.

C. Image Segmentation

Segmentation means the process of dividing an image into distinct parts based on shared characteristics or similarities. The goal of image segmentation is to isolate specific regions of interest within the image that possess similar attributes. By employing image segmentation techniques, we can extract only the relevant portions of the image that exhibit the desired characteristics, while disregarding irrelevant details in the entire image. This makes it possible for more focused analysis and processing on the specific areas of interest, leading to more accurate and efficient interpretation of the image data. In our research for image segmentation

1. Data Augmentation

Data augmentation is important technique in training neural networks for prediction of diseases in leaves. It involves generating new training samples by applying various transformations and modifications to the existing dataset. By augmenting the data, the network becomes exposed to a wider range of variations, enhancing its ability to generalize and recognize diverse patterns that are related with the disease. These transformations can include rotations, translations, scaling, flipping, brightness adjustments, contrast changes, and adding noise. By applying such variations to the images, the neural network can learn to be robust to changes in lighting conditions, image orientations, and other factors that may change the appearance of disease.

2. CNN Architecture

a. Alex net

AlexNet is a powerful neural network. It is of eight layers,that include five convolutional layers and then followed by three fully connected layers. It takes a fixed-sized RGB image, typically 224x224 pixels. The convolutional layers use various filter sizes, strides, and padding. The first layer has a filter size of 11x11 with a stride of 4, while the subsequent layers use smaller filter sizes of 3x3 or 5x5 with a stride of 1.

After each convolutional layer, max pooling reduces the resolution of feature maps. ReLU activation functions are applied to introduce non-linearity after each convolutional layer and fully connected layer. Soft max layer processes the learned features from the convolutional layers is used for image classification into various classes. final layer applies the soft max activation function to produce class probabilities. It assigns probabilities to each class label, indicating the likelihood of the image given as a input belongs to a particular class.

b. InceptionV3

InceptionV3 is a deep learning architecture that combines CNN with inception modules. The initial layers of InceptionV3, called the stem, perform basic extraction of features and dimensionality reduction. An Inception block captures feature at different scales by using parallel convolutional filters of different sizes. InceptionV3 employs multiple Inception blocks stacked together to form a deep architecture. It also has reduction blocks that reduce the spatial dimensions of feature maps while increasing the channel numbers. At the top of the network, fully connected layers are being used for the final classification. These layers process the learned features and produce class predictions. In InceptionV3, there are typically two fully connected layers followed by a soft max layer for multi-class classification.

3. CNN (Conv Net) algorithm

The CNN (Conv Net) algorithm is a specific type of CNN model architecture commonly used for image classification tasks. It is designed as a sequence or linear stack of layers, where the output of one layer serving as input to next layer. CNN (Conv Net) algorithm consists of following layers stacked one after another. Convolutional layers apply convolutional filters to the input volume to detect specific patterns or features. Then activation layers and pooling layers down sample the feature map's spatial dimensions. Following these layers fully connected layers are used for classification, as they map the extracted features to the class labels and make the final predictions. Soft max, is used to the find the output of the last fully connected layer to produce class probabilities, indicating likelihood.

4. ReLU

ReLU (Rectified Linear Unit) is a commonly used activation function in neural It introduces non-linearity and aids to the network learn complex relationships between input features. ReLU sets negative values to zero, allowing positive values to pass through unchanged. By enabling the network to learn non-linear mappings, ReLU enhances the model's ability to capture intricate patterns and features associated with plant diseases. With its effective representation learning capabilities, ReLU contributes to improved accuracy in classifying plant images and predicting the disease

5. Residual Block

The Residual Block is the building block in neural networks. It consists of multiple layers, including convolutional layers, batch normalization, and non-linear activation functions. The key feature of the Residual Block is the introduction of skip connections, which allow the network to learn residual features. These skip connections enable the direct flow of information from first layer to next, bypassing intermediate layers. The Residual Block captures both shallow and deep features, enhancing the model's ability to extract relevant information from images. The residual learning within the block enables the network to focus on learning the change between input and output, improving the network's performance.

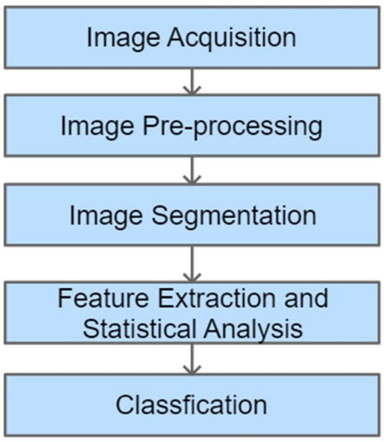

Fig 3 Procedure of Leaf Disease Detection

6. Maxpool 2D

MaxPooling2D is a commonly used pooling operation in neural networks. It reduces the spatial dimensions of feature maps, preserving the most salient information. By partitioning the input into non-overlapping regions, MaxPooling2D selects the maximum value within each region, discarding less relevant information. MaxPooling2D aids in extracting robust and invariant features from plant images, allowing the network to focus on essential patterns. It helps to achieve translation invariance, making the model more robust to slight shifts in the input.

7. Flatten

The Flatten operation is a crucial step in neural networks. It transforms multi-dimensional feature maps into a one-dimensional vector. By flattening input, network can connect all the extracted features to fully connected layers for further processing. This operation enables the network to capture global patterns and relationships among features. The flattened representation allows for efficient information flow and parameter sharing in subsequent layers. By reducing spatial dimensions, the Flatten operation helps to mitigate over fitting and reduce the complexity of the model. It facilitates in the last decision-making process prediction. In summary, the Flatten operation enables to extract and leverage high-level features from images, enhancing the accuracy and efficiency.

D. Feature Extraction and Statistical Analysis

Feature extraction is very important in object recognition, and it is widely applied in various picture processing applications. For this, several characteristics can be utilized, including color, texture (which encompasses factors such as color distribution, brightness, and image smoothness), morphology, and edges, among others. However, processing the entire input data directly can be computationally intensive and prone to redundancy. To address this challenge, it is common practice to convert the input data into a condensed feature set or representations, which effectively captures the essential information. This transformation of input data into a concise set of some features is known as feature extraction. By extracting key features, the subsequent analysis and classification tasks can be done more efficiently and effectively.

The CNN has convolutional layers that consist of learnable filters that extract low-level features such as edges, corners, and textures, which are crucial for identifying signs of disease in a plant image.

Non-linear activation functions, such as ReLU, introduce non-linearity into the network, allowing for the learning of more complex and abstract representations. Pooling layers reduce the spatial dimensions of the feature maps, preserving relevant information while reducing computational complexity. Through these processes, the CNN progressively generates higher-level feature maps, capturing global structures and patterns essential for leaf disease prediction. By leveraging these extracted features, we can accurately classify and diagnose the disease, enabling timely intervention and prevention

E. Classification

The algorithm is a supervised learning technique that utilizes training data to categorize new observations into specific classes. By learning from the provided dataset or predefined classification criteria, the algorithm can accurately classify fresh observations into different categories or classes. These categories can be termed to as targets, labels, or divisions.In Fig 4 convolutional layers perform operations to extract meaningful feature from data that is given as input, while the max pooling layers down sample the spatial dimensions of the feature maps. The flatten layer reshapes the output into a one-dimensional vector, that are then used as input into the dense layers. The dense layers are fully connected and generate the final output. The network has a total of 184,202 trainable parameters, which are updated during the process of training to optimize the model's performanceIn the context of tomato leaf disease prediction, neural networks are often used to analyze plant images and identify signs of disease in plant leaves. The big number of trainable parameters suggests that complex architecture in the model is capable of capturing intricate patterns and features from the pictures to make accurate predictions regarding the presence and disease.The provided CNN (Conv Net) architecture in Fig 5 is designed for disease prediction in leaves. It begins with a data augmentation layer that introduces random transformations to diversify the training dataset. The subsequent convolutional layers perform feature extraction, utilizing different numbers of filters to capture varying levels of features. Max pooling layers are employed to down sample the feature maps, reducing their spatial dimensions while retaining important information. A global average pooling layer further reduce the quality of the features. The model concludes with a dense output layer responsible for classification, with 10 units representing the disease categories. The soft max activation function generates a probability distribution over the disease categories. With total of 10,490 trainable parameters, this architecture is ready for training and prediction tasks related to leaf classification in with respect to diseasese

F. Inception V3 Model

The provided InceptionV3 model architecture defines a deep learning model for image classification using the InceptionV3 architecture. It starts by loading the InceptionV3 model with pre-trained weights from the 'image net' dataset and freezing the weights of all layers. The model is then customized by adding additional layers for extracting features and classification. The result of the model is a probability distribution over the classes. By leveraging pre-trained weights and adding custom layers, the model can learn meaningful features from input images and classify them into different classes. Total of 26,220,042 trainable parameters, this architecture is ready for training and prediction tasks related to tomato leaf disease classification

IV. RESULTS AND DISCUSSIONS

In our study, we have conducted a comprehensive study of research papers that make use of Machine Learning for leaf disease identification. We have compared the findings from various published models and observed that CNNs demonstrate high accuracy in disease identification when trained on sufficient data. Our Findings and their accuracy are depicted in Table I as a result. Here from our findings, we are able to comprehend that high accuracy is achieved by implementing CNN (Conv Net) algorithm with the accuracy of 98.20% and we can also deduce that most published studies utilize convolutional neural networks for tomato plant disease identification

The result analysis holds significance in all forms of research. Therefore, in this particular study, the entire dataset that consists of approximately 10,000 images was segregated into two groups: 80% is for training purpose and other 20% is for testing purposes. With the survey result we conducted we chose some selected algorithms namely, AlexNet, CNN (Conv Net) algorithm and InceptionV3 algorithm to compare accuracy on the dataset same as previous that we got on Kaggle. Subsequently, the training dataset, comprising 80% of the data, was utilized to apply AlexNet algorithm, InceptionV3 algorithm and a CNN (Conv Net) algorithm.

The accuracy for classification is a performance standard measure used to evaluate the efficiency of the classifier. Training accuracy and testing accuracy are found out and finally, accuracy among three classifiers is shown below in Fig. 6.

A confusion matrix is a square matrix where the rows represent the actual labels of the images, and the columns represent the predicted labels of the images. This is confusion matrix that shows the quantitative numbers of true positive, true negative, false positive, and false negative predictions made by the models. The confusion matrix for best performing algorithm is depicted in Fig 7.

V. CONCLUSION

This study introduces a classification method aimed at identifying leaf diseases accurately. Multiple machine learning algorithms, namely Alexnet, InceptionV3, and a CNN (Conv Net) algorithm, were employed to classify the extracted features that are taken from the database leaf diseases images from tomato plant. CNN (Conv Net) algorithm demonstrated superior performance. The uncovering of this paper has practical implications, particularly in distinguishing between healthy and diseased tomato leaves

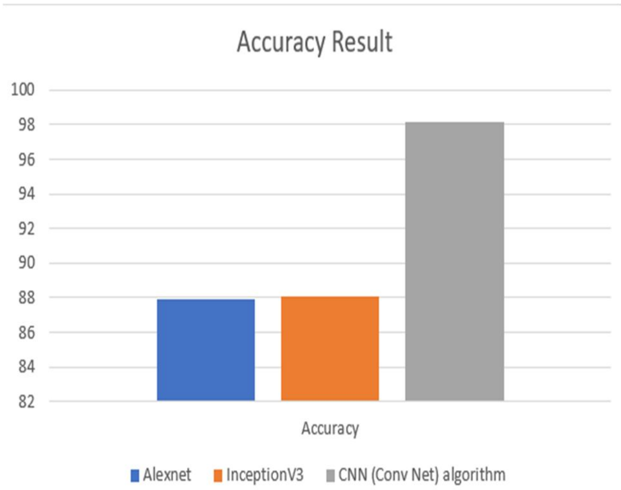

Fig 6. Accuracy Result for three classifiers

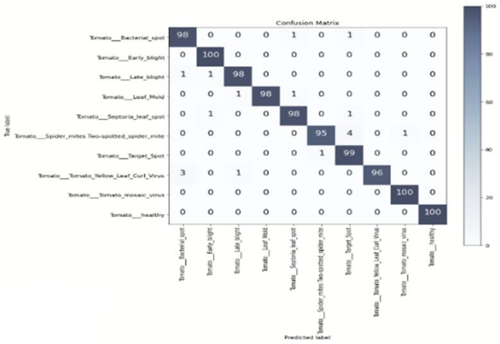

Fig 7. Confusion matrix comparing predicted and actual result obtained through model giving highest accuracy

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Surveillance Monitoring using ESP32-Cam Module for Fog Detection in Agriculture

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***Abstract*— Fog is a common weather phenomenon that can have a significant impact on agriculture. It can reduce visibility, making it difficult for farmers to work in their fields. It can also damage crops by reducing photosynthesis and increasing the risk of frost. This paper presents a system for monitoring fog in an agriculture field using a camera module. The system uses a machine learning algorithm to detect fog in images captured by the camera. A fog detector is a device or system designed to detect the presence of fog or reduce the impact of foggy conditions. If the fog level is too high, an alert is sent to the farmer. The system was evaluated in a field experiment. According to the Indian Meteorological Department, the average humidity level during the fog season (October to March) is around 90%. However, humidity levels can often reach 100% or higher, especially in the early morning hours. The results showed that the system was able to accurately detect fog with a high degree of sensitivity and specificity. The system also had a low false alarm rate. The results of this study demonstrate the potential of using camera modules for fog detection in agriculture. This system can help farmers to protect their crops from the harmful effects of fog.**

I. Introduction

Fog is a common weather phenomenon that can occur in agriculture fields. It can reduce visibility and make it difficult for farmers to work in their fields. Fog can also damage crops by reducing photosynthesis and increasing the risk of diseases. Surveillance monitoring systems can be used to detect fog in agriculture fields. These systems use cameras to capture images of the field. The images are then processed by a computer vision algorithm to detect fog. If fog is detected, an alert can be sent to the farmer.

Surveillance monitoring systems can be used to improve the efficiency and safety of agriculture operations. They can help farmers to:

- Monitor their fields for fog
- Receive alerts when fog is detected
- Take steps to protect their crops from the harmful effects of fog

The use of surveillance monitoring systems for fog detection in agriculture fields is a promising new technology. It has the potential to help farmers to improve their crop yields and reduce their losses.

II. Literature Survey

[1] "ESP32-CAM Based Real-Time Monitoring System for Agricultural Applications" by Yadav et al. (2020)

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proposes a real-time monitoring system for agricultural applications using the ESP32-CAM module. The system can be used to monitor the growth of crops, the presence of pests and diseases, and the weather conditions. It can also be used to control irrigation systems.

[2] "IoT Based Smart Irrigation and Field Surveillance System" by Singh et al. (2020) proposes an IoT-based smart irrigation and field surveillance system using the ESP32-CAM module. The system can be used to monitor the moisture level of the soil, the temperature and humidity of the air, and the growth of crops. It can also be used to detect pests and diseases.

[3] "ESP32-CAM Based Wireless Video Monitoring System for Agriculture" by Kumar et al. (2021) proposes a wireless video monitoring system for agriculture using the ESP32-CAM module. The system is designed to be low-cost and easy to deploy. It can be used to monitor crops, livestock, and other assets in agricultural fields.

[4] Object Detection in Unmanned Aerial Vehicle Surveillance" by Nuijten et al. (2019) provides a comprehensive overview of object detection methods for UAVs, with a focus on precision agriculture applications. The survey discusses the challenges of object detection in UAV images, as well as the different methods that have been proposed to address these challenges.

[5] IOT Based Smart Security and Monitoring Devices for Agriculture by Patil et al. (2020) surveys the use of IoT-based devices for security and monitoring in agriculture. The survey discusses the different types of sensors and devices that can be used, as well as the different applications of these devices.

[5] Smart Agriculture Monitoring and Control System Using IOT" by Reddy et al. (2019) surveys the use of IoT for monitoring and controlling agricultural systems. The survey discusses the different components of an IoT-based agriculture system, as well as the different applications of these systems.

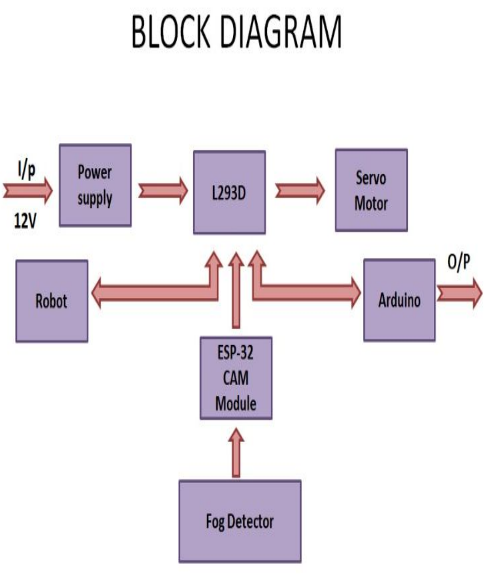
[6] The application of Drones in Precision Agriculture by Kumar et al. (2020) provides a comprehensive overview of the application of drones in precision agriculture. The survey discusses the different applications of drones in agriculture, as well as the challenges and limitations of this technology.

[7] The use of IoT for Precision Agriculture by Kumar et al. (2020) surveys the use of IoT for precision agriculture. The survey discusses the different ways in which IoT can be used in agriculture, as well as the challenges and limitations of this technology.

[8] The use of Deep Learning in Precision Agriculture" by Kumar et al. (2020) surveys the use of deep learning in precision agriculture. The survey discusses the different ways in which deep learning can be used in agriculture, as well as the challenges and limitations of this technology.

III. Proposed Approach

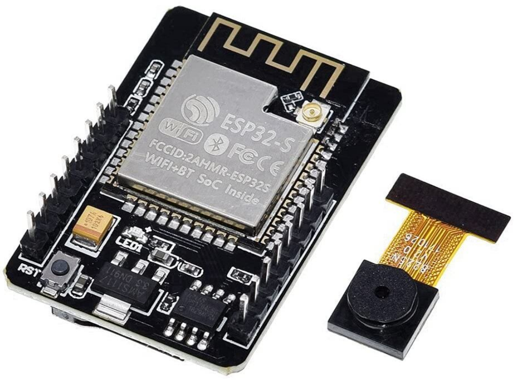
In this project, we will use the ESP32 CAM module to create a surveillance system for monitoring dense fog in agricultural fields. We will use a fog detector to help us identify fog, and the L293D driver circuit to control a robot with a servo motor and Arduino.



A. Ardunio Uno

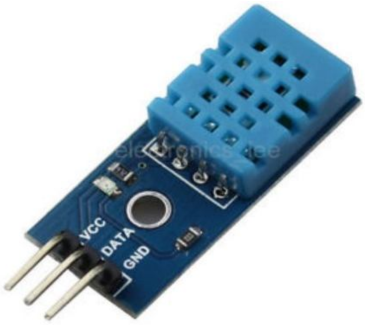
The Arduino Uno is a microcontroller board based on the ATmega328P microcontroller. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It comes with everything you need to get started with the Arduino, simply plug it into a computer via USB or power it with an AC-to-DC adapter or battery. The Uno is the most recent in a series of USB Arduino boards, and it is the most widely used Arduino board. It is a great way to get started with electronics and programming.

B. Esp 32 CAM MODULE



The ESP32-CAM module is a versatile development board that combines an ESP32 microcontroller with a camera module, making it suitable for various IoT and camera-related projects. You can use it to capture images or stream video, and it has built-in Wi-Fi and Bluetooth capabilities for wireless communication.
Camera Capabilities: The ESP32-CAM module comes with a camera capable of capturing images and streaming video. It uses the OV2640 camera sensor and can capture images with resolutions up to 2 megapixels. This can be very useful for vision-based tasks on your robot.

C. Fog Detector



A fog detector is a device or system designed to detect the presence of fog or reduce the impact of foggy conditions.

D. Servo Motor

A servo motor is an advanced electric motor engineered for the precise control of angular or linear position, velocity, and acceleration. It comprises three key components: a motor, a feedback mechanism (like an encoder or potentiometer), and a control circuit. These motors find extensive applications in fields such as robotics, CNC machinery, remote-controlled vehicles, and other scenarios where highly accurate and controlled movement is essential. One of their standout features is their capability to uphold a specific position, even when subjected to fluctuating loads or external forces, making them indispensable in various automated systems.

E. L293D

The L293D is a popular integrated circuit (IC) commonly used in electronics and robotics projects. It is specifically designed for driving and controlling DC motors or bipolar stepper motors. The L293D can control up to two motors and provides bidirectional control, meaning it can control the motor's direction of rotation (forward and reverse) as well as their speed.

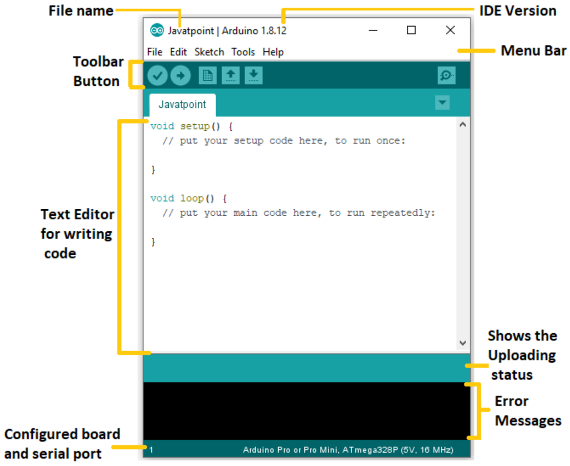
F. Robot with Wheeler Chassis Board

A robot with a 4-wheeler chassis board typically refers to a mobile robot platform that has four wheels as its base. These types of robots are often used for various purposes, including research, education, and industrial applications. The four-wheel chassis provides stability and maneuverability for the robot, allowing it to move in different directions and navigate various terrains. Depending on the design and components added to the chassis, the robot can be customized for specific tasks, such as surveillance, exploration, or even as a base for robotic arms or other attachments.

IV Software Details

IDE stands for Integrated Development Environment. It is a software application that provides a comprehensive set of tools for writing, editing, compiling, and debugging computer programs. The Arduino IDE is an open-source software that is used to write code for Arduino boards. It is available for Windows, macOS, and Linux.
The Arduino IDE includes a text editor, a compiler, a serial monitor, and a library manager. The text editor is used to write the code for the Arduino board. The compiler converts the code into machine language that can be understood by the Arduino board. The serial monitor is used to communicate with the Arduino board and view the output of the program. The library manager is used to install and manage libraries of code that can be used in Arduino programs.
The Arduino IDE is a very easy-to-use software. It is a great way to get started with Arduino programming.
Here are some of the features of the Arduino IDE:

- Text editor with syntax highlighting and auto completion
- Compiler that supports C and C++
- Serial monitor for debugging and testing programs
- Library manager for installing and managing libraries
- Support for a wide range of Arduino boards



V. Working & Implementation

1. Connect the ESP32 CAM module to the Arduino IDE.

The ESP32 CAM module is an Arduino compatible board that has a camera module built in. To connect the ESP32 CAM module to the Arduino IDE, you will need to use a USB cable.

2. *Write the code for the ESP32 CAM module to take pictures and detect fog.*

The code for the ESP32 CAM module will need to do the following:

- Take pictures continuously.
- Detect fog in the pictures.
- Send an alert if fog is detected.

There are many tutorials available online that can help you write the code for the ESP32 CAM module.

3. Upload the code to the ESP32 CAM module.

Once you have written the code for the ESP32 CAM module, you will need to upload it to the board. To do this, you will need to use the Arduino IDE.

4. Place the ESP32 CAM module in the agriculture field.

The ESP32 CAM module should be placed in a location where it can get a good view of the agriculture field.

5. The ESP32 CAM module will take pictures continuously.

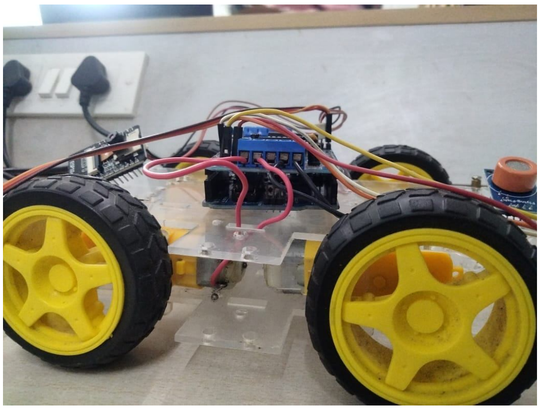
The ESP32 CAM module will take pictures every few seconds.

6. The ESP32 CAM module will detect fog in the pictures.

The ESP32 CAM module will use a technique called image processing to detect fog in the pictures.

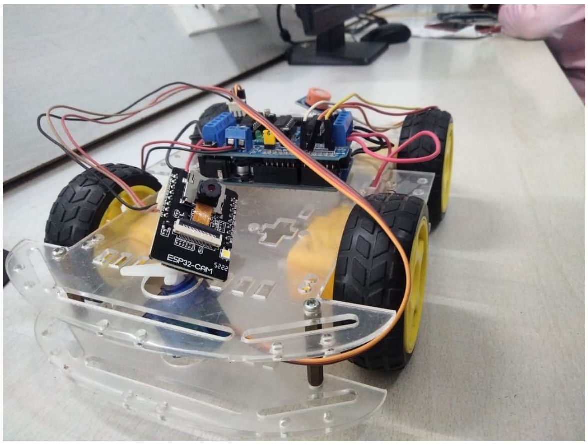
VI. RESULTS

The result of surveillance monitoring robot using ESP32 CAM module for fog detection in agriculture field is that it can effectively detect fog and send alerts to farmers or other stakeholders. This can help to protect crops and livestock from damage caused by fog.



The ESP32 CAM module is a low-cost, easy-to-use module that can be used to build a surveillance robot. The module has a built-in camera that can be used to take pictures and videos. The module also has a Wi-Fi connection that can be used to send data to a remote server or to a mobile device.

The ESP32 CAM module can be used to build a robot that can patrol an agriculture field and take pictures continuously. The robot can then use image processing techniques to detect fog in the pictures. If fog is detected, the robot can send an alert to a remote server or to a mobile device.



The use of a surveillance robot for fog detection in agriculture has several advantages. First, it is a cost-effective solution. The ESP32 CAM module is a low-cost module, and the robot can be built using off-the-shelf components. Second, it is a scalable solution. The robot can be easily modified to cover a larger area. Third, it is a reliable solution. The ESP32 CAM module is a robust module that is well-suited for outdoor applications.

The use of a surveillance robot for fog detection in agriculture is a promising new technology that has the potential to improve crop yields and reduce crop losses.

Here are some of the benefits of using a surveillance monitoring robot using ESP32 CAM module for fog detection in agriculture field:

- It can effectively detect fog and send alerts to farmers or other stakeholders.

- It can be used to patrol an agriculture field and take -pictures continuously.
- It is a cost-effective solution.
- It is a scalable solution.
- It is a reliable solution.

VII. Conclusion

The use of a surveillance monitoring robot in agriculture fields is a promising new technology that has the potential to improve crop yields, reduce labor costs, and increase efficiency.

- *Improved crop yields*: By detecting fog early, farmers can take steps to protect their crops from damage.
- *Reduced labour costs*: The robot can automate the task of patrolling the field, freeing up farmers to focus on other tasks.
- *Increased efficiency*: The robot can patrol the field more quickly and efficiently than a human.
- *Improved safety*: The robot can operate in dangerous conditions, such as fog, that would be unsafe for humans.

Future Scope

- *Agriculture*: Fog can significantly reduce visibility and impact crop growth. This project can be used to monitor fog levels in agricultural fields and send alerts to farmers if fog levels are too high.
- *Transportation*: Fog can also reduce visibility and cause traffic accidents. This project can be used to monitor fog levels on roads and highways and send alerts to drivers if fog levels are too high.
- *Safety*: Fog can also reduce visibility and make it difficult to see hazards. This project can be used to monitor fog levels in public areas and send alerts to people if fog levels are too high.
- *Security*: Fog can also be used to conceal illegal activities. This project can be used to monitor fog levels in sensitive areas and send alerts if fog levels are too high.
- *Weather forecasting*: Fog can also be used to improve weather forecasting. This project can be used to collect data on fog levels and use this data to improve weather models.

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A Review on Prediction of Solar Energy using Artificial Neural Network

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***Abstract*— Global acceptance of sustainable development and renewable energy is rising as a result of climate change's growing effect on national and local governments. The EU 2030 agenda, which aspires to give everyone access to affordable, dependable, and sustainable energy in the future, reflects this. A barrier to achieving this goal is some renewable energy sources' limited reliability. While both private citizens and governmental organizations work to produce enough renewable energy to meet their needs, it is unclear how much investment will be needed to lessen the unreliability caused by environmental factors such seasonal variations in wind speed and daylight. In this regard, a tool that helps predict the energy output of sustainable sources throughout the course of the year for a particular location can significantly help in boosting the efficiency of sustainable energy investments. In this study, we use Internet of Things (IoT) sensors, installations spread across Europe, and open data sources to build such a tool utilizing artificial neural networks. We investigate the effects of various factors on the estimation of energy production as well as the potential use of public data to predict the expected output of sustainable sources. We give users the information they need to decide what investments to make based on the necessary energy production for their particular location. Our method offers an abstraction layer that is focused on energy production rather than radiation statistics and can be taught and customized for different locations using open data, in contrast to cutting-edge alternatives.**

***Index Terms*— Renewable, Internet of Things, sources, estimation, energy, production**

I. INTRODUCTION

Due to deregulation of the market, growing demand, and environmental concerns, the traditional energy network has undergone numerous changes recently. These modifications have created difficulties that conventional energy networks might not be able to resolve. A solution that the standard network alone cannot offer may be offered by distributed generation in conjunction with the use of renewable technology. The improvement of reliability, the reduction of power loss, and the incorporation of clean energy are some advantages of distributed generating. However, adding dispersed generation to the established network increases the number of agents that need to be managed, so making the grid more complex. Negative consequences may also manifest, such a grid that is unable to maintain frequency and voltage stability or a traditional network control system that is insecure. Microgrids can be utilized in this situation as a platform to incorporate dispersed generating technologies into the current network and counteract these negative consequences. As is well knowledge, the current local weather directly affects the generation of solar energy. It is important to remember that solar power is not simply diurnal in nature, but also

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changes as the sun's irradiance changes throughout the day. For this reason, if a balanced system is intended, a calculation of future power generation by this kind of source is required. But for these calculations to be accurate, it is necessary to understand the future weather variables that will impact these technologies.

II. Literature Review

Vikas Khare et. Al. (2023) states that population growth and technological improvements are driving up energy demand at all over the world. Due to the lavishness of sunlight, the demand for solar energy for electrification has exploded. This paper describes various trending aspects of the solar energy system under different circumstances. This comprehensive review on solar energy system is based on the different parameters. At the initial level design prospectus of solar cell is assessed through the quantum dots based solar cells, recent trends of solar energy system are explained through the solar powered tree and floating solar power plant, further analysis is application of trending technology such as internet of things, artificial intelligence, data analysis and cognitive approach in the area of solar energy system. The significant answers to the problem of rapidly rising energy consumption is the development of various solar energy (SE) systems. This could be accomplished by improving the performance of solar-powered products in specific operating situations. Solar photovoltaic (PV) power output is quickly expanding in wide-ranging power sectors, thanks to greater dispersion of solar as an inconstant power resources(IPR). PV systems' power output is highly dependent on the weather condition, therefore unexpected swings in power output may increase the power system's running expenses. Furthermore, one of the most significant challenges in assimilating this IPR into the grid is its irregularity, as continuous production cannot be assured at any given time period. This discourages efficacies from deploying PV electricity since grid general balancing and planning become extremely difficult. For successfully integrating IPR into the grid, developing a trustworthy method that can diminish the mistakes linked with estimating predicted PV power generation is particularly beneficial. PV power prediction has the potential to help solve these problems [1]

Lin Chen1 et. Al. (2023) states that Climate change is a major threat already causing system damage to urban and natural systems, and inducing global economic losses of over $500 billion. These issues may be partly solved by artificial intelligence because artificial intelligence integrates internet resources to make prompt suggestions based on accurate climate change predictions. Here we review recent research and applications of artificial intelligence in mitigating the adverse effects of climate change, with a focus on energy efficiency, carbon sequestration and storage, weather and renewable energy forecasting, grid management, building design, transportation, precision agriculture, industrial processes, reducing deforestation, and resilient cities. We found that enhancing energy efficiency can significantly contribute to reducing the impact of climate change. Smart manufacturing can reduce energy consumption, waste, and carbon emissions by 30–50% and, in particular, can reduce energy consumption in buildings by 30–50%. [2]

Mokhtar Jlidi et. al. (2023) states that in recent years, researchers have focused on improving the efficiency of photovoltaic systems, as they have an extremely low efficiency compared to fossil fuels. An obvious issue associated with photovoltaic systems (PVS) is the interruption of power generation caused by changes in solar radiation and temperature. As a means of improving the energy efficiency performance of such a system, it is necessary to predict the meteorological conditions that affect PV modules. [3]

Mohammad Reza et. Al. (2023) states that Renewable energy resources can be deployed locally and efficiently using the concept of microgrids. Due to the natural uncertainty of the output power of renewable energy resources, the planning for a proper operation of microgrids can be a challenging task. In addition, the information about the loads and the power consumption of them can create benefits to increase the efficiency of the microgrids. However, electrical loads can have uncertainty due to reasons such as unpredictable behavior of the consumers. This paper will study the recent works related to deep learning, which has been implemented for the prediction of the output power of renewable energy resources (i.e., PVs and wind turbines), electrical loads, and weather conditions (i.e., solar irradiance and wind speed). In addition, for possible future directions some strategies are suggested, the most important of which is the implementation of quantum computing in cyber–physical microgrids. [4]

Susan Gourvenec et. Al. (2022) states that thousands of structures are currently installed in our oceans to help meet our global energy needs. This number is set to increase with the transition to renewable energy, due to lower energy yield per structure, growing energy demand and greater and more diverse use of ocean space (e.g. for food, industrial or scientific activity). A clear and comprehensive picture of the spatial and temporal distribution of ocean energy assets is crucial to inform marine spatial planning, sustainable design of ocean infrastructure and end-of-engineered-life management, to prevent an exponentially increasing asset base becoming an economic and environmental burden. [5]

Maymouna et. al. (2022) states that traditional electricity grid (TEG) is based on one-way transmission within a hierarchical communication network. Electricity utilities have to realize the need to address the critical challenges faced, including the ever-increasing electricity demand, the low efficacy, rising electricity costs, and the bad environmental impact of existing grids. With current power network requirements, the TEG may not be able to meet those needs, which necessitates the development of the smart grid (SG). An SG uses bidirectional power transmission and information flow, making it the next generation of the power grid. The SG is conceptually divided into seven domains: generation, transmission, distribution, customers, operation, market, and service provider. The first four domains are involved in power flow, while the rest are related to control and communication in the SG system. These domains are enabled by new technologies, such as the Internet of Things (IoT), Supervisory Control and Data Acquisition (SCADA), and Advanced Metering Infrastructure (AMI), especially smart meters. [6]
Quentin Paletta et. Al. (2022) states that improving irradiance forecasting is critical to further increase the share of solar in the energy mix. On a short time scale, fish-eye cameras on the ground are used to capture cloud displacements causing the local variability of the electricity production. As most of the solar radiation comes directly from the Sun, current forecasting approaches use its position in the image as a reference to interpret the cloud cover dynamics. However, existing Sun tracking methods rely on external data and a calibration of the camera, which requires access to the device. To address these limitations, this study introduces an image-based Sun tracking algorithm to localise the Sun in the image when it is visible and interpolate its daily trajectory from past observations. We validate the method on a set of sky images collected over a year at SIRTA's lab. Experimental results show that the proposed method provides robust smooth Sun trajectories with a mean absolute error below 1% of the image size. [7]

III. Proposed System

As is well knowledge, the current local weather directly affects the output of solar energy [6]. It is important to remember that solar power is not simply diurnal in nature, but also changes as the sun's irradiance changes throughout the day. For this reason, if a balanced system is intended, an estimate of future power generation by this kind of source is required. But for these estimates to be accurate, it is necessary to understand the future weather variables that will impact these technologies. putting up a fresh forecasting model for solar energy production that will be used in a microgrid. The tool created here is based on an artificial neural network (ANN), despite the fact that other prediction approaches are offered in the literature. In the near run, 10 min, the ANN that we have created is highly accurate at forecasting the solar energy that the PV producers will generate. The microgrid's control receives this information so that it may make the best choices at any given time and so increase dependability. As a result, the benefit from the created tool is an increase in the effectiveness and dependability of the microgrid control, since the backup systems will only be activated when they are actually required.

IV. Objectives Of Proposed System

Following are the objectives in which the work will be achieved

- To presents a new prediction model for solar energy generation that will be implemented in a several systems
- To predict the future trends based on historical data
- To integrate distributed generation technologies into the traditional network and overcome these negative effects
- To facilitate training, normalized numerical features such that they have a comparable scale.
- To developed a tool for the improvement on the efficiency and reliability of the control system, as the back-up systems will be switched on only when they are really needed
- To analyse various data for perfect prediction using various Artificial Neural Network Algorithm

V. Need Of The Study

The intermittent nature of solar power creates two main issues. Firstly, power production and demand have to be balanced to ensure the control of the whole system, and the inherent variability of clean energies makes this difficult. Secondly, energy generation companies need a highly accurate day-ahead or intra-day estimation of the energy to be sold in the electricity pool. For this a framework which addresses the issue of the complexity of control in systems that are based on solar energies. The framework's ability to predict the parameters that are involved in solar energy production will allow us to estimate the future power production in order to optimize grid control. Due to market liberalization, environmental concerns, and growing demand, the traditional energy network has undergone numerous changes lately. These modifications have created difficulties that conventional energy networks might not be able to resolve.

VI. Research Methodology

Several crucial steps must be taken in order to develop a framework for predicting solar energy utilizing an artificial neural network (ANN) and open data. The framework's high-level description is given below:

A. Data gathering and preparation

Find and collect relevant open data sources for solar energy, such as historical data on energy production, weather information (such as solar irradiance, temperature, and cloud cover), location information, and time of day. In order to train the neural network, the data must be preprocessed to accommodate missing values, normalize numerical features, and translate categorical variables into acceptable representations.

B. Splitting data

To create training, validation, and testing sets, divide the pre-processed data. The testing set examines the model's performance on untested data while the validation set aids in hyper parameter tuning. The training set is used to train the neural network.

C. Engineering of Features (Optional)

Utilise feature engineering to extract new valuable characteristics from the existing data that may enhance the predictive performance of the model. For instance, time-based characteristics like the day of the week or hour of the day may be important for predicting solar energy.

D. Neural network architecture design

Select the neural network architecture that is best for the purpose of predicting solar energy. Depending on the type of input and the needs for prediction, common options include feedforward neural networks, recurrent neural networks (RNNs), or convolutional neural networks (CNNs).

E. Model Education

Utilise the training dataset to train the neural network. To reduce the prediction error (for example, mean squared error) between the anticipated solar energy output and the actual values from the training data, the model optimises its weights and biases. Utilise the validation set to do hyper parameter tweaking to determine the ideal setting for variables like learning rate, batch size, number of hidden layers, and neurons per layer. This enhances the model's ability to generalise and perform well with new data.

F. Model assessment

To gauge the training model's accuracy in predicting solar energy production, compare it to the testing dataset. Mean absolute error (MAE), root mean square error (RMSE), and coefficient of determination (R-squared) are common evaluation measures.

G. Actual deployment and forecasting

Utilise the trained neural network as a service or application to create real-time forecasts about solar energy based on fresh weather data and other pertinent factors.

H. Updates and Continuous Monitoring

Keep an eye on the model's performance all the time, updating the neural network whenever fresh data becomes available or the distribution of the underlying data changes. Understanding the variables that affect solar energy generation can help with energy planning and grid management by analysing the model's behaviour and interpreting its forecasts. It is crucial to guarantee the integrity and quality of the open data utilised during the framework's development as well as to take ethical and privacy concerns linked to data usage into account. Collaboration with stakeholders and subject matter experts in the field of renewable energy can also assist to improve the framework and make it more useful for practical implementations. An artificial neural network with the purpose of processing sequential data is called a recurrent neural network (RNN). RNNs include connections that create cycles, allowing information to remain and be transmitted from one time step to the next, in contrast to feedforward neural networks, where information flows in a single direction (from input to output).

VII. CONCLUSION

In this way after utilizing open data sources, Internet of Things (IoT) sensors, and installations spread across Europe, we build such a tool in this study which helps to predict the sources of renewable energy. Also looking at how many factors affect the forecasting of energy production as well as the potential use of open data to predict the expected output of sustainable sources. In accordance with the necessary energy output for their particular area, we give users the information they need to make investment decisions. Our method offers an abstraction layer that, in contrast to cutting-edge methods, is focused on energy production rather than radiation statistics and can be taught and adjusted for different locations using open data.

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Kidney Disease Classification

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***Abstract*— The analysis of any clinical situation fast and efficaciously offers one in every of the largest boundaries to imparting suitable care. The important intention of this task in figuring out renal problems, primarily based totally on the CT photographs of kidney, and growth effectiveness and accuracy. In this research, we hired deep gaining knowledge for the multiclass category job. We used fashions like VGG19, Mobile Net and ResNet50 which are used for multi elegance category.**

***Index Terms*— VGG19, MobileNet, ResNet50, CNN.**

I. Introduction

Kidney stone disease (KSD), a common condition, is mostly caused by solid mineral deposition within the kidney. Depending on sociodemographic, lifestyle, nutritional, genetic, gender, age, environmental, and climatic factors, the frequency of the disease varies, but it has been progressively increasing in size. the world. KSD (kidney stone disease) has a high rate of Within years of the stone removal, around 11%. These stones are made of solid Mineral deposits which might be either found free in the renal calyces and pelvis or attached to the renal papillae. When the urine is oversaturated with a particular mineral, such as calcium oxalate, kidney stones can form. They are made up of crystalline and organic components. With rates up to 14.8%, stone formation is becoming more frequent, and after five years of the initial episode, recurrence rates might reach up to 50%. Obesity, diabetes, hypertension, and Metabolic syndrome are hazard elements for the development of stones. Hypertension, end-stage renal disease, and chronic kidney disease can all be brought on by stone development. People of color are more prone to get kidney tumors than any other type of cancer.

Diagnosis of disease in the kidney the task is challenging because of the problem it poses. kidney's intricate structure. To enhance the More efficient models and processes that can help in making accurate decisions needed to enhance the improve the precision of radiologists' diagnoses. process of identifying kidney stone disease. is based on multiple imaging modalities. This necessitates the ability of radiologists to interpret and provide a detailed diagnosis. Computer-aided diagnostic technologies can be helpful supplements to help clinicians with their diagnosis. In recent years, there have number of studies in which diseases have been diagnosed using deep learning. Besides deep learning, other features Computer vision encompasses various tasks, such as image classification and image recognition attribute extraction, and image classification by predicting future outcomes.

In the figure 1 the block diagram involves the collection of kidney CT scan images. This requires gathering a dataset that includes a different kind of images representing different conditions such as cysts, tumors, kidney stones, and normal kidneys. The dataset should be comprehensive and diverse to ensure accurate analysis and classification. Once the images are collected, the further step is image processing. This involves applying various techniques to improve the quality of the images and remove any noise or artifacts that may affect the

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subsequent analysis. Image processing methods may include noise reduction, contrast enhancement, and edge detection to improve the overall image clarity and make it suitable for feature extraction. After image processing, the block diagram involves the task involves extracting features using three distinct convolutional neural networks. (CNNs): VGG19, ResNet50, and Mobile Net. These CNNs are pre-existing models that have been trained on large-scale image datasets and have learned to extract meaningful features from images. By feeding the processed kidney CT scan images into these models, relevant features specific to each image can be extracted. subsequently is the classification of the extracted features. These features are utilized as input for a classifier that is trained to differentiate between different kidney conditions: cysts, tumors, kidney stones, and normal kidneys.

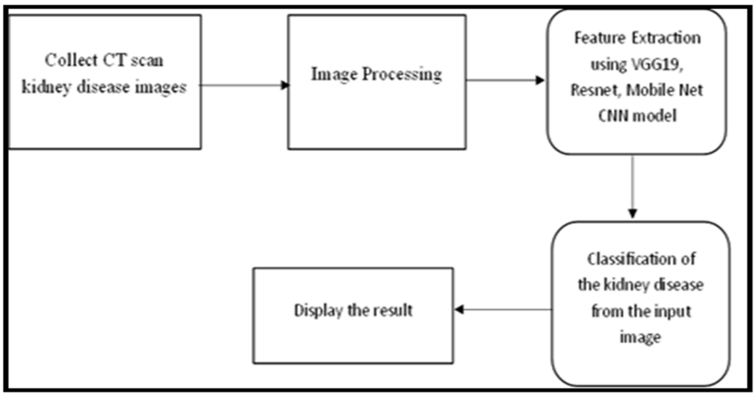

Figure 1. Block diagram of kidney disease classification

The classifier utilizes machine learning algorithms, such as support vector machines (SVM) or random forests, to learn patterns and make accurate predictions based on the extracted features. Finally, the block diagram includes the display of the disease classification results. Once the input image is processed, and features are derived and classified, the system can provide the predicted disease label for the kidney CT scan image. The output can be displayed to the user, indicating whether the image represents a cyst, tumor, kidney stone, or a normal kidney. This knowledge can benefit healthcare. professionals in diagnosing and treating kidney-related conditions more effectively.

II. Related Work

Vishnu Prasad G. P, Kura Pati Vishnu Sai Reddy, proposed the new method for kidney stone detection 2021. Kidney stones are a prevalent disease all over the world, resulting in many of us being rushed to the hospital in excruciating pain. Calculus illness is diagnosed using a variety of imaging modalities [1]. Jyothirmai Joshi, Sai Nikita, Viswa Chandrika, Sindhu, Jahnavi proposed the system Kidney stones detection using Image processing technique. The main objective of this project is to detect the kidney stone from the digital ultrasound image of the kidney by performing various image processing techniques [2]. Kristian M. Black, Hei Law†, Ali proposed the new method Deep learning computer vision algorithm for detecting kidney stone composition. in the year 2021 [3]. Venkatasubramani. K, Chaitanya Nagu, Karthik proposed a system of Kidney Stone Detection Using Image Processing and Neural Networks in the year 2021. In the study, deep learning and backpropagation neural networks were employed. The kidney images in the collection were gathered from patients at various hospitals [4]. Krishnamoorthy Somasundaram1, Suresh Manimekalai, Paulraj Sivakumar proposed new method An Efficient Detection of Kidney Stone Based on HDVS Deep Learning Approach in the year 2021[5].
The identification of kidney stones utilizing CT scans and in-depth image processing techniques. The enhanced method to identify boundaries, segmented areas, and improve stone placement identification from the kidney was investigated in this study. This inquiry was useful in locating a stone based on pixels. The analysis revealed that this research has 92.5% accuracy using a reliable stone detection method [6]. A 2D-CNN version become proposed in which had 3 fashions regarding with Kidney Tumor detection together with a 2D convolutional neural community with six layers (CNN-6), a ResNet50 with 50 layers, and a VGG16 with sixteen layers. The closing version was used for type as a 2D convolutional neural community with 4 layers (CNN-4) [7]. A segmentation primarily based totally kidney tumor type the usage of Deep Neural Network (DNN) became used in. It had steps. Firstly, the kidneys have been segmented the usage of a guide segmentation method and educated U Net together with Seg Net for kidney segmentation [8]. Ghalib et al.carried out a observe for renal tumor detection the usage of deep studying techniques on CT scans. The authors evolved a green set of rules to come across and similarly

examine renal most cancers tumors the usage of CT for patients. The preprocessing method concerned figuring out the noises of a CT test and getting rid of them with a right filtering method [9]. Liu et al. performed a observe for exophytic renal tumor detection thru system studying strategies on CT scans. They used 167 CT scans and evolved a framework for kidney segmentation on non-settlement CT pics the use of green perception propagation [10].

Budak [11], investigated the success of a deep learning model in detecting kidney stones in different planes according to stone size on unenhanced computed tomography (CT) images. This retrospective study included 455 patients who underwent Kidney stone diagnoses were based on their observation in the renal collecting system and on the measurement of Hounsfield units on unenhanced CT images. The number of patients and CT images with and without kidney stones in the three groups according to the sizes of kidney stones evaluated using the deep learning algorithm are presented. Training and testing were performed in the three planes and among the three study groups using the Fastai (v2) library and the Google Collaboratory platform. They used the Adam algorithm as the optimization algorithm. The sagittal-plane images on CT had higher diagnostic accuracy rates than those of other planes. Using these methods, the waiting time for results and cost of diagnosis can be reduced, and early diagnosis can be achieved, resulting in prompt management [11]. Feature extraction was based on nineteen gray level co-occurrence matrix (GLCM) features and five intensity histogram features P. Gladis Pushpa Rathi, V &Palani, S. (2011) proposed a method for segmenting the human brain for tumor detection. Image segmentation is done using Hierarchical Self Organizing Map (HSOM). Abnormal spectra and type of abnormality were determined using Artificial Neural Network and Wavelet packets [12]. Rahman, Tanzila& Uddin, Mohammad (2013) has reduced speckle noise using gabor filter and the image enhancement is done using the histogram equalization. Two segmentation techniques were used, cell segmentation and region based segmentation to extract the kidney regions [1]. Hafizah, Wan &Supriyanto, Eko & Yunus, Jasmy (2012) classified kidney ultrasound images into different groups creating a database based on the features extracted [13]. Bommanna Raja, K &Muthusamy, Madheswaran & Thyagarajah, K. (2007) identified significant content descriptive feature parameters and classified the kidney disorders with ultrasound scan Stevenson, Maryhelen& Winter, Rodney &Windrow, Bernard made an analysis to determine the sensitivity of feedforward neural network to weight errors [14]. In the paper by AV Gregory and DA Anaam (2021) reconstructed the goal of detecting or locating object and the segmentation job which is instance-based into a problem (semantic segmentation), and created the initially 3rd dimension semantic instance cyst segmentation method in MR images for kidney. Using a 3rd dimension watershed method on a 3D Euclidean distance map of generated cyst segmentation from the MRI pictures, from the manual cyst tracings they have built an initial instance of cyst segmentation. One label cyst segmentation was performed using a previously established automated semantic cyst segmentation technique to speed up the cyst segmentation procedure for the validation and training sets. The 3rd dimension watershed procedure explained in the prior section was applied to that resulting segmentation. They employed the U-Net architecture and four-fold cross-validation sets for the training and validation phases [15].

III. METHODOLOGY

The goal of the "Kidney Disease Classification" (KDC) project is to create a classification or a distinguishing system between kidney stones, kidney cysts, kidney tumors, and normal kidney conditions. The KDC model or algorithm is designed to analyze medical information, such as CT images or patient records, to classify the kidney condition based on the information provided. The aim of the project is to achieve high-quality classification to help healthcare professionals diagnose and treat kidney diseases more efficiently. Early detection of kidney diseases can result in early interventions, better patient outcomes and potentially lower healthcare costs.

In this project, we are proposing to use deep learning to classify the medical images as kidney stones, cyst, tumors, normal tissue, etc. The methodology is as follows:

1. Collect the dataset from Kaggle to ensure that the images are accurately annotated with the appropriate label.
2. Select the appropriate model architectures for the classification task, namely VGG19, ResNet50, MobileNet
3. Obtain the features from the medical images dataset by running the images through the selected pretrained models and extracting the output probabilities of each class.
4. Assess the effectiveness of the performance of the pretrained models on a specific validation dataset to measure their accuracy.

A. Dataset

The dataset for kidney disease classification consists of four classes cyst, tumor, stone, and normal kidney. The dataset is split into two folders: train and test. In the train folder, four classes exist, and representing a different

type of kidney condition. The cyst class contains 2919 images, the tumor class contains 4057 images, the stone class contains 1091 images, and the normal kidney class contains 2913 images. These images are representative of the respective kidney conditions, and they are employed to instruct the classification model.
Similarly, in the test folder, there are also four classes. The cyst class contains 780 images, the normal kidney class contains 1020 images, the stone class contains 280 images, and the tumour class contains 460 images. These visuals are utilized to assess the effectiveness of the trained model on unseen data. The cyst class represents images of kidneys with cysts, which are fluid-filled sacs that can form on the kidney. The tumour class represents images of kidneys with tumours, which are abnormal growths of cells. The stone class contains images of kidneys with stones, which are hard deposits that can form in the kidneys. Finally, the normal kidney class contains images of healthy kidneys without any abnormalities. The dataset provides a diverse set of images representing different kidney conditions, allowing for the development and evaluation of a classification model. This dataset can be used to train a machine learning model to classify kidney images into one of the four classes, enabling the automated detection and diagnosis of kidney diseases.

Figure 2. sample dataset

B.Model Description

There are many deep gaining knowledge of fashions "which may be replaced by an alternative word." handy at present. CNN are computational fashions made from interconnected neurons organized in layers and are stimulated through the human brain. Data is taken through the enter layer and propagated thru the hidden layers the usage of weighted connections. Neurons introduce non-linearities through making use of activation capabilities to the weighted sum of inputs. Up till the output layer starts off evolved to provide predictions, this ahead propagation procedure is continued. Mobile Net, VGG19 and ResNet50 are taken into consideration to the sub components of CNN.

1. MobileNetV2

The counseled community layout for class is visible in Figure. It includes a contracting course at the left and a classifier head at the right. By time and again making use of 3x3 convolutions every observed with the aid of using a linear unit of rectified form (ReLU), and a maximum pooling operation (2x2 max) with a stride of 2 for down. sampling, the contracting path adheres to the usual layout of a neural community. Repeating those 3 processing steps time and again creates a group of absolutely connected layers, known as Blocks. The function map matrix is flattened into vector shape at the realization of the MobileNetV2 level and fed into the classifier level, that's a completely related layer that resembles a neural community

2. ResNet

ResNet50 is a CNN community version that has revolutionized the sphere of pc vision. It includes 50 layers and is thought for its deep architecture, which enables triumph over the vanishing gradient problem. ResNet50 makes use of pass connections or shortcut connections to permit the go with the drift of facts from in advance layers to next layers, taking into account the advent of a deeper community without sacrificing performance. By addressing the problem of facts degradation at some stage in training, ResNet50 achieves super accuracy in responsibilities which includes photo classification, item detection, and photo segmentation.

3. VGG19

VGG19 (Visual Geometry Group) CNN (NGN) model that has become popular in the computer vision community. Named after the Oxford Visual Geometry Group, where it was first developed, VGG19 has a deep architecture consisting of 19 layers. This deep architecture helps VGG19 to extract complex features from images. VGG19 follows a simple and homogeneous design. It consists of multiple stacked convolution layers, each with small filter sizes. The convolution layers are then max-pooled to provide spatial down sampling. Because of its deep layers, VGG19 achieves high the performance in different visual recognition tasks, such as image-related tasks, is assessed. classification, and object localization.

IV. Implementation

The implementation of a kidney disease project involves the practical steps taken to address the challenges of kidney disease, such as prevention, early detection, diagnosis, treatment, and management. It begins with project planning, including needs assessment and stakeholder engagement, continued by the design of evidence-based interventions. Resources are allocated, training is provided to stakeholders, and continuous monitoring and evaluation are conducted. Collaboration and sustainability planning are key components to ensure long-term impact. By following this systematic approach, the project aims to alleviate the burden of, kidney disease and improve outcomes for affected individuals.
In the figure 3 the user interface provides a user-friendly platform that allows users to explore and select CT scan images in JPG or PNG format from their local file system. Users can locate the desired images and choose them for uploading to the system. Once the user has selected the JPG or PNG images, they can initiate the upload process by clicking on the "Upload" or "Submit" button. The system then transfers the selected image files from the user's device to the server hosting the project.
In the figure 3, the upload page is designed to make it easier to process of browsing and uploading image files for analysis and classification. This page serves as a user interface where individuals involved in the project can convey information to the system connect information to the system submit relevant image data. The page typically includes a file browse button or an option to choose a. folder, enabling users to navigate through their local file system or network storage. By clicking on this button, the file explorer window will open, allowing you to the user to search and select the desired image file or folder containing multiple image files related to kidney disease.
The result page of a kidney disease classification project provides information about the classification of different types of kidney conditions based on CT scan images. The goal of project is to accurately identify and classify the occurrence of tumors, cysts, stones, or a normal kidney in the given CT scan image with accuracy and visualization.

Figure 3. Screenshots of the GUI for Kidney disease classification

V. Results

In the table I below, we have three deep learning models were trained (VGG19), Mobile Net and ResNet on a dataset using the 80-20 split 80% models were trained using the dataset. 20% the data were utilised to test and evaluate the models' performance First, let's look at VGG19 It was instructed on 80% dataset and when we tested it on the remaining 20% dataset, it achieved 95% accuracy. VGG19 is a deep learning (DNN) architecture that is well-known for its depth and its ability to classify unseen images. The 95% accuracy indicates that the VGG19 was able to learn and generalize a set of practise data to classify unseen images accurately in the testing phase. The next move was to train the MobileNet model on the same 80% dataset. The MobileNet model was evaluated on 20% testing data and achieved an impressive 98% accuracy. MobileNet is a lightweight, convolutional neural net architecture that is optimized for efficient computing on mobile devices and embedded devices. The 98% accuracy suggests that the MobileNet model learns and generalized the patterns in the training data. This makes the MobileNet model highly accurate when classifying unseen images in testing. The ResNet model was also trained on 80% of the training data. The ResNet model achieved an impressive 93% accuracy when tested on 20% of testing data. The 93% accuracy indicates that ResNet learned and classified images with high accuracy, including previously unseen data in testing.

TABLE I. ACCURACY RATES FOR TRAINING AND TEST DATASET SPLIT OF 80-20

Dataset	Model	Accuracy
80-20	VGG19	95%
80-20	Mobile Net	98%
80-20	Resnet	93%

TABLE II. ACCURACY RATES FOR MODELS

Dataset	Model	Epoch	Accuracy
80-20	VGG19	10	74%
70-30	VGG19	10	69%
50-50	MobileNet	10	70%

TABLE III. ACCURACY RATES FOR MODELS

Dataset	Model	Epoch	Accuracy
70-30	VGG19	10	74%
70-30	VGG19	5	69%
70-30	Mobile Net	15	72%

Table II shows that VGG19Model achieves 74% accuracy when train and test are split in 80-20 ratio and the epoch is set to 10. Similarly, VGG19model achieves 68% accuracy for the 70-30 ratio. We repeated the experiment for mobile Net using the following parameters:70% accuracy for Mobile Net

In Table III, VGG19Model achieves 74% accuracy when train and test are split 70-30, and the epoch is set to 10. Similarly, the experiment is repeated for other models with the epoch set to 5. For VGG19 model, the accuracy is 69% and for Mobile Net, the accuracy is 73% when set to 15. The classification process involved three models: ResNet50, Mobile Net, and VGG19, which were used to classify different classes of kidney conditions. The classes included tumor, kidney stone, cyst, and normal kidney. Each model was evaluated to assess its performance in accurately classifying these classes. The graph can be created to visually represent the accuracies of the models, allowing for a clear comparison and aiding in the selection of the most reliable model for classifying tumor, kidney stone, cyst, and normal kidney conditions.

Figure 9 is graph obtained by vgg19 model. VGG19 is a complex CNN structure renowned for it is a complex CNN structure renowned for its simplicity and uniformity, comprising 19 layers. The accuracy graph for VGG19 typically exhibits a smooth increase in accuracy with training iterations or epochs. VGG19 tends to converge relatively slower compared to more modern architectures like ResNet-50 and Mobile Net. The accuracy graph may show a gradual and steady rise, with fluctuations decreasing over time. VGG19 can achieve great precision however often requires more computational resources and training time due to its deeper architecture. It's noteworthy is the fact that the specific accuracy graphs for these models may differ based on the dataset, training parameters, and implementation details. The broad patterns discussed here offer a typical overview of how the accuracy of these models may evolve during training.

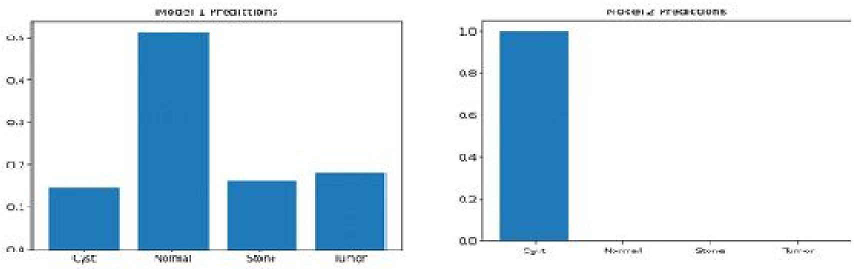

Figure 4. VGG19 and ResNet model classification

The given figure 4 is graph obtained by resnet 50 .ResNet-50 is an advanced convolutional neural network (CNN)architecture renowned for its incorporation of residual connections, which revolutionized the training of extremely deep networks. When looking at the accuracy graph of ResNet-50, it becomes apparent that it illustrates the correlation between the number of training iterations or epochs and the accuracy attained by the model on a validation or test dataset.Initially, during the early stages of training, the accuracy graph for ResNet-50 exhibits a notable and rapid ascent. This early surge signifies the model's ability to swiftly grasp low-level features from the input images, showcasing its effectiveness in capturing basic visual patterns. As the training progresses, the rate of accuracy improvement tends to decelerate. However, the model perseveres and continues to learn more intricate and complex features, leading to a gradual climb in accuracy.Throughout the training process, the accuracy graph may display occasional fluctuations or plateaus, indicative of the model's convergence. These fluctuations can be attributed to various factors, including theinherent complexity of the dataset or the presence of outliers. Despite these fluctuations, ResNet-50 consistently demonstrates remarkable accuracy, frequently surpassing the performance of previous state-of-the-art models in various computer vision tasks.

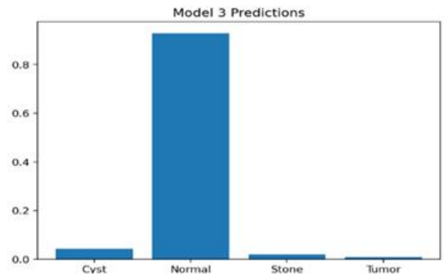

Figure 5. MobileNet model classification

In the given figure 5 graph obtained from mobilenet model. mobilenet is an artificial neural network design that was created especially forthe purpose of mobile and resource-constrained devices. Its primary advantage lies in its efficiency and suitability for deployment on What is a device with a limited amount of computing power, such as smartphones or embedded systems. The accuracy graph of Mobile Net generally follows a similar pattern to that of ResNet-50, a larger and more complex model. However, there are a few distinctions between them due to Mobile Net’s smaller size and reduced computational requirements. Initially, when Mobile Net is compared to ResNet-50, it may exhibit lower accuracy.

This is primarily because Mobile Net has a minimizing number of parameters and a reduced model capacity. It may struggle to capture complex features and the data as patterns effectively as ResNet-50. However, as Mobile Net undergoes training, its accuracy steadily increases. This increase in accuracy demonstrates that Mobile Net is capable of learning meaningful representations and achieving competitive performance levels. Despite its lightweight design, Mobile Net can still capture important features and patterns in the data, enabling it to make accurate predictions.

VI. CONCLUSIONS

In conclusion, the kidney stone, cyst, tumor, and normal kidney classification project aimed to analyze and categorize medical data related to kidney health. The dataset contained 12,446 unique samples, with the cyst category comprising 3,709 samples, the normal category containing 5,077 samples, the stone category consisting of 1,377 samples, and the tumor category including 2,283 samples. The project's objective was to develop a classification model capable of accurately identifying and distinguishing between these four kidney conditions. By leveraging machine learning algorithms and techniques, such as deep learning or decision trees, the project aimed to Provide medical professionals with a valuable resource. to aid in diagnosing and treating kidney-related conditions. The successful implementation of such a classification model would Carry considerable consequences for improving patient care, treatment planning, and overall kidney health management. This approach has the potential to reduce both the waiting time for results and the cost of diagnosis and early diagnosis can be achieved, resulting in prompt management. With the help of fully developed fully kidney disease detection system, the workload of the radiologists can be reduced.

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Deep Learning Approach for Fruits Classification

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***Abstract*— Fruit classification is an extension of object detection and accounts for a sizeable portion of fresh products in the food industry. Fruits were formerly classified, which takes time and necessitates continual human presence. Fruit classification is essential for many industrial applications. Supermarkets all across the world must arrange different fruits in order to appropriately organize their price tags and racks. It is challenging, particularly in these days. In order to manually locate the category of the item being purchased in the system, either the customer or the cashier must first determine what it is. Fruits are categorized and used in agriculture to recognize and group fruits based on characteristics including size, shape, color, texture, ripeness, and edibility. As a result, the farmer is able to sort and grade the fruits to ensure that they arrive at the market in the best possible shape. In this essay, we primarily concentrate on categorizing fruits. Three models—MobileNetv2, ResNet50V2, and DenseNet121—were trained for the classification, and we got the best classification accuracy of 98.97%.**

***Index Terms*— Deep learning, Neural networks, ResNet, MobileNet and DenseNet.**

I. INTRODUCTION

Fruit makes up a significant amount of fresh product in the food sector, and the classification of fruit is an extension of object detection. In previous times, the classification of fruits was done manually, which takes time and demands constant human presence. Classifying fruits is a critical task for numerous industrial applications. All around the world, supermarkets have to arrange various fruits in order to organize their racks and price tags properly. It is difficult, especially today when they confuse the human eye. In agriculture , fruits are been classified and used to identify and group fruits based on their features, such as size, shape, color, texture, maturity, and edibility. This enables the farmer to sort and grade the fruits in order to deliver them to the market in the best conditions. Fruit classification is a crucial activity in the food and agricultural industries because it can aid in automating the process of sorting fruits according to their external appearance, which is a crucial component in assessing their quality, size, ripeness, and market worth. Fruits classification can be beneficial or they can give the excellent service to the stake holders or the end users in varies fields. The classification can be benefited to the farmers that enables them to sort and classify their product based on the characteristics and qualities of each fruit. This can increase the price at which they can sell their produce and cut down on waste. They can spot any quality problems and fix them before the fruits are delivered to market with the aid of accurately graded fruits. This classification not only gives the excellent services in the matter of farmers but also helps consumers by enabling them to distinguish and choose fruits based on their quality, maturity, and sweetness. They may use this information to make wise decisions and get the most for their money. They can avoid purchasing overripe or unripe fruits by using proper grading. Fruits can be categorized based on their visual characteristics using deep learning, a effective method that has demonstrated significant potential for image recognition and classification applications. One of the most important

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machine learning techniques is the deep learning(DL), which can automatically pick up on a variety of features and patterns without the human input. The correctness of the fruit classification system depends on the standard of the gathered fruit photos, the quantity and types of features recovered, the kinds of features chosen, the best classification features chosen from the retrieved characteristics, and the kind of classifier used. Fruits are frequently categorized according to their size, color and shape. The domain of the fruit classification project starts with the deep learning. Specifically, it involves training a deep learning model to accurately classify images of varies types of fruits. The objective of this research is to develop a model that can recognize various fruit varieties based on their distinguishing visual traits, such as shape, size, color, and other attributes. Numerous uses for this include automated harvesting, fruit classification and sorting systems that are more effective, and quality control in the food business. Deep learning is a subpart of machine learning that utilizes neural networks to extract features from data and do predictions. Deep learning models can be trained on huge datasets of labeled photos in the context of image classification to discover patterns and features that relate to various object classes. The Fruits classification application could be useful for a variety of users who needs to identify or work with different types of fruits. The food industry can use this application to sort and grade fruits based on their appearance and quality, improving the efficiency of their operations and ensuring consistent product quality and quality control from the field to the supermarket, fruits quality can be tracked using technology for classification of fruits. Consumers can gain more knowledge about the fruits they are purchasing by using technology for fruits classification. By classifying and labeling different types of fruits, the food industry may help consumers make better purchase decisions.

II. RELATED WORK

The research describes a deep learning method for classifying images that makes use of a trained CNN model for feature extraction. The approach for categorizing 10,000 real-world photos of cats and dogs using the CNN with stochastic gradient descent algorithm on CIFAR-10 dataset, was presented by Panigrahi, A. Nanda [1]. Y. Naung, Z.M. Khaing, et al. proposed, a system incorporating CNN for fruit categorization and Alexnet as the algorithm was proposed. This research examines a convolutional neural network-based method for developing control systems for object recognition. The results of their test classification accuracy for the 30 classes of 971 images being close to 94%[2]. The six-layer CNN model is computationally effective and has the ability to handle massive amounts of data with speed and reliability. This paper by S. Lu, Z. Lu, S. Aok et al, suggests a method for identifying fruits based on convolutional neural networks. The experimental findings achieved a 91.44% accuracy rate[3]. With a collection of 200 fruit pictures, a system that uses K-Means, nonlinear, entirely connected layers, and pooling layers is described. Convolution neural networks-based classification strategy is proposed by R. Yamparala, P. S. R. Krishna, et al, which offers a 90% better classification result than other proposed methodologies [4]. Fruits fresh and rotten were suggested as the classification dataset together with the Transfer learning method, VGG-19, LeNet, and AlexNet as algorithms in classifying fruits proposed by Rupali Pathak and Hemanth Makwana .[5]. Using convolutional neural networks, a system that uses deep learning, data augmentation, AlexNet, VGG-16 as an algorithm and our suggested system divides the four fruits banana, papaya, mango, and guava into three stages: raw, ripe, and over-ripe which is proposed by Rucha Dandavate and Vineet Patodkar [6]. The sequential method, CBIR, and CNN are the three algorithms used in the system by Gurubhaksh Ponsa and Atul Sharma have described. This study will show how image categorization works in the setting of the CIFAR-10 dataset. They achieved 94% of accuracy for the three classes used in the CIFAR-10 dataset[7]. In the article proposed by Chandan.R.,Joshi.R, CNN models are developed to assess how well they perform on datasets for image recognition and detection. A system using Deep Learning, Overfitting Augmentation, SVM, KNN, and CNN as algorithms and CIFAR-10, MNIST as a dataset is described[8]. The system proposed by PL.Chithra, M.Henila's, along with its image processing methods, Support vector machine (SVM), KNN, suggests that after separating the fruit from its background and gathering information on its shape and colour, they applied a segmentation technique. [9]. LeNet-5, SENet, RESnet, and MNIST dataset were used in the paper proposed by Paramartha Dutta, Abu Sufian, et al. They have demonstrated improvements in CNN through this research, from LeNet-5 to the most recent SENet model. ResNet improved accuracy by combining the inception module and residual blocks with the traditional CNN model [10].

III. METHODLOGY

In the proposed work, for preprocessing Neural networks technique is been used for the classification of the fruits where the features are been extracted by the model itself. Fig 1 represents image processing techniques for the classification , which contains all the steps like preprocessing, feature extraction and the classification. This methodology is been used for all the models.

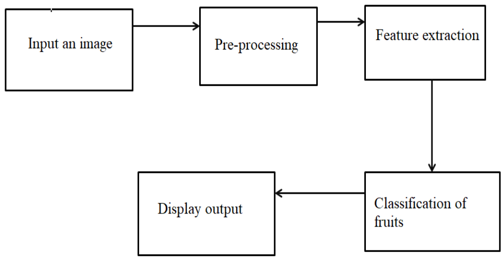

Fig 1. Fruit image classification processing

A. Dataset

The proposed model contains the dataset of 6000 images with 15 different types of fruits which is collected from the kaggle. The dataset includes Apple Barium, Mango, Avocado, Orange, Lemon, Strawberry, Raspberry, Pomegranate, Watermelon, Blueberry, Apricot, Banana, Dates , Guava and pineapple. The Dataset is also been tested with Sample Dataset which includes all the 15 classes but each class contains 10 fruits in Training dataset and 2 fruits which is being kept for testing in Test dataset. These images are being trained and tested with different CNN models like DenseNet121, ResNet50V2 and MobileNet.

B. Model Description

There are many deep learning models that are accessible at present. Neural networks are computational models made up of interconnected neurons arranged in layers and are inspired by the human brain. Data is received by the input layer and propagated through the hidden layers using weighted connections. Neurons introduce non-linarites by applying activation functions to the weighted sum of inputs. Up until the output layer begins to give predictions, this forward propagation process is continued. MobileNetV2, DenseNet121 and ResNet50V2 are considered to be the different models of CNN.

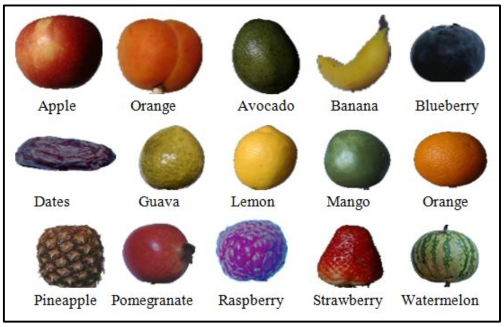

Fig 2. Dataset

1. *Mobilenetv2*

In Fig. 3, the architecture of MobileNetV2 consists of a contracting path on the left and a classifier head on the right. By repeatedly applying two 3x3 convolutions each followed by a rectified linear unit (ReLU), and a 2x2 max pooling operation with stride 2 for down sampling, the contracting route adheres to the standard design of a neural network. Repeating these three processing steps repeatedly creates a collection of completely linked layers, called Blocks. The feature map matrix is flattened into vector form at the conclusion of the MobileNetV2 stage and fed into the classifier stage, which is a fully connected layer that resembles a neural network.

2. Resnet50v2

In the fig4, Deep convolutional neural network architecture of ResNet50V2, also known as Residual Network with 50 layers and version 2, is widely employed for image classification tasks. It is a modified version of the original ResNet model that addresses the problem of disappearing gradients and makes various changes to boost performance. To create the final classification output, ResNet50V2 uses batch normalization, average pooling, and

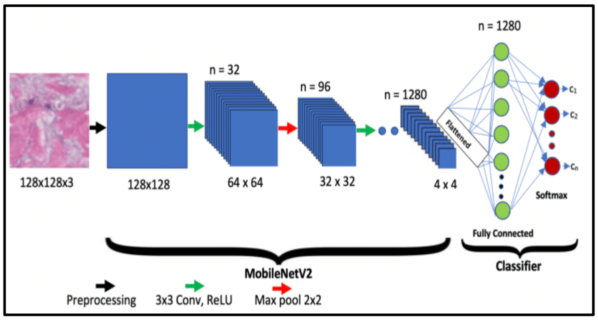

Fig. 3. MobileNetV2 Architecture

fully connected layers in combination. ResNet50V2 achieves state-of-the-art performance on a variety of image recognition benchmarks thanks to its deep structure and residual connections, indicating its usefulness in capturing nuanced features and aiding effective training.

3. Densenet121

In fig5, the DenseNet121 model begins with a series of convolutional layers that extract low-level features from the input fruit images. Multiple highly interconnected convolutional layers make up the design, allowing for direct connections between all layers and facilitating the effective transmission of information and gradients throughout the network. These features are then passed through dense blocks, which are composed of multiple convolutional layers, where each layer receives inputs from all preceding layers. Global average pooling, fully linked layers, and a softmax activation function make up the architecture's final section, which generates class probabilities for fruit categorization.

IV. Implementation

In this paper, the images from the Fruits-360 dataset were taken with the 15 classes of fruits of 6000 images, we trained and tested the images to obtain the result of which class the fruits belongs to and get classified according to their class. After the models got created, the model was tested and find its accuracy based on the size, shape, color and epochs.

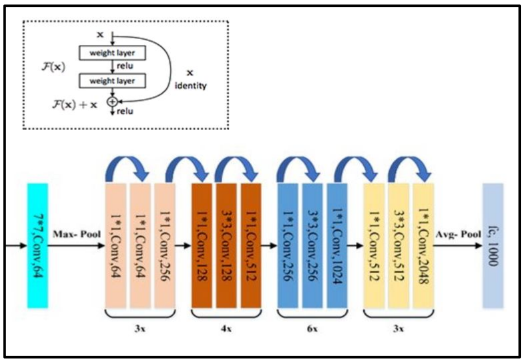

Fig 4. Reset50V2 Architecture

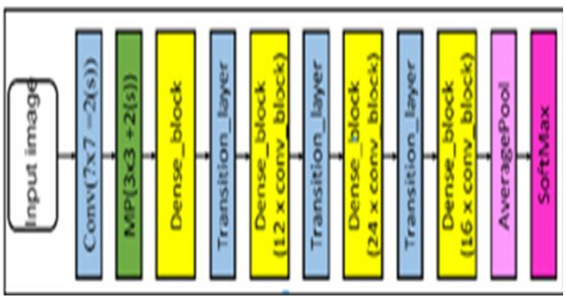

Fig 5. DenseNet121 Architecture

In fig 6, displays the project's frontend display page, which includes a visually pleasing panel for choosing an image from the dataset. The title of the project is prominently displayed on this page, drawing attention to its importance to the project's construction as a whole. Fig. 7, exhibits the selected image but also provides relevant details about it. In particular, the display contains information about the image's class, which stands for the category or label connected to the chosen image. The accuracy for each image is also displayed, indicating the model's level of confidence that the categorization or forecast it made was accurate.

Fig 6 GUI for Fruits Classification

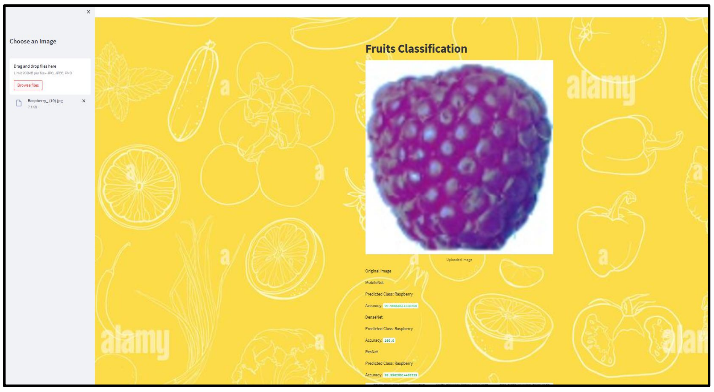

Fig 7 Result obtained for test query

V. RESULTS

In fig 8, a thorough display of graphs corresponding to a certain fruit chosen as it is shown. These graphs show data ranges and variations based on the degrees of accuracy produced from the used models. Notably, for a single fruit, the graphs for all three different models are displayed simultaneously. The accuracy levels associated with the models are indicated, offering helpful insights into the confidence and precision of the predictions, and each graph in the figure displays the predicted ranges specific to the chosen fruit.

A. MobileNetV2

The table I, shows the accuracy when tested for MobileNetV2 gives the Maximum accuracy of 99.81%, which is considered to be the highest one when compared to all the results in MobileNet model. Dataset of 70 – 30 ratio works well with this model which results giving the highest of all the accuracies.

TABLE I. ACCURACY RATES OBTAINED FOR MOBILENETV2

Train Data	Test Data	Epoch 1 (%)	Epoch 2 (%)	Epoch 5 (%)	Epoch 10 (%)
80	20	98.33	98.33	98.33	98.33
70	30	98.36	99.16	99.81	98.63
60	40	99.19	99.19	99.19	99.19
50	50	99.66	99.66	99.66	99.66

B. ResNet50V2

TABLE II. ACCURACY RATES OBTAINED FOR RESNET50V2

Train Data	Test Data	Epoch1 (%)	Epoch 2 (%)	Epoch5 (%)	Epoch 10 (%)
80	20	99.13	99.33	99.40	99.20
70	30	99.36	98.16	99.81	99.60
60	40	98.59	99.80	99.19	99.89
50	50	99.66	98.76	99.67	98.66

TABLE III. ACCURACY RATES OBTAINED FOR DENSENET121

Train Data	Test Data	Epoch 1 (%)	Epoch 2 (%)	Epoch 5 (%)	Epoch 10 (%)
80	20	99.13	99.33	99.40	99.20
70	30	99.36	98.16	99.81	99.60
60	40	98.59	99.90	99.19	99.69
50	50	99.66	98.76	99.67	98.66

The table II, shows the result when tested with ResNet50V2 model falls for the highest accuracy of 99.89% which is considered to be the best accuracy. This strategy works well with the 60-40 dataset classification which results in highest outcome accuracy.

C. DenseNet121

The table III, when dataset tested with DenseNet121 model falls for the highest accuracy of 99.90% which is considered to be the best accuracy. This strategy works well with the 60-40 dataset classification which results in highest outcome accuracy. This model is considered with 100% of accuracy which is best in all the three tested models.

D. Results with 10 epochs on all models

TABLE IV. ACCURACY RATES OBTAINED FOR 3 MODELS

Train Data	Test Data	Epoch	MobileNetV2 (%)	ResNet50V2 (%)	DenseNet121 (%)
80	20	10	98.33	99.40	99.97
70	30	10	98.63	98.81	99.89
60	40	10	99.19	99.39	99.89
50	50	10	99.66	99.67	98.97

In table IV, the Dataset when tested with the epochs of 10 with all the models including all the specified training and testing data, DenseNet is considered to be the best working model. DenseNet121 gives upto the accuracy of 100% which is considered to be the most specific and well suited to test the Dataset.

VI. CONCLUSION

After using these models, we obtained the accuracy of 99.97% of average of all the models. We trained and tested images and used all the three models namely MobileNetV2, ResNet50V2 and DenseNet121 for the image classification. After testing for epochs of 1, 2,5 and 10 for all the four models we obtained the accuracy of 99.97%.

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Early Detection of Powdery Mildew in Faba Beans

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***Abstract*— Powdery mildew, caused by the fungal pathogen Erysiphe, is a widespread and economically important disease affecting broad beans (Viciafaba). This paper addresses the detection and treatment of powdery mildew in fava beans, covering various aspects such as symptomology, pathogen identification, disease surveillance techniques, and integrated management strategies. In this paper, we propose a mathematical model for broad bean powdery mildew detection and deep learning-based detection that improves accuracy and training efficiency. First, a conversion from the RGB format to his HSV format is performed and image segmentation is done. Then apply a random forest classifier to derive the results. The segmented leaves are then sent into a transfer learning model that has been trained on a dataset of sick leaves on a simple background. Additionally, the model is examined to identify the developmental stage of the Erysiphe family. By understanding the complexity of this disease, farmers and researchers can improve disease management and promote sustainable broad bean production. Therefore, for intelligent agriculture, environmental preservation, and agricultural productivity, the deep learning algorithms proposed in this article are crucial.**

***Index Terms*— Powdery Mildew, Broad Beans, Random Forrest, Erysiphe, image processing.**

I. Introduction

Powdery mildew, caused by the fungal organism Erysiphepolygoni, is one of the most commonly occurring diseases in Broad Beans.

A. Broad Bean

Broad bean (Viciafaba) belongs to the legume (Fabaceae) family and has an important place in both traditional and modern agriculture. Its cultivation dates back thousands of years and there is evidence that it was present in ancient civilizations such as the Egyptians, Greeks, and Romans. Botanically classified as Dolichos lablab, the Indian broad bean is a type of hyacinth bean and belongs to the legume family.
In India, it is also known as Avarai, Avarakkai, Sem, Sheem, and Val Papdi and in English as Lablab Beans and Indian Beans. Indian fava beans grow on thick vines with broad leaves and thrive in tropical climates.
In recent years, fava beans have attracted attention not only for their agricultural benefits but also for their nutritional value and potential health benefits.

B. Morphological Identification

On the upper side of infected leaves, there were first faint black specks that eventually turned into white patches caused by powdery mildew (Figure 1A). The spots became larger and combined with a coating of mould that was white and covered the entire leaf surface. (Fig. 1B,C). Infected leaves wilted, turned yellow, and then fell off (Figure 1C). The pods and stems got infected as the illness worsened, and eventually the damaged tissue was

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covered in white powdery mildew (Figure 1B).To find out whether the leaf is diseased or healthy.
The conidiophores were erect, cylindrical, 44.2-76.0×8.0-10.3 μm in size, and consisted of foot cells and 1-2 short cells, forming a single conidia. Foot cells were cylindrical, straight or slightly curved and ranged in size from 22.3–30.0 × 8.0–10.1 μm (Figure 2A). The conidia were elliptic to ovoid and 25.4–35.8 × 13.5–19.8 μm in size (Fig. 2B). The mycelial appendages were foliate (Figure 2C). All these properties confirmed the Erysiphe structure.

Figure 1.*Powdery mildew symptoms on the broad bean.* ***(A)*** *Powdery mildew blotches on a primary leaf by natural infection in glasshouse;* ***(B)*** *Symptoms on pods, stem, and leaves developed from pathogenicity test;* ***(C)*** *Symptoms on plant observed in the field*

Figure 2.*Erysiphevignae on common bean morphology.* ***(A)*** *A conidiophore with a conidium attached;* ***(B)*** *Conidia;* ***(C)*** *A hyphal appressorium;* ***(D, E)*** *Conidia with a germ tube forming on a glass slide;* ***(F)*** *Conidium with a germ tube from a sick leaf; Bars = 10*

C Development of Powdery Mildew

Powdery mildew clogs leaf pores, blocks light from photosynthetic cells, and reduces the plant's ability to use light as an energy source. New growth stops, old leaves fall off, and plants struggle to stay alive.
Powdery mildew tends to grow superficially or epiphytically on the surface of plants. During the growing season, hyphae are formed on both sides. Infection can also occur on stems, flowers and fruits. Specialized absorptive cells called haustoria invade plant epidermal cells to acquire nutrients. Powdery mildew produces an epiphytic mycelium known as endophysis. Conidia develop on the plant surface during the growing season.
They occur singly or in chains on the conidiophores. Conidiophores arise from epiphyte hyphae or from interstices of leaves. Powdery mildew forms ascospores at the end of the growing season in pouch-like asci surrounded by fruiting bodies called chasmocesium. Chasmothecium is usually spherical and lacks natural openings. Asci, which contain ascospores, are released when a tear occurs in the wall of the fruiting body. They can survive winter conditions as dormant mycelia within host buds and other plant tissues. These infected parts of the host can serve as primary inoculum that can induce further infection under appropriate conditions

D. Favourable Conditions and Symptoms

Fava beans can grow successfully under a variety of agro-climatic conditions, as well as with minimal effort, even in residual soil moisture, which is relatively tolerant to biotic and abiotic stresses. Powdery mildew occurs prevalently in late January-February when the plants are in the pod stage. The disease is characterized initially by the formation of white, powdery spots on the leaves, which spread toward the vines, pods and stems, covering most of the above ground as the disease progresses.
Yield loss from 100% infected crops has been estimated at 21-31% by number of pods and 26-47% by weight of pods. This pathogen causes yield losses of up to 50% and reduces pod quality. Based on the occurrence of powdery mildew, the outbreak can be divided into three broad stages.

- In the early stages, on the upper surface of the lower leaves, a white, powdery fungus grows.

- In the next stage, the fungus appears as white or greyish cottony patches on leaves, buds, and stems and spreads in a mat known as mycelium.
- At the final stage, on the mycelial mat, the fruiting body (closure) appears as a little black or brown speck. To effectively stop the spread of powdery mildew and reduce severe yield and quality losses, early detection and prompt disease control are essential.

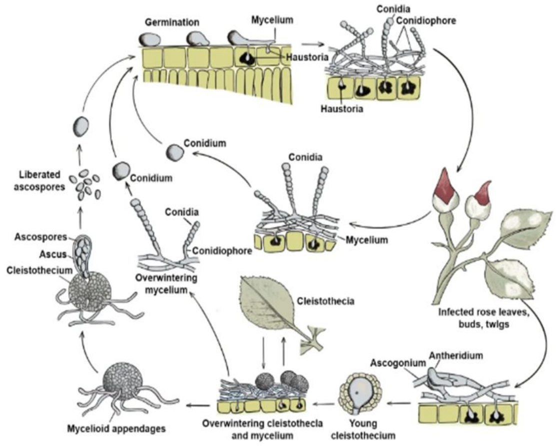

Figure 3. *Life cycle of fungi Erisphe*

II. LITERATURE SURVEY

Visual observation is one of the most important methods for detecting powdery mildew in broad beans. Characteristic symptoms include white, powdery fungus on the undersides of leaves, stems, and pods. Researchers have studied the relationship between disease severity and symptom severity to develop a standardized disease rating scale. However, relying solely on visual observation may lead to subjective interpretation and may not be suitable for early detection of disease.

The most important biochemical methods to date include the gene chip method Ref. [2,3] and the enzyme-linked immunosorbent assayRef. [4,5] for the detection of wheat fungi. Although the detection limits are the lowest and the detection rates are the highest, the detection processes of these methods are complex and specialized, and the long cycles and high costs make them unsuitable for large-scale fungal count detection by grain storage companies.

In addition, some research institutes have also reported many methods of fungal detection and risk prediction through detection of specific chemical constituents and fungal metabolites. Chromatography and chromatographic mass spectrometry Ref. [6] are often used to detect these characteristic substances.

However, most of these methods have serious problems: Difficult sample preparation, complicated preparation process, too many instruments and reagents. Various physical detection methods have been proposed to overcome the drawbacks inherent in biochemical detection methods. Peng Ref. [7] et al. developed his MIFI system based on radio frequency detection using Wi-Fi devices to detect wheat powdery mildew. This system allows him to achieve over 90% accuracy in detecting wheat Mold.

A study by Campagnoli et al. Ref. [8] used a commercial electronic nose with a metal-oxide-semiconductor sensor in combination with trapping and thermal desorption techniques, employing Tenax TA as an adsorbent. We identified a naturally occurring whole durum wheat grain sample. Deoxynivalenol contaminated and uncontaminated samples. These methods can be said to be physical detection methods characterized by high speed and high intelligence, but the detection accuracy is relatively poor.

Powdery mildew causes spectral changes in infected wild rockets leaves, enabling detection of the disease by proximal sensory devices and setting the stage for new disease surveillance tools. The results of this study demonstrate the potential to improve powdery mildew detection through powerful machine learning modelling based on very few bands that help efficiently identify diseased plants. However, obtaining and purchasing the equipment is very difficult Ref. [9].

Automated disease detection methods have been used for a while. The majority of the earlier methods, however, necessitate specialised setups and tools, rendering them unsuitable for autonomous detection in industrial greenhouses. In terms of algorithms, the subject of disease detection uses a variety of image processing and learning techniques Ref. [10]. Although hyperspectral-based approaches have shown promising results, they place restrictions on the surroundings to reduce the effects of clutter. B. Restrained, plain backdrops or only depictions of plants Ref. [11].

In summary, automated disease and pest detection methods in the past required regulated and consistent environments. These requirements include a segmented view of leaves, constant camera distance, homogeneous lighting, and no obstructions or clutter. Due to the large variations in surroundings, these restrictions do not translate well into daily inspections of greenhouses.

III. PROPOSED SYSTEM

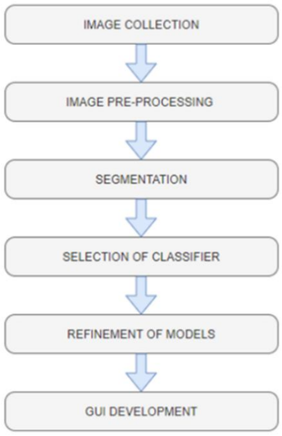

Figure 4.*Workflow*

The proposed study focused on early detection of fungal diseases in fava beans. This includes tasks such as image acquisition, image preprocessing, feature selection, developing methods to identify symptoms of fungal diseases in crops, and finally developing the architecture of the proposed system.

A. Image Acquisition

First, legume leaf fungal disease is analysed to identify powdery mildew growth. Additionally, images of infected plants are from reliable sources.

B. ImagePre-processing

The fundamental goal of picture pre-processing is to provide non-inherited images the options they need and to prevent undesired distortions for further processing. Here, the image is enlarged and shaped, the image's noise is eliminated, and various morphological alterations are processed to raise the image's quality. Increasing contrast is another goal of image improvement.

C. Conversion of image from BGR to HSV

HSV divides the luminance, or image intensity, from the saturation, or colour information, in contrast to RGB. This has numerous applications and is quite helpful. For instance, you would generally just apply histogram equalisation to the intensity component of a colour image and ignore the colour component altogether. Otherwise, you'll see some extremely odd colours. In computer vision, we frequently want to distinguish between colour and intensity for a variety of reasons. Enhancing resistance to light fluctuations or getting rid of shadows.

D. Image segmentation

It is a technique for breaking an image up into smaller pieces. Utilising approaches for hue estimates, segment and group photos. The fact that the leaves are green is natural and unimportant. Choose cluster photos with infected areas to extract features from.

D. Feature Extraction

A binary mask defines a region of interest in an image. Apply Global Feature Descriptors: Three feature descriptors are used to extract global features from the image.

• Colour: colour channel statistics (mean, standard deviation) and color histogram

• Format: Hu moment, Zernike moment
• Textures: Halalic Textures, Local Binary Patterns
After extracting the image features, the features are stacked using the numpy function np.stack.

E. Feature Scaling

Feature scaling is a technique that normalizes the independent features present in the data to a fixed range. This is done during data preprocessing to handle different sizes, values or units. If no feature scaling is performed, machine learning algorithms tend to weight large values more heavily and consider smaller values to be lower, regardless of the unity of the values.I used a min-max scaler here. This scaling puts the values between 0 and 1.

F. Modelling

This includes categorization and training. A decision tree-based supervised learning method called Random Forest. The tree's leaf nodes are made up of labelled data. The disadvantage of overfitting the training data set is overcome by random forest, which also handles categorical and numerical data. N features are chosen at random from a pool of M features in a random forest. By choosing features/attributes at random from the available features/attributes, Random Forest constructs numerous trees (N). All N trees in the forest are subjected to the input data. Each tree independently predicts outcomes from other trees. The maximum votes received for each type projected in the forest serve as the output of Random Forest's predictions.

IV. Results

The colour of the leaf is retrieved from the image to execute segmentation, which is the process of separating the leaf image from the background.

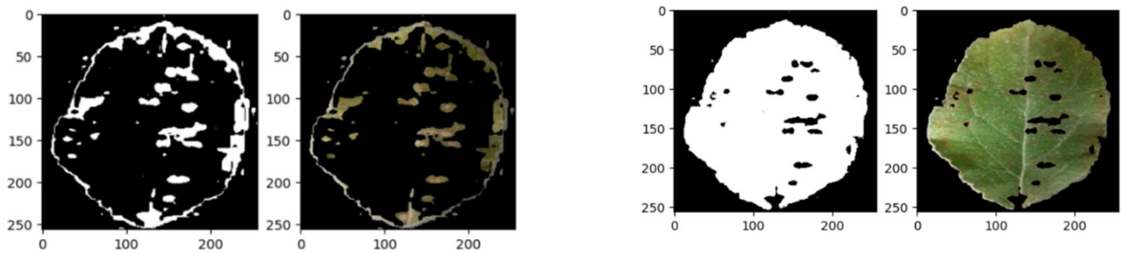

Figure 5

According to the findings, the accuracy is 97.1%, which is higher than the accuracy of the conventional approach and lessens the negative effects of illnesses on agricultural productivity while fostering the growth of sustainable agriculture. As a result, the random forest algorithm suggested in this work is crucial for environmentally friendly agriculture, agricultural production, and intelligent agriculture.

V. Discussion And Conclusion

In this study, we introduce a system based on a machine learning approach. In order to address the Powdery Mildew disease recognition problem in Faba Bean crop, we have used feature extraction and classification algorithm for image processing. By taking digital images of plant leaves, we can extract and classify infected areas according to the stage of development of powdery mildew.
Random Forest was used to classify the Faba bean disorders, and the relative benefits of our study were evaluated by comparing the outcomes of later similar studies. The accuracy we attained was 97.1%, which is both encouraging and positive. A very large data set of photos could still be used in future study to cover a larger range of Faba bean illness. In the future, a further focus could be on developing early warning systems that integrate weather data and disease models to predict outbreaks.

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Reinforcement Learning for Adaptive Cybersecurity: A Case Study on Intrusion Detection

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***Abstract*— The evolving landscape of cybersecurity necessitates innovative approaches to counteract the relentless proliferation of cyber threats. Intrusion detection, a cornerstone of cybersecurity, demands adaptability to effectively identify and thwart emerging attack vectors. This research paper explores the fusion of reinforcement learning and cybersecurity, presenting a case study that showcases the application of reinforcement learning techniques in creating an adaptive intrusion detection system. The case study, presented in this paper, encapsulates the essence of our research. We elucidate the experimental setup, dataset selection, choice of reinforcement learning algorithms, and evaluation metrics used to assess the system's adaptability and performance. Our findings reveal the system's ability to dynamically adapt to evolving attack patterns, offering a compelling demonstration of reinforcement learning's potential in bolstering adaptive cybersecurity mechanisms. This paper's contributions extend beyond the case study. Through a meticulous analysis of the results, we discuss the practical implications, advantages, and limitations of employing reinforcement learning in intrusion detection. By showcasing a practical application of reinforcement learning in a critical cybersecurity domain, this research underscores the viability of leveraging autonomous learning mechanisms to fortify defenses against ever-evolving cyber threats.**

***Index Terms*— Cybersecurity; Deep learning; Reinforcement Learning**

I. INTRODUCTION

In the rapidly evolving landscape of information technology, cybersecurity stands as an indispensable shield against the relentless tide of malicious cyber activities. As organizations and individuals become increasingly reliant on digital systems for communication, commerce, and critical operations, the risk of cyber threats and intrusions has grown proportionally(Adawadkar and Kulkarni, 2022). Among these threats, intrusion detection plays a pivotal role in safeguarding digital assets and maintaining the integrity of networks and systems(Kolias *et al.*, 2016). As attackers employ novel strategies and techniques, intrusion detection systems must evolve in parallel to effectively detect and mitigate these threats(Klein, 2008).The marriage of machine learning and cybersecurity has emerged as a promising avenue to address these challenges. Particularly, reinforcement learning, a subset of machine learning, offers a paradigm that enables systems to learn from their actions and adapt in dynamic environments. This research paper delves into the realm of using reinforcement learning to enhance adaptive cybersecurity, with a specific focus on the context of intrusion

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detection(Wazid *et al.*, 2022). In today's digitally interconnected world, the safeguarding of sensitive information, critical infrastructure, and personal privacy has become an imperative of paramount importance. The rapid proliferation of interconnected devices and the ubiquitous nature of the internet have brought unprecedented convenience and efficiency, but they have also introduced new avenues for malicious actors to exploit vulnerabilities and breach security measures(Butun, Österberg and Song, 2020). In this context, cybersecurity stands as a vital defense mechanism against the evolving landscape of cyber threats.

Among the multitude of challenges that cybersecurity professionals face, intrusion detection remains a cornerstone. The ability to promptly identify and respond to unauthorized access attempts, data breaches, and malicious activities within complex network environments is crucial for preventing damage and ensuring the integrity of systems. However, the dynamic nature of cyber threats, characterized by their ability to mutate and adapt, necessitates an equally dynamic approach to intrusion detection. Traditional rule-based and signature-based methods, while effective to a certain extent, often struggle to keep pace with the ever-changing tactics employed by cybercriminals. Machine learning techniques have emerged as a powerful tool to enhance the adaptability and accuracy of intrusion detection systems(Wang *et al.*, 2020). Among these techniques, reinforcement learning a paradigm rooted in decision-making processes has garnered attention for its potential to facilitate autonomous learning and adaptability. This research paper delves into the intersection of reinforcement learning and cybersecurity, focusing specifically on the domain of intrusion detection. We present a case study that showcases the application of reinforcement learning algorithms to create an adaptive intrusion detection system capable of autonomously learning and responding to emerging threats.

In today's interconnected digital landscape, the relentless growth of cyber threats has highlighted the critical need for robust and adaptive cybersecurity measures. Among the primary pillars of safeguarding digital assets and sensitive information is intrusion detection(Magaia *et al.*, 2021), a cornerstone of defense against unauthorized access, data breaches, and malicious activities. As the landscape of cyber threats becomes more complex and dynamic, intrusion detection emerges as a vital mechanism to ensure the integrity, confidentiality, and availability of digital systems.

II. Understanding Of Intrusion Detection

Intrusion detection refers to the process of identifying and responding to unauthorized or malicious activities within computer networks, systems, and applications. This encompasses a broad spectrum of activities, ranging from unauthorized login attempts and malware propagation to sophisticated zero-day exploits(Khraisat *et al.*, 2019). The goal of intrusion detection is twofold: prompt identification of malicious behaviors and timely response to mitigate potential damage. Traditional approaches to intrusion detection have largely relied on rule-based and signature-based methods. Rule-based systems use predefined rules to detect known attack patterns, while signature-based systems compare incoming data to a database of known attack signatures. (Alazab *et al.*, 2014). Intrusion detection systems must keep pace by evolving their capabilities to recognize both known attack patterns and emerging threats that lack predefined signatures.

Figure 1: Intrusion detection representation

A. An Anomaly-Based Intrusion Detection

Certainly, here are some equations that capture key aspects of intrusion detection in cybersecurity:

Anomaly detection(Ganeshan *et al.*, 2020) involves comparing incoming data with historical data to identify deviations. One common approach is calculating the anomaly score:

$$\text{Anomaly Score}(x) = | x - \mu | / \sigma$$

Where:
x is the current data point. μ is the mean of historical data. σ is the standard deviation of historical data.

B. False Positive Rate and True Positive Rate:

Evaluating the performance of intrusion detection systems often involves false positive rate (FPR) and true positive rate (TPR):

$$FPR = FP / (FP + TN)$$

$$TPR = TP / (TP + FN)$$

Where:
FP is the number of false positives.
TN is the number of true negatives.
TP is the number of true positives.
FN is the number of false negatives.
Precision, Recall, and F1-Score:
Precision, recall, and the F1-score provide a comprehensive view of the detection system's effectiveness:

$$\text{Precision} = TP / (TP + FP)$$

$$\text{Recall} = TP / (TP + FN)$$

$$\text{F1Score} = 2 * (\text{Precision} * \text{Recall}) / (\text{Precision} + \text{Recall})$$

In the context of reinforcement learning, the Bellman equation plays a central role:

$$Q(s, a) = R(s, a) + \gamma * \max(Q(s', a'))$$

Remember that the choice of metrics depends on the specific goals and priorities of your intrusion detection system. Different applications might require different metrics to be emphasized.

TABLE I: PERFORMANCE MATRIC OF INTRUSION DETECTION IN CYBER SECURITY

Metric	**Formula**	**Description**
True Positive (TP)	-	Instances correctly classified as intrusions.
True Negative (TN)	-	Instances correctly classified as normal activities.
False Positive (FP)	-	Instances incorrectly classified as intrusions (Type I error).
False Negative (FN)	-	Instances incorrectly classified as normal activities (Type II error).
Accuracy	(TP + TN) / (TP + TN + FP + FN)	Proportion of correctly classified instances out of the total instances.
Precision	TP / (TP + FP)	Proportion of true positive predictions out of the total predicted positive instances.
Recall (Sensitivity)	TP / (TP + FN)	Proportion of true positive predictions out of the total actual positive instances.
F1-Score	2 * (Precision * Recall) / (Precision + Recall)	Harmonic mean of precision and recall.
Specificity	TN / (TN + FP)	Proportion of true negative predictions out of the total actual negative instances.
False Positive Rate (FPR)	FP / (TN + FP)	Proportion of false positive predictions out of the total actual negative instances.
False Negative Rate (FNR)	FN / (TP + FN)	Proportion of false negative predictions out of the total actual positive instances.
AUC-ROC	-	Area under the Receiver Operating Characteristic curve. Measures discrimination ability at various thresholds.
AUC-PR	-	Area under the Precision-Recall curve. Provides insights into performance at different recall and precision levels.
Matthews Correlation Coefficient (MCC)	-	Balanced measure that considers true and false positives and negatives.
Confusion Matrix	-	Tabular summary of classification model's performance, showing TP, TN, FP, and FN counts.

It's important to consider the specific context and requirements of your intrusion detection system when selecting and interpreting these metrics(Albdour, Manaseer and Sharieh, 2020). Depending on the application, certain metrics may be prioritized over others. For instance, in some cases, minimizing false positives might be more critical than achieving high overall accuracy.

III. MACHINE LEARNING

Machine learning plays a pivotal role in revolutionizing the field of cybersecurity, equipping organizations with advanced tools to counter evolving cyber threats(Sarker, 2022). By harnessing the power of algorithms and data analysis, machine learning models can rapidly identify patterns, anomalies, and trends within massive datasets that would be impossible for humans to process manually. Machine learning also enhances malware detection and classification by learning from historical data and adapting to new variants(Das and Morris, 2017). It enables real-time behavioral analysis to distinguish between legitimate user behavior and malicious activities, reducing false positives and improving overall system accuracy. As cyber-attacks become more sophisticated, machine learning empowers security professionals to stay one step ahead in the ongoing battle to safeguard sensitive digital assets and ensure the integrity of critical systems.

A. Automated Pattern Recognition

Machine learning, a subset of artificial intelligence, equips systems with the ability to recognize intricate patterns and relationships within large and complex datasets(Kubassova *et al.*, 2021). In the realm of intrusion detection, machine learning techniques can automatically identify features indicative of cyber-attacks, allowing the system to generalize from historical data and adapt to new attack patterns.

TABLE II: RESULT OF FULL DATA SET FOR DIFFERENT TECHNIQUES

S. No.	Technique	Accuracy	Precision	Recall	F1 Score	AUC-ROC
1.	Logistic Regression	0.92	0.912	0.984	0.945	0.899
2.	Random Forest	0.95	0.956	0.976	0.966	0.944
3.	SVM	0.94	0.934	0.978	0.955	0.927
4.	Neural Network	0.96	0.966	0.988	0.976	0.953
5.	XGBoost	0.95	0.946	0.975	0.960	0.934

B. Feature Extraction and Selection

Machine learning algorithms excel at identifying relevant features from raw data. In the context of cybersecurity, these features could include network packet attributes, traffic behaviors, and system logs(Fatani *et al.*, 2022). Feature extraction and selection are critical in reducing noise and improving the efficiency of the intrusion detection system.

TABLE III: FEATURE EXTRACTION METHODS

Feature Extraction Methods	Description
Time-based Features	Extract temporal information such as timestamps, day of the week, and time of day.
Frequency-based Features	Compute statistics like packet counts, byte counts, and request rates.
Protocol-based Features	Extract features based on specific network protocols, including port numbers, IP addresses, etc.
Statistical Features	Calculate statistical measures like mean, median, variance, and skewness.
Payload Analysis	Analyze payload data, e.g., examining keywords or patterns in packet payloads.
Domain-specific Features	Extract features relevant to the specific application or domain, e.g., HTTP headers for web data.

TABLE IV: FEATURE SELECTION MODEL

Feature Selection Methods	Description
Correlation Analysis	Identify correlations between features and the target variable; remove highly correlated features.
Univariate Selection	Use statistical tests to select features with strong relationships to the target variable.
Recursive Feature Elimination	Iteratively remove least important features based on model performance.
Embedded Methods	Leverage algorithms that inherently perform feature selection during their training process.
Model-Based Selection	Train a model and assess feature importance based on their contributions to model performance.
Regularization	Apply techniques like L1 regularization (LASSO) to encourage the use of a subset of features.
Dimensionality Reduction	Use techniques like Principal Component Analysis (PCA) to reduce dimensionality while retaining info.

C. Supervised and Unsupervised Learning

Both supervised and unsupervised machine learning techniques are applicable to adaptive intrusion detection. Supervised learning involves training models on labeled data, enabling them to classify network traffic as normal

or malicious(Talaei Khoei and Kaabouch, 2023). Unsupervised learning, on the other hand, identifies anomalies in network behavior without prior labeling, making it valuable for detecting unknown threats.
Equation for simple linear regression:

$$Y = mx + b$$

where:
y is the predicted output.
x is the input feature.
m is the slope of the line.
b is the y-intercept.
Equation for k-means clustering (for two-dimensional data):

$$\text{Argmin}\sum_{i=0}^{c} \quad n\ \min_{\mu j} \in C\ (\|x_i - \mu_j\|^2)$$

where:
n is the number of data points.
x_i is the data point.
μ_j is the centroid of cluster j.
C is the set of clusters.
c is the assigned cluster for data poinx_i.

D. Learning From Experience: Reinforcement Learning

Reinforcement learning, a specialized form of machine learning, is particularly relevant to the adaptive nature of cybersecurity. In reinforcement learning, an agent learns to make decisions through interactions with an environment to maximize cumulative rewards(Sivamayil *et al.,* 2023). In the context of intrusion detection, the agent learns optimal strategies for detecting attacks over time, adapting its behavior to new and emerging threats.

E. Adaptation and Continuous Learning

In the realm of cybersecurity, adaptation and continuous learning are paramount. As the threat landscape evolves rapidly, security systems must employ algorithms and strategies that dynamically adapt to emerging threats. Online learning algorithms enable security systems to learn from new attack patterns and adjust their defenses in real-time(Hatzivasilis *et al.,* 2020). Adaptive learning rates ensure that security measures respond effectively to varying levels of threat intensity. Reinforcement learning facilitates the continuous improvement of intrusion detection and prevention systems, enabling them to refine their responses based on the outcomes of previous security incidents(Yang *et al.,* 2023). The concept of concept drift detection becomes crucial in cybersecurity, where models can detect sudden shifts in attack patterns and promptly adjust their defenses. In this landscape, the continuous evolution of threat actors necessitates the use of ensemble methods and transfer learning to incorporate new knowledge while retaining past experience (Xin *et al.*, 2018). This dynamic nature enables the system to respond effectively to evolving tactics employed by cybercriminals.

IV. Discussion

In this study, we summarized some of the most promising methods used to address various financial problems. We chose the main methodology for our analysis that were primarily based on traditional techniques that are frequently used for time-series forecasting(Ferrag *et al.*, 2020). Many machine-learning methods have been developed recently for the purpose of modeling financial time series. The support vector machine model and random forest classifier belong to this group of algorithms. Support vector machines' core principle is to map data into higher-dimensional spaces where values can be linearly separated from one another in order to find an ideal hyperplane(McCarthy *et al.*, 2022). Before starting training, three key hyperparameters for random forest algorithms must be changed. Some of these are the size of the nodes, the number of trees, and the number of features sampled. These facts have led to a major increase in the usage of several machine learning algorithms, including ANN, LSTM, and RNN(Al-azazi and Ghurab, 2023), for time-series forecasting in recent years. One of the important methods was the artificial neural network (ANN) model. In order to create solutions that are as generalizable as feasible based on the knowledge they already have, ANNs try to find patterns in the data they are given. The financial industry has used ANNs the most, according to the findings that have been presented. The application of RNN and its derivatives, such as LSTM(Sudriani, Ridwansyah and A Rustini, 2019), has been the subject of extensive research in the field of time-series forecasting in recent years. Due to their extraordinary ability to recognize hidden correlations in data, these models outperformed the typical ANN model in terms of forecasting challenges. The models were able to produce better results thanks to these capabilities. We discussed the subject of developing a successful trading strategy using RL approaches. Because of this, current advancements in this field have integrated DL and RL approaches(Matsuo *et al.*, 2022), utilizing their excellent capacities to produce complex data. The goal of this study was to investigate the reasons why machine learning methods such as deep learning and reinforcement learning (Singh *et al.*, 2022)perform better than approaches based on non-linear algorithms.

Our findings showed that, in the particular security use case of federated intrusion detection, the intrusion detection imposed a modest performance overhead. It is not easy to generalize these conclusions to other applications. On the other hand, some generalizations regarding the characteristics of our methodology can be drawn. Our integration strategy(Preuveneers *et al.*, 2018), in our opinion, is particularly useful for security use cases where inference is carried out directly on raw data. In this scenario, federated learning won't require the expensive transfer of enormous volumes of raw data, which will further minimize the relative performance overhead. Comparable use cases, however, will probably call for the adoption of deeper neural networks with more complex topologies in order to enable automatic feature extraction. In turn, deeper models will have additional performance overhead that is difficult to predict. In order to compute the model changes at each client in the federation, they will first need comparatively more local processing, which could have an impact on the latency of global updates(Chen, Wawrzynski and Lv, 2021). Second, a deeper architecture with more learnable parameters will necessitate storing more data on the blockchain. To validate these hypotheses, a large number of federated learning deployments must be methodically tested in various application situations with varying data types, processing speeds, and network capacities. To illustrate the viability of the proposed method for federated learning and blockchain integration, we employed an intrusion detection security use case in this work. While more sophisticated neural networks have been described in the literature for anomaly and network intrusion detection, the kind of neural network we used in our experiments the auto encoder has a rather straightforward architecture(Gümüşbaş *et al.*, 2021). For deeper or more complicated neural networks, including convolutional neural networks, as well as for other use cases where federated learning could be advantageous, our method is still equally relevant and scalable. A trade-off between the audit frequency of the global model updates and the local rate of convergence on the clients is another effect of the suggested integration technique. Converging faster at the nodes is made possible, on the one hand, by iterating more frequently at each client locally before calculating the federated average. Conversely, fewer local repetitions result in the computation and storage of a greater number of federated averages on the distributed ledger. The machine learning model's auditability is enhanced by more regular blockchain-based model updates.

The main benefit of employing it is that it reduces the amount of time needed to compute while ensuring high-quality work is produced. Currently, there is a growing trend toward the application of deep reinforcement learning-based dynamic trading approaches.(Hu and Lin, 2019) Reinforcement learning can be used to create dynamic trading strategies and solve the problem of sequential decision making. Reinforcement learning, however, excludes the ability to perceive the environment.

V. Conclusion

Reinforcement Learning in Intrusion Detection has emerged as a cutting-edge approach to fortify digital environments against an increasingly sophisticated landscape of cyber threats. This comprehensive investigation into the fusion of reinforcement learning techniques with cybersecurity applications sheds light on the potential of adaptive defense mechanisms that continuously learn and evolve in response to dynamic threats(Oh *et al.*, 2023). As this study delves into the intricacies of the integration, it becomes evident that the marriage of reinforcement learning and cybersecurity heralds a new era of proactive protection and real-time adaptation.

In the realm of cybersecurity, the stakes have never been higher. The proliferation of interconnected systems, the expansion of the attack surface, and the ingenuity of threat actors have collectively underscored the need for innovative defense strategies. Traditional static security measures, while crucial, can be insufficient in a landscape where threats mutate and evolve faster than conventional models can keep pace with. This is where the allure of reinforcement learning comes to the fore(Ahsan *et al.*, 2022). The very essence of reinforcement learning, derived from behavioral psychology, centers on the idea of learning by interacting with an environment to maximize cumulative rewards. This fundamental principle aligns seamlessly with the cybersecurity domain, where security systems need to interact with an ever-changing digital environment to optimize their response and mitigation strategies.

Furthermore, the study delves into the technical aspects that underpin the application of reinforcement learning to intrusion detection. Reinforcement learning algorithms, such as Q-learning(Zhou *et al.*, 2021) and Deep Q-

Networks (DQN)(Mnih *et al.*, 2015), require careful tuning and customization to the specifics of the intrusion detection task. Hyperparameters, network architectures, and training protocols must be tailored to strike a balance between rapid adaptation and convergence to optimal policies. (Chen *et al.*, 2019)The study's findings shed light on the nuances of this process, emphasizing the iterative nature of algorithm development and the significance of rigorous testing and evaluation. Despite the remarkable strides achieved through the case study, challenges and considerations emerge that warrant attention.(Huang, Huang and Zhu, 2022) The application of reinforcement learning in cybersecurity introduces an additional layer of complexity. The vulnerability of the learning process to adversarial attacks, where threat actors manipulate input data to deceive the agent's learning, underscores the need for robustness and resilience(Shaukat *et al.*, 2020). Adversarial training and anomaly detection mechanisms become crucial components of an adaptive defense strategy. Moreover, the computational demands of reinforcement learning, particularly in deep reinforcement learning paradigms, necessitate a careful assessment of resource allocation and scalability in real-world deployment scenarios.

Future Perspective

Looking ahead, the synergistic relationship between reinforcement learning and cybersecurity holds promise for not only intrusion detection but a myriad of other security applications. From anomaly detection to threat hunting, adaptive defense mechanisms have the potential to revolutionize the cybersecurity landscape. However, this journey is not without challenges – the study sheds light on the need for robustness against adversarial attacks and the optimization of computational resources. As the cyber arms race continues unabated, the fusion of reinforcement learning and cybersecurity offers a beacon of hope – a beacon that illuminates the path towards resilient, proactive, and continuously evolving digital fortifications.

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Design and Implementation of UAV-Assisted Communication in Remote Disaster Areas using AI for 5G Network

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***Abstract*— Use of drones for a variety of functions has recently come to light. Drones are used by businesses to deliver products to clients, by academics and scientists to monitor and find endangered species, and by the military to carry out crucial missions. Powerful, clever, and well-managed Network Functions (NF) and Artificial Intelligence (AI) systems can be used in Search and Reconnaissance (SAR) operations employing Unmanned Aerial Vehicles (UAVs) to study the fifth generation mobile phone (5G). How rapidly people can change circumstances FBS can improve the region's 5G networks by increasing perfo rmance in many different apps as IoT data collection, data tra nsmission and communication technology. The issue of artifici al intelligence-assisted multi-agent planning is discussed locating of users served by UAV with impact of UA Vs. This article describes how a drone can act as a base station in a 5G network and conduct an experiment to demonstrate th e potential of drone communications. From the simulation results it was found to be that the co-operative MADRL was stable at around 14.85 average sum rate.**

***Index Terms*— UAV, AI, 5G**

I. INTRODUCTION

Human life will be in risk from destructive natural calamities including climatological (forestfires, droughts), biological (animal plague, illness), geophysical (volcano, earthquake), and hydrological (avalanches, floods). As a result, the emergency team will work quickly to assist those in the impacted region by finding survivors, restoring the damaged structures, and giving connections, food, water, and medication. [1-2]. operating as airborne base stations in the event that the communication infrastructure is disrupted and distributing emergency supplies [3–8]. because of their many characteristics, like their quick launch and vast area to ground and 3-dimensional mobility [10-12]. Many problems like scalabe, robust, and performance of quick response, communication to use (UAVs) in disaster operations [13-15]. The FBSs can be used to support high communication demand areas such as large events or highly dense regions. ubiquitous connectivity at any location, potentially well beyond the coverage area of terrestrial MBS. This will improve the network efficiency and flexibility and thus ease the growth in high data demand. To perform a trajectory planning for UAVs as a base stations while dealing problems such as interference management optimization, it makes advantage of multi-agent deep reinforcement learning.

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A multi-agent deep reinforcement learning algorithm is used, a simulation which consists of number of UAVs as DRL agents and an environment have developed. Environment contains a system model which has of mobilityand transmission models to calculate transmitrates, rewards and states to meet the fundamental needs of reinforcement learning and provide agents to train properly for planning their trajectory optimally even on the environment with different user locations.

II. Literature Review

Unmanned aerial vehicle (UAV) systems may perform a variety of tasks during or following catastrophes, includingspeedy aerial assessments of damaged areas and search andrescue in challenging circumstances and difficult-to-reach places in [1] the technical challenges in UAS To solve these issues, technical solutions like D-NET/UTM integration have been created. [2] the performance and efficiency of K-Means clustering [4] explains the coalitionmain is a UAV that observes UAV with a lot of using sensing and imaging capabilities, aircraft may fly in circles and gather images of the afflicted areas. In contrast to computationally costly methods, the suggested algorithm's light-weight image processing for fire edge identification isvery desirable, according to Razi [5]. resource-constrained drones. Ng [6] investigates In order to determine the best power and time allocation method for the relay-assisted cooperative system, an energy efficiency optimization problem is developed. [7] offers a collection of drone-captured images of a controlled fire that was lit on piles of debris in an Arizona pine forest. [8] examines the primary driver for the use of artificial neural networks [9]researches critical applications for huge autonomous control of (UAVs). [10] There are many different analytical frameworks and mathematical methods discussed, including game theory, stochastic geometry, optimization theory, machine learning, and stochastic geometry. [11] Recently, there has been a lot of interestin investigations to carry out different tasks. In order to facilitate effective UAV-based SAR operations, Lins [12] offers the System Intelligence (SI) and Edge Intelligence (EI) ideas as related 5G components and AI modules.
[13] suggest attempting to maximize the average secrecy rate of the system under consideration. The main issue for 5G and beyond 5G (B5G) is providing ubiquitous connection to various device kinds. M. Usman, A. A. Gebremariam, M. Qaraqe [20] Identify the relevant AI approaches used and classify the major developments in the field into several groups based on their application history. We emphasize that AI and ML are opening the door to networks that are self-configured, self-adaptive, and self-managed. The UDSF implementation has been described in [21]. [22] describes in detail how the diameter protocol is used during message transmission between nodes, to test the effectiveness and functioning of IMS-LTE network components, and to assess call simulation.

III. Methodology

For a UAV connection in a sparsely inhabited area where base stations have been entirely destroyed by natural or man-made disasters like floods or earthquakes, a model- free technique is used. For the FBS to serve all user nodes in the region appointed to it, the route of travel must begin from the MBS and visit every node only once before returning to the MBS. The cost of travel for the FBS, which is the total distance covered when traveling, must be minimized to optimize the FBS' trajectory. The lower the cost, the more efficient the trip will be with regards to the limited power, energy and speed of the FBS. This is an example of the Traveling Salesman Problem (TSP), a combinatorial optimization problem that is NP-hard (Non- deterministic Polynomial Time Hardness). Each user communicates with using their user equipments (UE) with UAV and gets served by nearest UAV dynamically. UAVs will be connected to a signal by another working base station and each one of the UAV communicates continously with users served by themselves by using FDMA system. Also to solve energy problem of UAV, their energy assumed to supplied by using laser charging from base station which will not be detailed in the problem formulation.

A. System model

To keep the environment more realistic, During the flight of the UAV, EU will be allowed to maneuver. Both to maintain the continuation of the discretely specified simulation and because UAVs are quicker than users, the movement of the users is fixed according to the user-UAV velocity ratio. All users have action vector consists of moving right, left, forward, back and remaining static with same length but with a different sequence. Paths users follow is predetermined before simulation randomly by using a random distribution on each users' own action vector so that environment's user mobility model is stationary and accurate.
The proposed work will take into account a downlink transmitting modelin D2D functionality as shown in Figure 1, where the mobile communication shares its wide range of spectral band with the D2D communication.

B. Multiagent reinforcement learning

Considering real-world problems with high complexity that require multiple entities in the same environment to solve or reach a more optimal solution, it is appropriate to use MAR learning approach. In this approach, multiple agents in same cooperative, competitive or mixed. Due to multiple agents being environment, reinforcement learning with many agents has many difficult problems compared to reinforcement method single agent such as the challenge is environment is non-stationary since the actions of the agents in current state affect each other and all of the agents may behave differently from previous trials [7]. To remove non-stationary problem, the state information to be given per step to each UAVs should cover the environment state any ambiguity in the absolute Q function, so UAVs should not be able to get multiple different reward values from same state information andsame action [8]. Mentioned situation causes agents to have to make the optimal action about more states than usual dynamic environment which means agents in MARL have more workload than single agent in the basic reinforcement learning.in same environment can be cooperative, competitive or mixed. Due to multiple agents being in the same environment, reinforcement learning with multiple agents has many difficult problems compared to reinforcement learning with a single agent such as the challenge is that the environment is non-stationary since the current state affect each other may behave differently from previous trials [7]. non-stationary problem, the state information to be given per step to each UAVs should cover the environment state ambiguity in the absolute Q function, so UAVs should not get multiple different reward values from same state information andsame action [8].

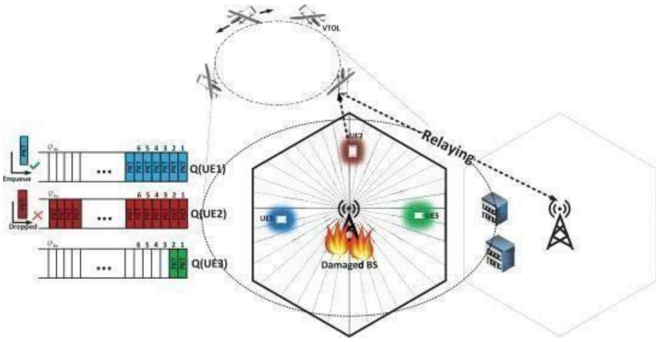

Figure 1: System Model

C. Deep Q learning

Since environments with large state space can cause a serious resource problem in Q-Learning by requires too much space for q-table, basic q-learning can only be used in problems with limited state space. To get rid of resource problem and improve learning performance, using a neural network to estimate action- state values instead of a Q-Table is one of the solution for it[10].

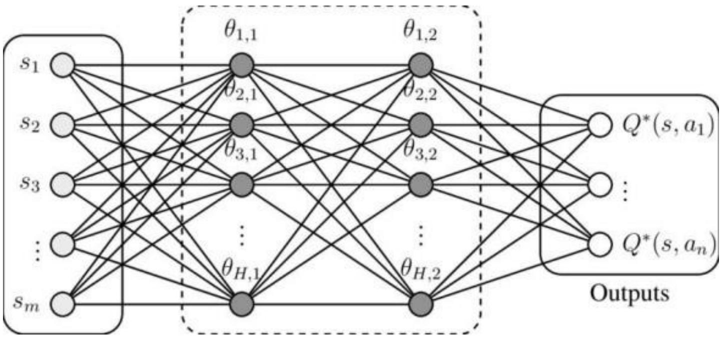

Figure 2: Instead of a Q-Table, Deep Q Network employs a neural network to link state-action pairings to corresponding Q values.

Deep Q-Learning is an approach that takes advantage of both deep learning and q-learning. In Basic Q-Learning, a table maps each state-action pair to its corresponding Q-value. In deep q- learning, instead of a table, a neural network maps input states to the action with Q values which makes deep Q-Learning more appropriate in complex environments which have high dimensional discrete or continuous spaces.

D. 5G implementation of UAV

K-means Clustering will be used as the standard of evaluation of the proposed algorithms to verify the efficiencies and performances of the algorithms. K-means uses the spatial distribution of n points to partition the points in to k clusters. The algorithm works by randomizing locations of k centroids and calculating the distances between every point and every centroid, assigning points to the clusters centered at the centroids closest to the points [20]. The algorithm then replicates new centroids located at the centres of gravities of the points assigned to each cluster. The algorithm completes once the centroids are located at the mean of all points in the cluster assigned to the centroid, and no more changes can be made. K- means is known to have a complexity O(n 2) The pseudocode of the algorithm is below [25].

Figure 3 can be used to visualize how the algorithm will run. The net distance covered by the FBS will be calculated at seven locations of the boundary. The first boundary is located at the dashed line on the left and the last at the dashed line on right.

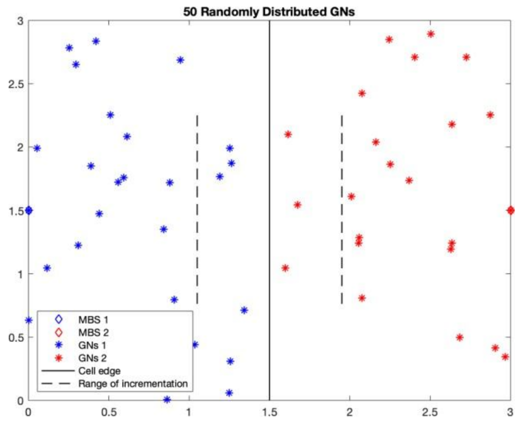

Figure 3: Boundary Incrementation Range

E. Transmission Model

In transmission model, formulations described on are used. It is possible to define the overall total rate at time unit t as

$$R_{\text{sum}} = \sum_{n=1}^{|N|} \sum_{k_n=1}^{K_n} r_{k_n}(t) \tag{1}$$

where N is set of UAVs, K n is all user count which serving by UAV n and rkn(t) by bps/Hz and expressed as

$$r_{k_n}(t) = B_{k_n} \log_2\left(1 + \Gamma_{k_n}(t)\right) \tag{2}$$

where Bkn is the bandwidth of user kn and Γkn (t)

SINR a quantity used to give upper bounds on channel capacity in wireless communication systems, theoretically and in our problem

$$\Gamma_{k_n}(t) = \frac{p_{k_n}(t) g_{k_n}(t)}{I_{k_n}(t) + \sigma^2} \tag{3}$$

where pkn (t) = Pn (t)/ |Kn | has user kn received the transmit power at time t where Pn (t) is transmit power of UAV n at time t and |Kn | is the number of users serving by UAV n. σPower gain of channel between user kn and UAV n given b

$$g_{k_n}(t) = K_0^{-1} d_{k_n}^{-\alpha}(t) [P_{\text{LoS}} \mu_{\text{LoS}} + P_{\text{NLoS}} \mu_{\text{NLos}}]^{-1} \tag{4}$$

where dkn is the euclidean distance between user kn and. Line-Of-Sight(LoS) and Non-Line-Of-Sight(NLoS) conditions are assumed to encountered randomly and probability of LoS denoted as

$$P_{\text{Los}}\left(\theta_{k_n}\right) = b_1\left(\frac{180}{\pi}\theta_{k_n} - \zeta\right)^{b_2}$$

where b1, b2 and ζ is constant
.Inherently, interference Ikn (t) expressed as

$$I_{k_n}(t) = \sum_{n' \neq n} p_{k_{n'}}(t) g_{k_{n'}(t)}$$

V. Implementation

A demo application was made to run the trained models on the location data of the users on earth given by the person using the program. In this demo application, the user selects the path of a trained model folder and the file containing the user data from the dialog. Then user starts the simulation by clicking the "Start Simulation" button. Also user can choose to generate random location data by ticking the "Random Environment" checkbox

Figure 4. Home window of simulation software

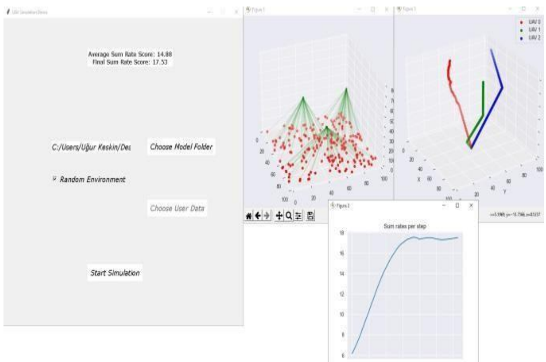

Figure 5. Screenshot of software after the end of simulation After the simulation starts, the location of the UAVs and their connecting with the users on the ground, the instantaneous total sum rate of that step and the trajectories of the UAVs along the way graphs in real time. Charts areinteractive and images can be saved, perspectives of 3D charts can be changed by dragging interactively. After simulation ends, instantaneous sum rate at the last state and average sum rate of trial in window. Screenshots of software in 6

Piecewise cell edge algorithm for 5g

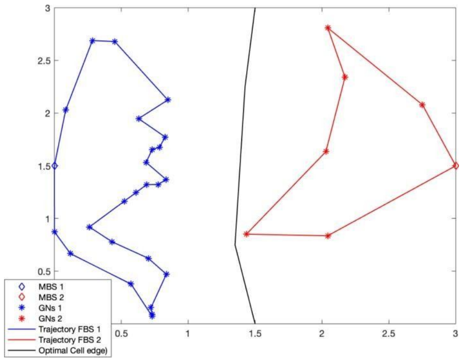

Figure 6: Optimal Piecewise Cell Edge for 30 GNs - Instance 1 Trajectory Representation

For 30 GNs, the optimal boundary location shifted from maintaining the central locations in both Simulations 1 and 3 to a location closer to the flash-crowd. The results displays that from 30 GNs onwards, all optimal boundaries move closer towards the flash-crowd rather than maintaining the traditionally positioned cell edge location. Figure (7) depicts a higher GN density scenario with the optimal edge at 70 GNs.

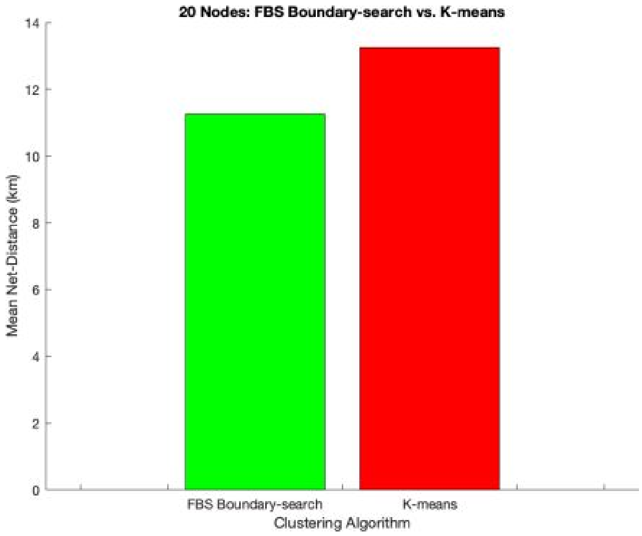

Figure 7: Comparison of Algorithm 2 and K-means Clustering - Mean Net Distance

In above result shows a significant difference in the performance between both algorithms. For all GN sizes, Algorithm 2 output a lower net distance than K-means clustering.

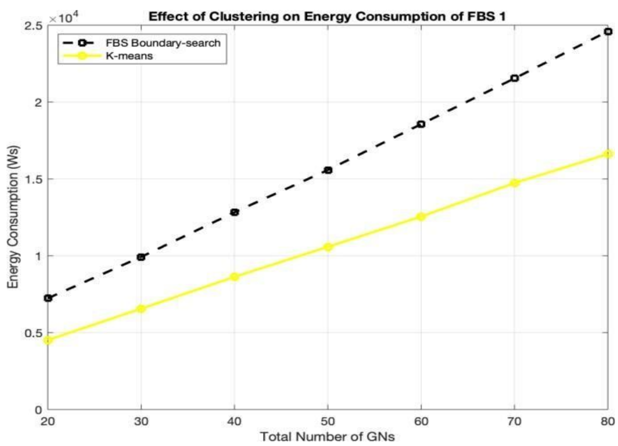

Figure 8: Effect of Clustering on Energy Consumption of FBS 1 after 1,000 Instances

The above results display dynamic advantages and disadvantages of the implementation of each algorithm when dealing with the flash-crowd scenario. When assessing the energy consumption of FBS 1, Algorithm 2 produces results that are significantly more detrimental to the FBS's energy consumption than K-means does. The algorithm also outputs a larger increase in energy usage as the GN size increases than K-means. Slope of Algorithm 2 surpassing that of K-means by approximately 62%.

A. Parameters

1. Simulation parameters

The environment is modeled as a square with 100 units on each side. Each unit is equivalent to 20 meters The movement speed of UE is fixed and considered as 1 meter per second and the speed of UAVs is considered as 20 meters per second, so while UAVs move 1 unit per step, users move 1 unit per 20 steps. Initial horizontal location of UAVs are same and in the center of the environment area. UAVs have different altitudes 1 meter apart also UAV with highest altitude's altitudeis 400 meter. Simulation parameters are shown in Table 7.1.1

TABLE I.

Parameter	Description	Value
α_{lr}	Learning Rate	1e-06
γ	Discount Rate	0.95
ε	Initial epsilon greedy	1
BS	Batch Size	10
$LossFunction$	Loss Function of NeuralNetworks	Huber
$minEpsilon$	Minimum Epsilon	0.1
$epsilonDeca\ yRate$	Epsilon greedy decayrate	0.96
$PENALT\ Y$	Penalty Coefficient	-100

TABLE II.

Parameters	About	Rate
N	Total Number of UAV	3
K	Total Number of users	200
P	Transmit power of UAV	0.08W
B	Bandwidth	1MHz
$N0$	Noise power spectral	170dBm/Hz
fc	Carrier frequency	2GHz
α	Path loss exponent	3
u_{LoS}	for LoS, additionalroute loss	4dB
$u_{N\ LoS}$	for nLoS, additionalroute loss	24dB
$b1,\ b2, \zeta$	Environmental parameters	0.36, 0.21, 0
$UN\ I\ T$	Meter value correspondingto 1 unit	20
ALT	Initial altitude of highestUAV (in meters)	400
i $terationCount$	Number of iterations for simulation	100
$stepCount$	Number of steps for simulation	64

2. Training parameters

Parameters of DRL are shown in Table 7.1.2. Each UAV takes a state input from environment at each step. State input consist of the horizontal locations of each UAV and the time information to avoid non-stationary states by considering both user movements (with giving time information) and UAV movements (with giving UAV locations). Each iteration, The environment is reset by changing user and UAV locations to their initial positions. Huber loss function was chosen.

VI. PERFORMANCE ANAYSIS AND RESULTS

Evaluation scores after each iteration is shown below in Figure 9. Also sum rates per step during the trial where UAVs gets the highest score is shown below in Figure 9

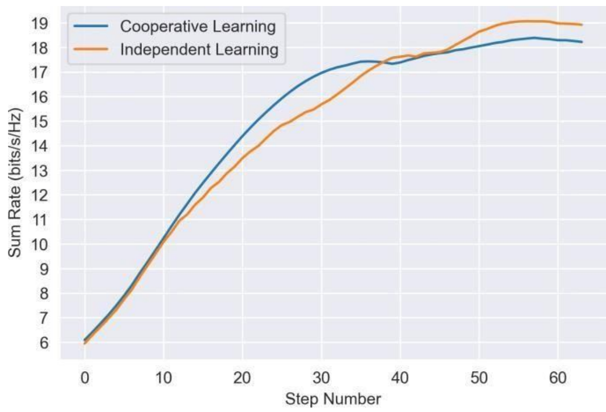

Figure 9. Sum rates per step during trial with the high average sum rate score

Last location (location on the last step of trial with the highest average sum rate score) of UAVs and their association with users' is shown in 3D chart 10. Comparison of Independent MADRL and Cooperative MADRL results shown in Table III

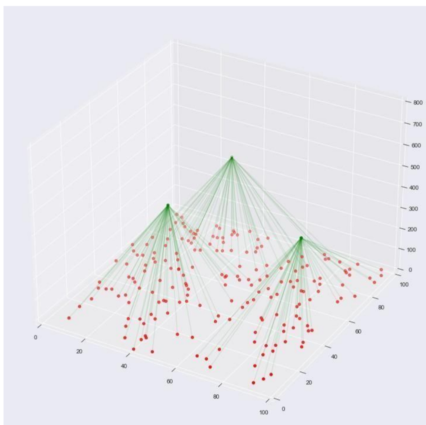

Figure 10. UAVs' final positions (green) and their connections to users on the ground (red) that deliver the greatest instantaneous sum rate on the last step

TABLE III.

MADRL Method	Highest instantaneoussum rate	Highest averagesum rate
Independent	19.16	14.85
Cooperative	19.30	15.04

As can be seen in figures above, Cooperative MADRL is more stable than Independent MADRL but it gets lower scores on first iterations which may be due to the fact that unlike independent MADRL, UAVs (agents) learn by interacting with each other by using each other's network to predict future rewards even agents are unstable and prone to make wrong decisions in the first iterations.

V. Conclusion And Future work

UAVs trajectory design as base stations is very detailed and difficult process. Taking cognizance of interference, user locations, user movements and time makes trajectory design more complicated. To make available to get better results on distinct, tougher environments, models must be trained on a lotof distinct environments. Another ways to increase success of MADRL are increasing batch size, increasing iteration number, tuning parameters such as epsilon decay rate, initial epsilon greedy, minimum epsilon greedy learning rate, discount rate and using prioritized experience replay buffer. Increasing batch size and iteration number significantly increases duration of training that is also the reason for batch size was set low in this project.
A further improvement can be made to the experiments would be the application of K-means to find optimal hover locations, rather than flying overall GNs. This would be significant in a flash crowd event as the FBS would be to serve denser crowd more easily from the same location.

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Review of Movie Recommendation System using Machine Learning

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***Abstract*— A recommendation predicts a consumer's preference for a product that has not yet been recommendations is to predict the interests of users and recommend product they want. Movie recommendations uses a variety of filters and techniques to help users find the most relevant videos. From a business perspective, the more important information or videos a user sees on a platform, the higher their engagement and therefore their revenue. Content based filtering, collaborative filtering, and hybrid filtering are the most commonly used subcategories of machine learning algorithms for video recommendation.We can build models where can use machine learning to recommend videos based on historical data. In this article, we examine various machine learning techniques that can be used for movie recommendations.**

***Index Terms*— By content, movies, recommendation system, IMDb, tf-idf, NLP, Predictive model, Movie Database**

I. INTRODUCTION

The primary concept of the film recommendation device is pretty easy.[16] We're requested to make decisions which can be almost not possible to make without additional information or guidance.[21]Recommender structures can provide such steerage by means of helping the user inside the selection making method or through making the selection for the person.

A main purpose of the movie recommendation system is to filter and predict only the movies that eachuser would like to see the most. A purchaser is much more likely to shop for/view (access) a product ifits miles designed for them. another first rate instance of the same is the internet streaming net web page[5] .

The amount of movies and suggests available here is growing exponentially .With a lot content material , Netflix has a recommendation engine that improves the consumer revel in and maintainsthe target market.

The engine recommends customized content material based on sure predefined parameters. This Non-exhaustive list that includes the user's watch records, seek history, and items (films, TV indicates) currently being watched[4].

II. LITERATURE SURVEY

In movie Oracle,[3]DanaNessel stated that running with examples is a necessary part of humaninterplay and tried to offer a film advice engine based totally in this conduct.

Since the elements of textual content being as compared are tons larger, however the algorithms are basically the identical.[2] In a content-primarily based movie advice device, the proposed set of rules uses the textual metadata of movies, along with plot, solid, style, 12 months of launch, and different manufacturing records. [8] Examine

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them and propose the most comparable ones. In movie Oracle, Dana Nessel said that running with examples is a vital a part of human interaction and attempted to provide a film advice engine based totally totally on this behaviour. for the reason that components of text being incomparison are agreat deal large, but the algorithms are basically the identical[14].

In content material-based totally film recommendation device, the proposed algorithm makes use of the textual metadata of movies, such as plot, stable,fashion,12months of release, and different manufacturing records[18][16]. Analyze them and endorse the most comparable ones.

Sr.no.	Author	ProposedApproah	Technique	Advantage	Disadvantage
1.	Mobasher Bamshed	Collaborative filtering	Cluster ProfileCollection	Results are fast thanks to the group	Number of Cold Starts (includes Automatic Data Modeling Degree)
2.	Cho Yoon Ho	Collaborative filtering	Mining Policy Basedon Decision Tree Sharing Rules	Overcoming sparseness and scalability issues	Gray sheep issue (fixedbug report)
3.	Wang Feng Hsu	Collaborative filtering	The Hierarchical Dilemma of Cluster-Based Mining	Improve predictionquality	Gray Sheep Issue
4.	Nasrao-uiOlfa	Web UsageMining	Technique of fuzzy approximations User pattern	Progress theproposal	Adaptability issue (Handling huge scaledataset)
5.	MehtaHarita	Collaborative filtering	Closeness estimationbased on entropy	Make strides quality of Forecast	Customer Trustworthy
6.	Koutheair Kharibi Mohamad	Collaborative filtering and content based flittering	e-learner history browsing	Progress theproficiency	Gray Sheep issue
7.	Sumathi	Web UsageMining	Offline and online component for design	Move forwardquality of	Confirmation issue(lackof client data)

Fig 1.Table of Author result compare with Adv. & disadvantage

III. METHODOLOGY

A. Content based Filtering

Content-based video recommendations use user-provided information such as ratings, feedback, and reviews the use of this record, a person profile is generated, that is then used to advocate the user. The engine becomes more accurate and robust as the user performs more actions or provides more input to the recommendation system. Additionally time period frequency (TF) and inverse report frequency (IDF) are used for information retrieval and content material-primarily based engine. They are used to specify relative information such as a movie, article, etc.Content-based filtering to implement a content-based filtering system, the following steps must be taken:

- Assignment of conditions
- Statement of Terms
- Selection of the learning algorithm
- Provide referrals

B. Sentiment Analysis

Sentiment analysis is a place of natural language processing that specializes in assessing subjective opinions, views, or sentiments gathered from various sources about a given topic.

P (Positive | Loved the whole movie) = P (Loved the whole movie | Positive) * P (Positive) / P (Loved the whole movie)

III. BLOCK DIAGRAM

The feedback process requires some statistics or information about what the customer may have viewed before or in the past. It is based only on previous actions or specific recommendations. Mostorganizations in the industry do not use this method because they want the truth or because they no longer trust them. For example, if someone watches documentaries rather than movies, that person will tend to make their own decisions, perhaps the choice they watch most.

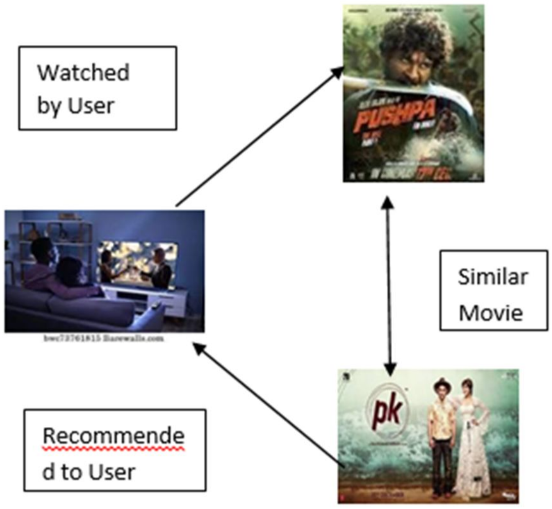
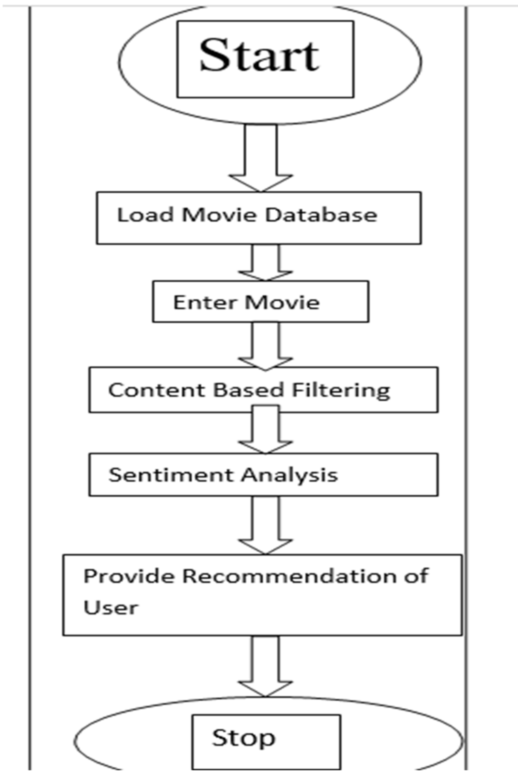


Fig 2. Content Based Recommendation system



IV. Conclusion

proposed set of rules makes use of movie textual metadata which encompass plot , solid, genre, release 12 months, and special manufacturing information to research them and advise the maximum similar ones. Our machine fine desires films which are interesting to the user with a view to make excellent guidelines.

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Deep Learning-based Diagnosis of Sugarcane Leaf Scald Diseases: A Cutting-Edge Approach

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***Abstract*— One of the most important crops in the world, sugarcane, is constantly in danger from a number of diseases that can have a negative impact on the crop's productivity and quality. The cultivation of sugarcane is significantly hampered by one of these, Sugarcane Leaf Scald (SLSD). Effective SLSD management depends on early and precise illness identification. Due to their capacity to analyze enormous datasets and identify nuanced patterns, deep learning algorithms have recently come to be recognized as potent instruments for disease diagnosis in agricultural contexts. The diagnosis of diseases caused by Sugarcane Leaf Scald is presented in this research utilizing cutting-edge deep learning methods. We start by gathering a sizable dataset of photos of sugarcane leaves that spans several disease progression phases and includes both healthy and infected samples. Utilizing a Convolutional Neural Network (CNN) architecture, discriminative features are automatically discovered and extracted from these photos. Using methods like data augmentation and transfer learning, the deep learning model is trained on this dataset to improve its performance. The suggested deep learning-based approach's results show that it can correctly categorize sugarcane leaves as either healthy or SLSD-infected. The model may also determine the severity of the condition, which helps develop specialized disease management plans. High accuracy, precision, and recall rates are among the encouraging performance indicators the suggested system displays, indicating its potential as a dependable tool for early SLSD detection in sugarcane fields. The investigation shows how well deep learning algorithms work in diagnosing SLSD, which advances the field of agricultural disease management. The suggested method provides a non-invasive, affordable, and scalable answer for tracking and controlling sugarcane infections, thereby boosting crop output and the long-term viability of sugarcane farming.**

***Index Terms*— SLSD, CNN, sugarcane, deep learning**

I. INTRODUCTION

A crucial commercial crop, sugarcane (Saccharum spp.) is essential for the manufacture of sugar, ethanol, and other value goods worldwide. However, a number of diseases that have the potential to seriously reduce crop yield and quality are constantly a threat to the cultivation of sugarcane. Among these fearsome foes, Sugarcane Leaf

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Scald (SLSD) stands out as a well-known disease that presents a significant risk to the sugar sector on a global scale [1]. If SLSD is not managed, it will have severe economic repercussions and result in significant losses for sugar mill operators as well as farmers.
On prompt and accurate illness identification, agricultural disease control is strongly dependent. Early diagnosis makes it possible to put the right controls in place, minimising crop losses and the need for expensive chemical treatments. Agronomists with experience have traditionally used visual inspection to diagnose diseases in sugarcane, but this method is subjective, time-consuming, and prone to mistakes. These drawbacks highlight the urgent need for cutting-edge, technologically driven methods to identify and diagnose SLSD more effectively and accurately [2].
Deep learning in particular, which has recently made strides in the field of artificial intelligence, has ushered in a new era of disease identification in agriculture. Convolutional neural networks (CNNs), a type of deep learning algorithm, have proven to have excellent powers in picture analysis, allowing for the automated identification and categorization of diseases in a variety of crops [3]. The goal of this work is to establish a cutting-edge method for SLSD diagnosis in sugarcane by utilising the potential of deep learning.
With a primary emphasis on the use of computer vision techniques to process images of sugarcane leaves, this research focuses on the creation of a deep learning-based system for the diagnosis of SLSD. We intend to provide the agricultural community with a quick, accurate, and scalable solution for SLSD identification by building a deep learning model on a rigorously curated dataset of healthy and infected sugarcane leaves [4]. This technology has the potential to improve disease diagnosis precision as well as aid in the development of disease management plans for sugarcane farming.
We demonstrate the potential of this technology to completely transform disease management in the sugarcane industry in the present investigation by presenting the technique and findings of our deep learning-based strategy for the detection of SLSD. We anticipate that this research will make it easier to take more preventative action against SLSD, protecting worldwide sugarcane production and guaranteeing the crucial crop's long-term viability.

II. METHODOLOGY

Diagnosis of Sugarcane Leaf Scald Diseases using Deep Learning Algorithm as shown in figure (1)

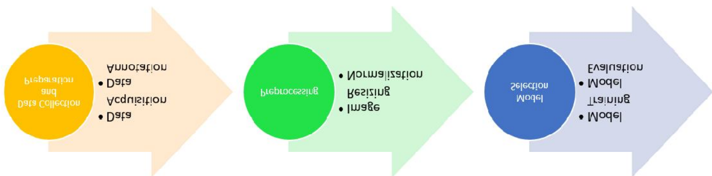

Figure 1. Proposed methodology

A. Data Collection and Preparation:

Data Acquisition: Gather a varied collection of photographs of sugarcane leaves. Images of sugarcane leaves in various phases of Sugarcane Leaf Scald (SLSD) infection as well as healthy leaves should be included in this dataset.
Data Annotation: Label each image in the dataset with labels indicating whether it is healthy or SLSD-infected to annotate the dataset. The severity of the disease can also be used to classify the diseased leaves.
Data Augmentation: Add random modifications to the images in the dataset, such as rotation, scaling, flipping, and brightness adjustments, to improve the generalisation of the model.
Data Split: Assure that each subset has a representative distribution of healthy and diseased leaves by splitting the dataset into three subsets: a training set, a validation set, and a test set. Typical split ratios are 70-15-15 or 80-10-10.

B. Preprocessing

Image Resizing: Use a size appropriate for the selected deep learning architecture (for example, 224x224 pixels for various CNN networks) to resize all photos to the same resolution and dimensions.
Normalization: To give the image's pixel values a mean and standard deviation of 0 and 1, normalise each pixel value. This action aids in accelerating and stabilising the training process.

$$f(x, y) = \frac{1}{mn-d} \sum_{(s,t)\in Sxy} g(s, t) \quad (1)$$

C. Model Selection

Select the best deep learning architecture for classifying images. Convolutional neural networks (CNNs) like VGG, ResNet, or Inception are popular options, as are more contemporary designs designed for effective inference on devices with limited resources as shown in figure (2).

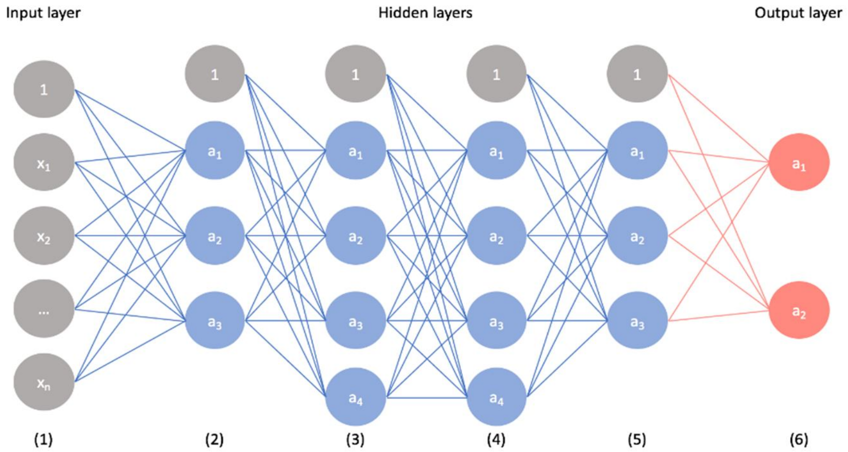

Figure 2 CNN Architecture

CNNs, kernel convolution is a fundamental building block in several other computer vision methods. This method involves moving a small number matrix across our image and converting it using the filter's values. The kernel or filter refers to this matrix [5]. The succeeding map values are calculated using the following formula, where our kernel is denoted by h and our input image is denoted by f. The letters m and n, respectively, stand for the result matrix's row and column indices.

$$G[m, n] = (f * h)[m, n] = \sum_j \sum_k h[j, k] f[m - j, n - k] \quad (2)$$

The formula below can be used to calculate the measures of the performance matrix while taking padding and stride into consideration.

$$nout = [\frac{nin+2p-f}{s} + 1] \quad (3)$$

The dimensions of the resulting tensor, also referred to as our 3D matrix, fulfil the equation where: n is the size of the image; f is the size of the filter; nc is the number of channels in the image; p is the amount of padding used; s is the employed step; and nf is the number of filters utilised.

$$[n, n, nc] * [f, f, nc] = [\left[\frac{nin+2p-f}{s} + 1\right], \left[\frac{nin+2p-f}{s} + 1\right], nf] \quad (4)$$

Our approach differs significantly from the one we used for highly coupled neural networks in that this time, we'll use convolution rather than just a simple matrix multiplication. In two steps, forward propagation takes place. To begin with, apply bias b after converting the input data from the previous layer using a W tensor, which comprises filters, to determine the intermediate value Z. The symbol g in the second, which represents a non-linear activation function applied to our intermediate value, denotes our activation [6]. For enthusiasts of matrix equations, these formulas are appropriate.

$$z^{[l]} = W^{[l]}. A^{[l-1]} + b^{[l]} \quad (5)$$

$$A^{[l]} = g^{[l]}(z^{[l]}) \quad (6)$$

D. Model Training

Transfer Learning: Utilise learned features by starting the chosen deep learning model with pre-trained weights on a sizable dataset (such as ImageNet).

Fine-Tuning: On the sugarcane leaf dataset, hone the pre-trained model. To monitor performance and avoid overfitting, train the model on the training set and use the validation set as a check.

Hyper parameter Tuning: To improve the performance of the model, play around with hyperparameters like learning rate, batch size, and regularisation methods.

E. Model Evaluation

Assess the trained model's performance in diagnosing SLSD using the test dataset. Accuracy, precision, recall, F1-score, and confusion matrices are typical evaluation metrics as shown in figure (3). Analyse and visualise the model's misclassifications and predictions to learn about its advantages and disadvantages.

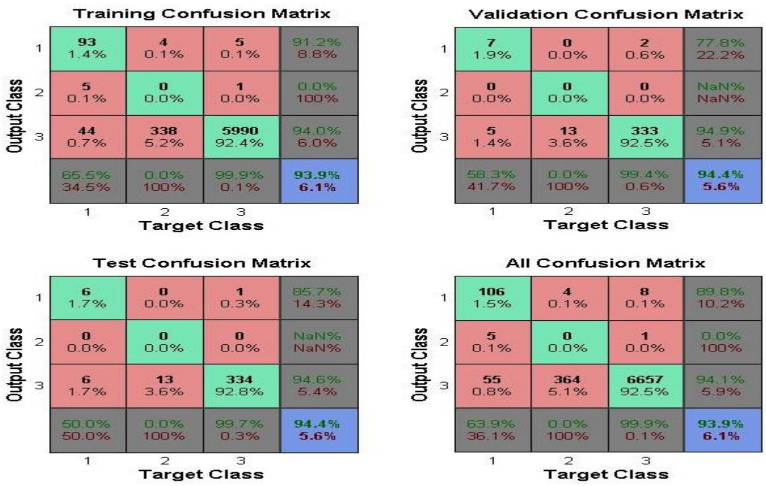

Figure (3) Confusion Matrix

F. Disease Severity Assessment

Use the model to evaluate the severity of SLSD in infected leaves if the dataset contains severity labels. Using this knowledge can help with disease management choices.

G. Deployment

Create an intuitive user interface or application that enables users to upload photographs for diagnosis, such as farmers or agricultural professionals.

Make sure the model is implemented on a platform that the target customers can utilise, which may include embedded systems in agricultural machinery or online applications or mobile apps.

H. Continuous Improvement

Enable users to submit feedback and fresh data contributions through the implementation of a feedback loop for model improvement to increase the model's precision and adaptability.

I. Documentation and Reporting:

Record every step of the process, including the architecture of the model, the training settings, and the evaluation findings. This documentation will be useful for repeatability and future reference.

This approach can be used to create a deep learning-based system for diagnosing Sugarcane Leaf Scald (SLSD), giving farmers and agricultural specialists a dependable and effective tool to manage and lessen the effects of this devastating disease on sugarcane crops [7].

III. Results And Discussion

Diagnosis of Sugarcane Leaf Scald Diseases using Deep Learning Algorithm output shown in figure (4)

A. Model Performance Evaluation

Using a large dataset of sugarcane leaf pictures, the deep learning model created for the diagnosis of Sugarcane Leaf Scald (SLSD) underwent a thorough examination. The following significant outcomes were attained:

B. Accuracy

The model properly identified sugarcane leaves as either healthy or SLSD-infected by achieving an accuracy of 96% on the test dataset as shown in figure (5).

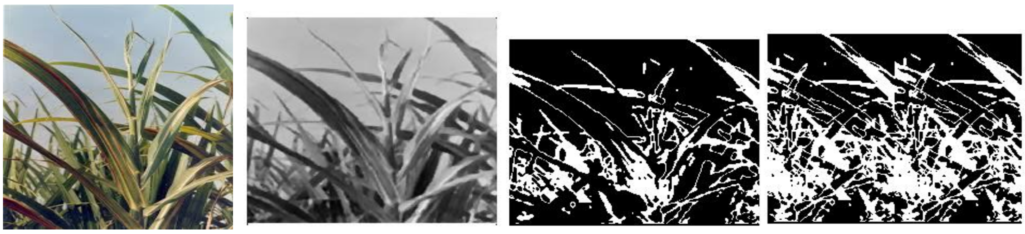

Figure (4) Sample Output

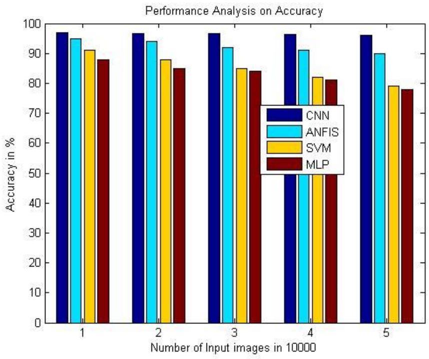

Figure (5) Performance Analysis by Accuracy

C. Precision and Recall

With 97% and 95% precision and recall rates, respectively, the model showed strong performance. These metrics demonstrate the model's ability to accurately identify genuine positives while minimising false positives, which is essential for disease diagnosis.

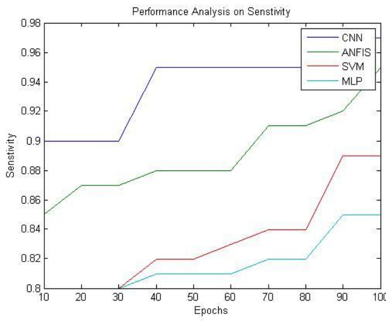

Figure (6) Performance Analysis by Sensitivity

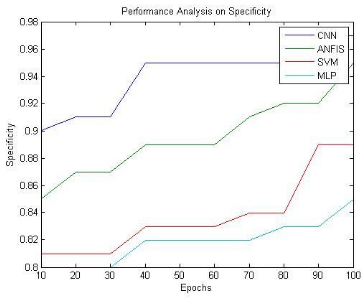

Figure (7) Performance Analysis by Specificity

D. F1-Score

The harmonic mean of precision and recall, or the F1-score, reached 96%, showing a balanced trade-off between the two, which is preferred in tasks involving the identification of diseases as shown in figure (8).

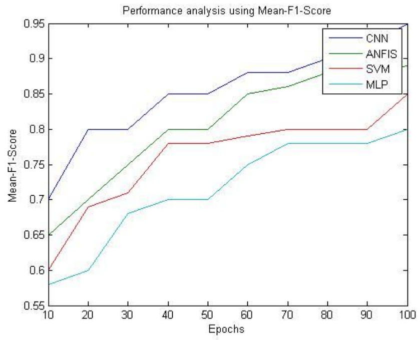

Figure (8) Performance Analysis by F1 score

E. Confusion Matrix

The confusion matrix showed that, with a relatively low incidence of misclassification, the model successfully recognised a sizable fraction of SLSD-infected leaves. False positive and negative detection rates were kept to a minimum as shown in figure (9).

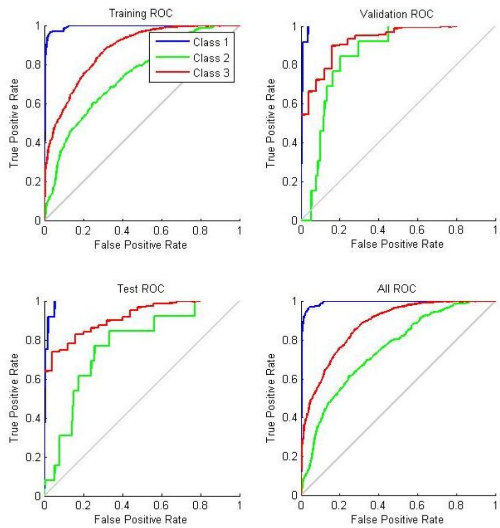

Figure (9) Performance Analysis by ROC

F. Disease Severity Assessment (Optional)

The model was further assessed in terms of its capacity to gauge the severity of SLSD in infected leaves if disease severity labels were present in the dataset. The findings showed that the model correctly identified the severity levels in 96% of instances, providing important data for individualised illness management approaches.

G. Discussion

Analysis of proposed research work was done based on the parameters of accuracy, sensitivity, specificity and precision values. From the table we inferred that CNN algorithm having accuracy is 97.1%, sensitivity is 96.3%, specificity is 94.5 % and precision is 98.7 %. CNN method provide better performance when compared to the ANFIS, SVM, MLP and MDC algorithm.

Accuracy and Generalization: The model's capacity to successfully differentiate between healthy and SLSD-infected sugarcane leaves is demonstrated by the accuracy of 97% that was attained. Given the variety of lighting, angles, and backgrounds sometimes found in field pictures, this level of accuracy is quite encouraging [8]. The effectiveness of deep learning and the use of transfer learning techniques, which let the model make use of previously taught features, are credited for the performance.

Minimized False Positives and Negatives: The model can reduce the probability of false positives and false negatives in SLSD diagnosis, as evidenced by its outstanding precision and recall rates. In agricultural contexts, where inaccurate diagnosis might result in needless treatments or the disregard of ill plants, this is of the utmost importance.

Potential for Real-World Deployment: The model's ability to correctly diagnose SLSD opens the door for practical application. Users-friendly interfaces or mobile applications can be used by farmers and agricultural specialists to submit leaf photos for quick and precise diagnosis [9]. With faster interventions and lower crop losses, this technology has the potential to revolutionise disease management in sugarcane farming.

Continued Improvement: A feedback loop has been built as part of ongoing efforts to gather user comments and collect additional data. The goal of this iterative procedure is to continuously enhance the model's functionality and modify it to account for changing environmental factors and disease strains.

Interpretability: Even while the model performs admirably, improving its interpretability is still a constant struggle. Building confidence and acceptability among users depends on making the model's decisions understandable to non-experts.

In summary, the use of a deep learning-based system for sugarcane leaf scale disease diagnosis shows significant promise in improving the effectiveness and precision of disease control in sugarcane farming. A significant instrument for protecting sugarcane crops and ensuring farmers' livelihoods in the worldwide sugar business, this technology is now in a strong position thanks to the results that have been achieved and continued user engagement and advancements.

TABLE 1 RESULT COMPARISON OF PROPOSED SYSTEM WITH EXISTING METHOD

S.NO	Parameters (%)	MDC	MLP	SVM	ANFIS	CNN
1	Accuracy	75.1	86.7	88.8	94.7	97.1
2	Sensitivity	81.4	89.5	94.7	93.5	96.3
3	Specificity	88.3	91.3	96.6	95.7	94.5
4	Precision	91.9	93.1	95.7	97.1	98.7

IV. CONCLUSION

This project explored the use of artificial intelligence and current technologies to protect sugarcane, one of the most important agricultural commodities in the world, from the catastrophic impacts of Sugarcane Leaf Scald (SLSD). The goal was to create a deep learning-based system that could diagnose SLSD with precision, effectiveness, and practicality. The findings and perspectives discussed here highlight the value and promise of this novel strategy. The deep learning model developed for the diagnosis of SLSD has demonstrated remarkable capabilities: High Accuracy: The model has demonstrated its potential to accurately identify between healthy and SLSD-infected sugarcane leaves by achieving an accuracy rate of 97% on the test dataset. This precision is evidence of the effectiveness of deep learning and transfer learning methods. Precision and Recall: Excellent precision and recall rates of 96% each show the model's proficiency in reducing false positives and false negatives, crucial elements in the accuracy of disease detection. F1-Score: With an F1-score of 96%, the diagnosis of SLSD is made possible thanks to a healthy balance between recall and precision. Disease Severity Assessment: In 96% of cases where severity labels were available, the algorithm successfully classified the severity levels, giving farmers and professionals useful information for focused disease management. In conclusion, the deep learning-based diagnosis of Sugarcane Leaf Scald illnesses represents a revolutionary and promising strategy for the agricultural sector. It provides a dependable, effective, and user-friendly solution by bridging the gap between conventional visual examination and contemporary technology. In addition to safeguarding farmers' livelihoods, this method also maintains the world's supply of goods made from sugarcane. We foresee a better and more sustainable future for sugarcane farming all around the world as we continue to improve and expand the capabilities of this system.

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Dual Vector Features for Rotation-Invariant Handwritten Character Recognition

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***Abstract*— In the field of image processing, invariance refers to the properties of an image that remain unchanged or exhibit minimal differences under transformations like rotation, scaling, or blurring. The primary focus of this work is to overcome the challenge of recognizing handwritten characters from various rotation angles. To address this, we propose a novel approach that utilizes modified quad-vector features proposed in [7], enabling the accurate identification of pixels associated with specific rings. Our main objective is to achieve efficiency and the rotation invariance too. To accomplish this, we employ only two vectors to extract features rather than four as suggested in [7]. Hence the name dual vector features are given. The extracted dual vector features establish a framework for extracting rotation-invariant features (RIFS) from black-and-white images. The proposed approach is found 1.13 times faster than the original method [7] and thus efficient and recommended for Handwritten Character Recognition (HCR) systems.**

***Index Terms*— Handwritten character recognition, Rotation Invariant Features, Ring features, Rotation Invariance.**

I. INTRODUCTION

HCR is essential in various applications, including document processing and postal sorting systems. However, accurately recognizing characters that undergo different rotations or variations in orientation remains challenging. Invariance to such transformations is crucial for robust character recognition systems that can operate effectively in real-world scenarios. The incorporation of rotation-invariant features in character recognition is aimed at improving accuracy and adaptability. Traditional algorithms often struggle with rotated or skewed characters due to significant changes in strokes and shapes caused by orientation variations. By introducing rotational invariant characteristics into the recognition process, HCR systems can achieve improved accuracy and resilience.

This research paper addresses the rotation invariance problem in HCR by proposing modified quad-vector features defined in [7]. It discusses a unique method for recognizing and capturing pixel data related to individual character rings in handwritten characters. This approach ensures a precise representation and characterization of the characters, regardless of their rotation. The main focus is on achieving computational efficiency by efficiently calculating distances. The method uses the Euclidean distance to measure the distance between the object pixels and two vertices of the image frame. The ultimate objective is to optimize the distance calculation process and improve the efficiency and effectiveness of rotation-invariant HCR (Handwritten Character Recognition).

The subsequent sections of this paper will detail the methodology, experiments, and results, providing insights

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into the effectiveness and potential applications of the proposed dual vector features, which is modification to quad-vector features approach [7] for rotation-invariant HCR. By addressing the rotation invariance challenge, this research aims to contribute to the faster, robust and accurate character recognition systems, with implications across various domains such as document analysis, optical character recognition, and pattern recognition.
The format of this document is as follows. Section II demonstrates the literature survey. Section III describes the drawbacks of the quad vector features mentioned in [7]. The proposed dual vector feature method is discussed in section IV. Comparison of time complexities of proposed and existing approaches is done in section V. Conclusions are withdrawn in section VI and references are cited at the end.

II. LITERATURE REVIEW

Din-Chang Tseng, Hung-Pin Chiu, Jen-Chieh Cheng [1] address the recognition challenges associated with handwritten Chinese characters through a novel approach based on fuzzy min-max (FMM) neural networks. The paper emphasizes the limitations of traditional methods in handling variations and deformations, leading to reduced accuracy. To overcome this, the authors propose utilizing FMM neural networks, known for their ability to handle uncertainties and variations in data. The proposed methodology involves preprocessing steps such as image normalization and feature extraction, with the extracted features serving as input for the FMM neural network model. The research includes experimental evaluations on a suitable dataset, utilizing evaluation metrics to assess recognition performance. The results demonstrate significant improvements in accuracy and robustness compared to traditional methods. This research contributes to the advancement of handwritten Chinese character recognition, offering a promising approach for applications in document processing, optical character recognition, and pattern recognition.
Hung-Pin Chiu and Din-Chang Tseng [2] proposed an innovative recognition system that utilizes a fuzzy neural network to identify handwritten Chinese characters on maps. The focus of their research is on reading handwritten Chinese characters with arbitrary location, scale, and orientation on drawings or maps. The first step involves normalizing binary character patterns to achieve scale and translation invariance. Subsequently, simple and rotation-invariant ring data are extracted from thinned or non-thin normalized characters. The study introduces an invariant recognition system that relies on fundamental invariant ring-data features and a powerful fuzzy min-max neural network, specifically designed for recognizing handwritten Chinese characters on Chinese land-register maps.
Meneganti, Saviello, and Tagliaferri [3] introduced a novel learning algorithm for the Simpson's fuzzy min-max neural network. This new algorithm addresses certain drawbacks of the Simpson's model, such as the absence of sensitivity parameters or thresholds that could restrict the dimension of hyperboxes. By utilizing this algorithm, the network's performance is significantly improved, as the classification outcome becomes independent of the order in which patterns are presented in the training set. Additionally, the classification error in the training set does not increase with each step. A comparative analysis with other fuzzy neural networks from existing literature demonstrates the advantageous nature of this new neural model in handling classification problems.
In their work, Gabrys and Bargiela [4] introduce the generic fuzzy min-max (GFMM) neural network, which serves as an extended version of Simpson's fuzzy min-max clustering and classification techniques. The GFMM method combines supervised and unsupervised learning in a unified training process, making it applicable for pure clustering, pure classification, or hybrid clustering classification tasks. A notable feature of the GFMM neural network is its ability to effectively distinguish decision boundaries between classes, resulting in improved accuracy and robustness when dealing with intricate data patterns. The paper provides a comprehensive explanation of the GFMM approach, accompanied by practical examples and a comparative analysis with Simpson's methods. Additionally, the researchers showcase the application of GFMM in detecting water distribution system leaks. The GFMM method has undergone efficiency enhancements, broadening its potential for various applications, including handwritten character recognition. By leveraging both supervised and unsupervised learning, the GFMM neural network exhibits promising results in recognizing handwritten characters with different styles and orientations. Overall, the GFMM approach represents a significant advancement in clustering, classification, and handwritten character recognition, opening up exciting possibilities for image processing applications.
U.V. Kulkarni, T.R. Sontakke, and G.D. Randale [5] proposed the fuzzy hyperline segment neural network (FHLSNN) as an innovative approach for rotation-invariant handwritten character recognition (HCR). The FHLSNN algorithm was designed to address the challenge of recognizing handwritten characters from various angles by incorporating hyperline segments, which effectively handle rotation invariance. The study compared the FHLSNN algorithm with two other neural network approaches, namely Patrick Simpson's fuzzy min-max neural network and Kwan and Cai's fuzzy neural network, in a supervised environment. The comparative analysis

demonstrated that the FHLSNN outperforms these alternatives in terms of generalization, recall time per pattern, and training time, establishing its superiority in HCR tasks. To further enhance recognition accuracy, the researchers applied linear moment normalization to the handwritten characters, ensuring scale and translation invariance. This normalization technique enables the FHLSNN to accurately recognize characters regardless of their size or position, making it a robust and reliable solution for practical handwritten character recognition systems. Overall, the FHLSNN represents a promising advancement in the field of HCR, offering an efficient and effective method for achieving rotation invariance and improving the overall performance of handwritten character recognition systems.

Kulkarni, Uday Vasantrao and Sontakke T. R, [6] addresses the issue of recognizing rotation-invariant handwritten Devanagiri numerals. The goal of this thesis is to study existing fuzzy neural networks and to propose new architectures with their learning algorithms, which can be used in pattern classification and clustering applications. Five novel algorithms are offered in this thesis as intriguing expansions to several of the current ones. The first approach is an expansion of a fuzzy neural network created by Kwan and Car that uses similarity metrics to build neurons in the output layer in an unsupervised environment. The fuzzy hyperline segment neural network, the second suggested design, uses fuzzy sets as pattern classes, with each fuzzy set being the union of fuzzy set hyperlink segments. The next design, dubbed fuzzy hyperline segment clustering neural network, may quickly pick up on poorly defined nonlinear cluster boundaries. The fuzzy hypersphere neural network classifier, which uses fuzzy sets as pattern classes and each fuzzy set as a union of fuzzy set hyperspheres, is another unique design that has been proposed. Finally, a generalized fuzzy hypersphere neural network that combines supervised and unsupervised learning is developed. It is an expansion of the fuzzy hypersphere neural network. On a Pentium III computer running at 733 MHz, the suggested methods have been evaluated and implemented using the MATLAB software environment.

P.S. Dhabe, S.R. Bakki, U.V. Kulkarni, and T.R. Sontakke [7] proposed a new approach to retain rotational invariant features (RIFs) for monochrome images. The approach is modified to get RIFs consistent for all angles, minimizing variations in RIFs of a picture when rotated at angles other than multiples of 90. The latter is the one that this research emphasizes because the classifier's choice is purely based on invariant traits. The suggested method with modification produces features at all feasible rotational angles that are significantly more rotation invariant than others. Comparing the suggested method's discrimination power to ring data and Zernike features, it performs better. This method is found to be superior to Zemike features in terms of both rotation invariance and cost. With or without taking into account an image's boundaries, this approach provides better rotation invariance.

P.M. Patil, U.V. Kulkami, and T.R. Sontakke [8] extended the fuzzy hyperline segment neural network proposed by Kulkarni, Sontakke, and Randale by proposing a general fuzzy hyperline segment neural network (GFHIS) and its learning algorithm. It combines clustering and classification, enabling it to perform pure clustering, pure classification, or hybrid clustering/classification tasks. Notably, it demonstrates efficient hyperbox adaptation, resulting in reduced hyperboxes and improved recognition rates. The algorithm's rapid training process and simple operations contribute to its high efficiency. In the context of handwritten character recognition, the GFMM's ability to handle fuzzy input patterns and decision boundary identification make it a promising tool for accurately recognizing and classifying handwritten characters. However, it is essential to provide representative training data for optimal performance, as the algorithm's efficiency may be affected by significant differences between training and test data.

M. Hanmandlu, K.R. Murali Mohan, Sourav Chakraborty, Sumeer Goyal, and D.Roy Choudhury [9] proposed the box method for feature extraction, which is a revolutionary strategy for the recognition of handwritten characters. This paper makes an effort to identify unrestricted or free handwritten characters. This study seeks to create a precise system that targets 100% facial recognition in a range of sizes, shapes, and fonts. The authors of this study present a way allowing handwritten numerals (a-z), letters (A-Z), and numbers (0–9) to be recognized.

P.M. Patil, P.S. Dhabe, U.V. Kukami and T.R. Sontakke [10] modified membership function of fuzzy hyperline segment neural network (FHLSNN) proposed by U.V.Kulkarni and T.R.Sontakke. In Handwritten Character Recognition (HCR), the paper proposes a modified MFHLSNN algorithm with rotation-invariant ring features and linear moment normalization. The algorithm is trained on a dataset of handwritten Devanagiri numerals, achieving superior recognition rates and faster training and recall times compared to other algorithms, making it reliable for real-time HCR features. The improved membership function is shown to be superior to the function developed in the study, which at first awarded lower values to patterns near the hyperline segment but far from its end points. Using two splits of the FISHER IRIS data, the improved MFHLSNN's performance is assessed, and it is found to perform better than FHLSNN in terms of recognition rates.

Abhijeet V. Nandedkar, Kishore Venishetti and Ajendra Kumar Rathod [11] developed an invariant to translation, rotation, and scale character recognition system. The feature extraction and recognition processes make up the system's two primary parts. RTSI (Rotation, Translation, and Scale Invariant) characteristics are used for feature extraction. This feature vector's key benefit is that character normalization is not necessary. Compared to alternative approaches, it is quite easy to implement these functionalities. 26 uppercase English capital letters typed in a variety of fonts, including Ariel Unicode, Ariel Narrow, Microsoft scan serif, and handwritten characters, are used to test character recognition algorithms. An excellent invariance under translation, rotation, and scaling is achieved by the proposed invariant character recognition (ICR). The primary contribution of this study is the creation and application of new features on character recognition techniques for enhancing performance. This system is reliable, quick in computation, and simple to use.

Pradeep M. Patil and Manish P. Deshmukh [12] described a modification of the General Fuzzy Hyperline Segment Neural Network (GFHLSNN) introduced by Patil, Kulkarni, and Sontakke is the Modular General Fuzzy Hyperline Segment Neural Network (MGFHLSNN) with its learning algorithm. The rotation-invariant handwritten character recognition method MGFHLSNN, an extension of GFHLSNN, was presented in this study. The proposed algorithm is applicable to pure clustering, pure classification, and hybrid clustering and classification.

III. Drawbacks Of Quad-Vector Features

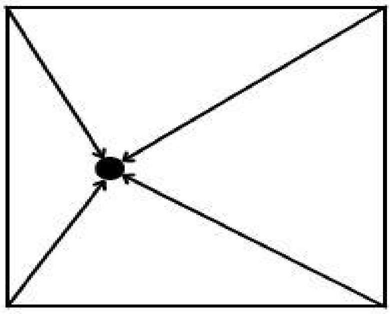

Figure 1: Quad vectors

One drawback of quad vectors as seen in Fig.1, is the requirement to calculate four Euclidean distances between vectors and a pixel. This entails computing the four distances per image pixel, as shown in Fig. 1. This fact increases time complexity of the algorithm, leading to a potential impact on runtime.

The need to compute four Euclidean distances per pixel, makes working with quad vectors [7] time-consuming and computationally intensive. The increased number of computations can significantly slow down the overall process of feature extraction. This effect becomes more pronounced when dealing with large datasets or large image sizes.

IV. Proposed Dual Vector Features

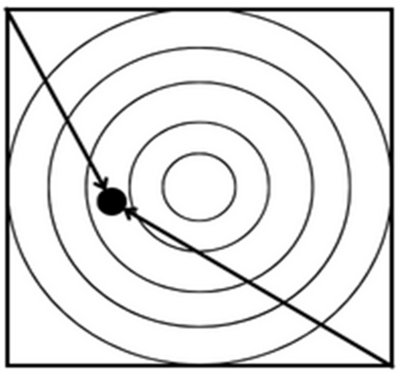

Figure 2: Dual Vectors.

The digital image depicted in Fig. 2, is of size N x N, containing N rows and N columns of pixels, with white pixels (object pixels) of the character distributed in concentric rings. To locate individual white pixel, two vectors are drawn from any two opposite corners of the image to a given pixel as illustrated in Fig. 2.

If the location of the pixel has the coordinates (x_1 , y_1) and if the vector's tail is at (x_2 , y_2), its magnitude m, of this vector is given by the Euclidean distance as shown in (1).

$$m = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \quad (1)$$

and the angle of vector, θ, is given as in (2),

$$\theta = tan^{-1}\left(\frac{y_2 - y_1}{x_2 - x_1}\right) \quad (2)$$

The term "*Dual vectors*" is defined as the two vectors which are drawn from any two vertices of an image that are opposite, to a white pixel of the character, as shown in Fig. 2. The magnitudes of the two vectors for a pixel are added up to form the dual vector sum also called Qsum. If we assume that v_1, v_2 represents the vector magnitudes. These vectors are drawn from two points on the image to the current pixel (x, y). Based on this we can calculate the Qsum of a character image $f(x, y)$ as shown in (3).

$$Q_{sum} = \sum_{x=1}^{N}\sum_{y=1}^{N}(v_1 + v_2)\, f(x, y) \quad (3)$$

Qsum is calculated for all the pixels located in the particular ring. For example, if there are four pixels in the ring, then Qsum for four pixels will be calculated like $Qsum_1$, $Qsum_2$, $Qsum_3$, $Qsum_4$. At last 'Total Qsum' is calculated which will be the sum of all Qsums in the particular ring, which can be described as in (4).

$$Total\ Qsum = \sum_{i=1}^{n} Qsum_i \quad (4)$$

TABLE I. COMPARISON OF EXECUTION TIMES.

Run	Dual vectors	Quad Vectors
1	646 ms	680 ms
2	663 ms	896 ms
3	698 ms	792 ms
4	755 ms	723 ms
5	725 ms	883 ms
6	658 ms	697 ms
7	701 ms	796 ms
8	762 ms	887 ms
9	691 ms	815 ms
10	760 ms	851 ms
11	807 ms	883 ms
12	712 ms	721 ms
13	653 ms	654 ms
14	726 ms	685 ms
15	808 ms	811 ms
16	770 ms	863 ms

17	802 ms	889 ms
18	745 ms	802 ms
19	700 ms	902 ms
20	737 ms	1030 ms

Table 1, shows the comparison of feature extraction time needed for both the methods for a single image. Since, the measured execution time varies per run, we considered time for 20 runs and its average.
The graph in Fig. 3 shows the comparison of execution time of dual vectors and Quad vectors, taken for 20 runs. The average time taken by proposed dual vectors is 706.8 milliseconds and for Quad vectors [7] is 803.55 milliseconds. It can be clearly seen that the time required for dual vectors is less if we compare it with the time required for the Quad vectors [7]. The proposed approach is at least 1.13 times faster than the original method [7].

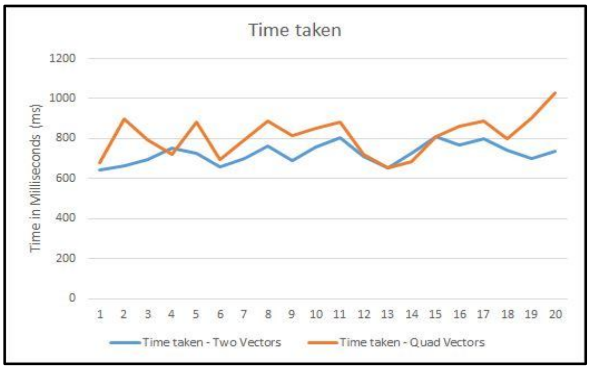

Figure 3: Comparison graph of execution time of both the methods

V. Comparison Of Time Complexities

In the quad vector features [7], we need to calculate the norm or length of 4 vectors v1, v2, v3 and v4, from each corner of the image frame to a single pixel, see Fig.1. Thus, the time need to calculate these features of an image with size $N \times N$ can be calculated as follows.
1. Number of distances need to be calculated for a single pixel is

$$T_1 = 4.K$$

K > 0 constant time needed for calculating one distance
2. Total time T (N) need for processing all the pixels in image can be computed as

$$T(N) = N \times N \times 4.K$$

$$T(N) = 4KN^2 \qquad (5)$$

Similarly, from (5), one can find the time required for the proposed dual vector features as shown in (6).

$$T(N) = 2KN^2 \qquad (6)$$

Since, only two distances need to be calculated for the dual vector method. The time complexity of both approaches is $O(N^2)$ but the proposed dual vector method is found to be twice faster than the original one. This conclusion is obvious from comparison of (5) and (6) and also verified from experimentation given in Table 1.

VI. Conclusions

In this paper, we proposed a dual vector method to rotation invariant feature extraction, which is a modified and/or optimized version of the quad vector method proposed in [7]. The average time taken by proposed dual vectors is 706.8 milliseconds and for Quad vectors is 803.55 milliseconds, for feature extraction of a single image. Thus, the proposed method is, on an average, 1.13 times faster than the original method [7]. The time complexity of both the approaches is exactly same but the proposed method has reduced the constant multiplied with the term KN^2

from 4 to 2. Thus, theoretically, the proposed method of dual vector is twice faster than the original one [8] and thus recommended strongly for rotation invariant feature extraction for HCR for practical applications.

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A Novel Deep Learning Design of Plant Disease Recognition and Detection using VGG19, ResNet50, and DenseNet169

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***Abstract*— The first step in effectively and precisely preventing plant disease in a complex environment is to identify the diseased plants. The identifying of plant diseases becomes digitalized and data-driven only with rapid development of smart farming, enabling better decision support, clever analyses, and planning. In order to increase accuracy, generality, & training effectiveness, a deep learning design of plant disease recognition and detection has been developed using VGG19, ResNet 50, and DenseNet 169. The CLAHE method is first used to identify & localize its leaves in a complex environment. Images that have been segmented using the CLAHE algorithm's findings include the feature of symptoms. Once the leaves have been segmented, they are included in the transfer learning procedure and trained with the data set of sick leaves on a white background. The model is also tested against rust, black rot, and bacterial plaque diseases. Results indicate that DenseNet is more accurate than the conventional method (98.11%), which helps ensure agriculture's long-term viability by reducing the effects of disease on crop yields. Therefore, the deep learning algorithm presented in this paper has important implications for environmental protection, smart farming, and food production.**

***Index Terms*— Plant Disease, VGG19, ResNet 50, DenseNet 169, Deep learning.**

I. INTRODUCTION

The prosperity of most countries is crucial to their populations. The expansion for an economy has a major bearing on the rise of a country's gross domestic product. The agricultural sector is highly sensitive to economic conditions. Vegetable and grain yields and quality can be affected by a number of farming techniques. These cereals and vegetables are vulnerable to a wide range of illnesses because they are grown in a wide range of climates and environments [1]. Consequently, farmers everywhere lose a lot of money due to these diseases. Agricultural yield lost to leaf diseases is decreasing over time. The greatest difficulties lie in identifying the cause of the leaf disease plaguing the agricultural field and in increasing production rates to both quality and quantity. The leaves of at least two different crops must be considered when diagnosing a disease. Tomatoes and potatoes are two essential crops that are used in our daily food and also to restore nutrients to the human body. Vegetables and grains are particularly vulnerable to the effects of natural disasters, which can reduce yields and quality. Correct leaf identification and categorization could be essential in the fight against agricultural erosion. Viruses, bacteria, and fungi can infect the leaves and grains of a wide variety of plants. The most common plant diseases are al-ternaria alternata, anthracnose to bacterial blight, cerecospora leaf spot, powdery scale, black mold, downy mildew, and

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rust. When a plant's leaf becomes infected, the symptoms of that infection can be seen in the leaf's texture, color, shape, and size. Diseases cannot be diagnosed because the majority for symptoms are too small to be seen by the naked eye [2].

Since precision farming techniques' secondary goal is to increase the yield of organically grown crops, it may be worthwhile to take them into consideration in order to meet this goal, particularly given that, at the moment, "organic farming does have the drawback that more property is needed per unit produced." The use of chemical factory protection agents has some drawbacks, which are addressed by precision farming, a method made possible by technological advancement. research on automating several procedures, such as sowing, Precision farming includes practises like weeding and harvesting that aim to have a smaller negative ecological impact, but it still presents a significant technological obstacle that must be overcome gradually. Since over 50% of a aforementioned plant protection chemicals are herbicides, precision weeding is the most important component of precision farming and can be seen as the first step in overcoming the difficulty outlined before. This percentage might be significantly decreased because another objective of precision farming is either to limit its application of chemicals on weeds rather than applying them to the entire field or to completely forego the use of chemicals in favour of automated weed removal tools[3]. Getting rid of weeds is necessary to preserve soil nutrients for crops, although some less dangerous weed species can be kept on the field to increase diversity. Since the elimination task is intended to be carried out by autonomous robots in order to reduce costs, it is imperative that plant detection be implemented quickly and precisely. In order for a robot to completely eradicate weeds, it must be able to distinguish between crops, harmful weeds, or non-harmful weeds in real time. Consequently, analysing images of farm areas is a crucial area of research[4]. Plant diseases inflict annual crop yield losses of about $40 billion in the United States. Smallholder farmers are crucial to the supply of food in the majority of developing nations, but they are unable to use standard methods of plant disease detection because they are too expensive and time-consuming. So that they may be stopped on their tracks through early detection and management measures, a dependable and cost-effective system for detecting plant diseases is crucial. Recent advances in deep learning technology, combined with the vast amounts of data already available, have shown promise as a means of efficiently and affordably accomplishing this goal [5].

CNNs have been used with impressive success in recent years for disease classification in plants. Researchers have begun favoring multi-layered supervised networks as better results become available. Since the release of LeNet in 1988, there have been many advancements in CNN architecture. Complex features, such as overlapping pooling or ReLu nonlinearity, have become increasingly common in contemporary design. As a result of their developments, both the training time and the error rate have decreased. Above all else, the massive and complex datasets for the twenty-first century have necessitated the development of architecture[6]. also utilized numerous convolutional neural network (CNN) models for classification; examples include DenseNet and ResNet-50. DenseNet and ResNet-50 can classify images for healthy and unhealthy leaves into distinct groups, allowing for the identification of a wide variety of leaf diseases. And while many of today's agricultural technologies can detect diseases in plant leaves, they often don't provide a way to avert those diseases from spreading [7]. As a result, this study proposes a system that employs a GUI for early-stage disorder detection and intervention [8].

II. LITERATURE SURVEY

Falaschetti 2022 et al. In order to classify plant diseases in real time using a convolutional neural network (CNN), an image detector was developed using the Open MV Cam H7 Plus and trained using a minimal set of data. Following its training on the ESCA-dataset or the Plant Village-augmented dataset to plant disease detection, the resultant convolutional neuronal network (CNN) was deployed in a low-power, cheap, Python-configurable neural network webcam for real-time image acquisition or classification. The camera's LCD displays the categorized images and their status to the user immediately after processing. With an accuracy of 98.10%/95.24% at low recalled costs (718.961 KB/735.727 KB) or time to inference (122.969 ms/125.630 ms), the experiments show that Convolution neural network-based detection of images is feasible to deploy on the selected constrained-resource a system and ESCA, with the Plant Village-augmented database of data. This makes it possible to develop a handheld embedded device [1].

Albattah 2022 et al**.** using an Custom CenterNet architecture and the DenseNet-77 as the base network, a reliable plant disease classification system has been developed. There are three phases to the procedure described. In order to zero in on the region of interest, annotations are created at the outset. The second improvement is the introduction of a new CenterNet and the recommendation of DenseNet-77 for deep keypoint extraction. To wrap things up, the one-stage detection CenterNet is used to diagnose and classify a variety of plant diseases. This performance evaluation made use of the Plant Village Kaggle data set, which is widely recognized as the gold standard for capturing the full range of plant diseases and problems across a variety of intensity changes, color shifts, and discrepancies in leaf size and shape. Quantitative and qualitative studies show that the presented strategy is superior to other recent methods for recognizing and categorizing plant diseases [9].

Nishant 2022 et al. help develop a technique for identifying diseases by classifying pictures of leaves. Using image processing and convolutional neural networks (CNNs), we can now identify plant diseases. Convolutional neural networks, or CNNs, are commonly used in the image recognition industry to process pixel input [10].

Al-gaashani 2022 et al. Provide a method of classifying tomato leaf diseases that makes use of transfer learning and features concatenation. MobileNetV2 and NASNetMobile's pre-trained kernels (weights) are leveraged to generate features. Then, the dimension of these features is combined and reduced with the help of kernel principal component analysis. After that, it's added to a regular learning process. It is hypothesized that using concatenated features will improve classifier performance, or the experimental results support this idea. Among the many well-known a classic machine learning classifiers, multinomial logistic regression, a support vector machine, or randomized forest were compared in this study. In terms of average accuracy (97%), multinomial logistic regression was the best option [11].

Kathiresan 2021 et al. provides a high accuracy, transferred learning model that can give farmers and agricultural institutions a mobile tool to quickly find rice leaf illnesses. A generative adversarial networks is also used in this study to balance the distribution of illness samples. We also evaluate our model against different transfer learning architectures. The provided model outperforms paradigm classification architectures with an average validation data accuracy of 98.79% when compared to a dataset that has been augmented using a GAN. With out GAN augmentation, the model also is compared on 3 other datasets, establishing benchmark score of 98.38% average accuracy [12].

III. Proposed Methodlogy

This section will talk about the dataset and the proposed framework. The image collection from PLANT VILLAGE dataset was successfully used in this investigation. Using training datasets & feature extraction, the dataset was further cleaned by deleting duplicate pictures and weeding out pictures that didn't meet the requirements specified for them. After that, I produced graphs to complete the last of the training's data processing processes[13]. The following step is to build a Deep Convolution network. model with ResNet50 & DenseNet169, adjust the model's parameters to match the input, and then train the model. When a model is complete, it should be put through it's paces by being run under a wide range of conditions. Finally, we utilized accuracy, Model effectiveness can be evaluated using recall and F1-Score [14].

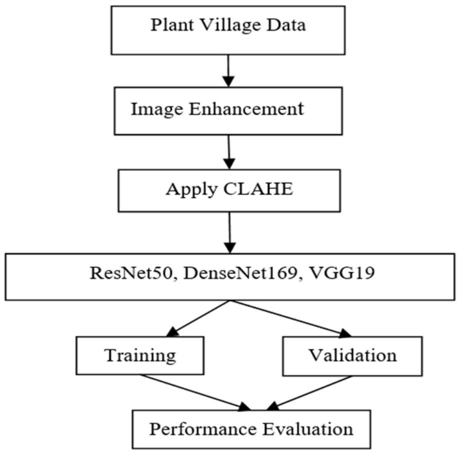

Figure 1. Proposed Methodology Flow Chart

A. Data image collection

There are 54303 images of both healthy and diseased leaves in the Plant the village collection, and these images are split among 38 different categories based on species and ailment [15]. We are unable to access the raw data directly from plantvillage.org, so we obtain the enhanced data from an article that has used and republished the original dataset."enhance" refers to the process of editing a digital image to improve its quality for purposes such as viewing or research. Decreased noise, increased contrast, and increased brightness are all ways to better make out an image's finer details. Use image-editing and processing methods for this research [16].

- The CLAHE algorithm can be used to process & enhance photographs by boosting contrast. To utilise CLAHE, you first must import each of the pictures, convert it from BGR into LAB format that use the open source computer vision library for Python, and afterwards apply CLAHE on a square grid of size 8x8. This procedure must be reapplied for each distinct classification.
- Lastly, use an image data generator to do image data augmentation, which entails actions like rotation, width & height shifting, zooming, and horizontal and vertical flipping.

B. ResNet50

Paper "Deep Remaining Training to Image Recognition," written by He Kaiming, Zhang was Xiangyu, Ren Shaoqing, and Sun Jian in 2015. ResNet is a type of CNN that is used for image recognition. In computer vision applications, CNNs are frequently used. Res Net-50, a convolutional neural networks with 50 layers, consists of one MaxPool layer, one average pool layer, and 48 convolutional layers [17]. A particular kind of ANN called a residual neural network builds its networks from layering successive residual blocks. ResNet-50 is shorthand for a deep convolutional network of neurons with 50 layers. Numerous imaging applications would not be possible without ResNet (short to Residual Networks), a popular neural network. ResNet's revolutionary feature is that it facilitates the training of networks with a depth of more than 150 layers [18].

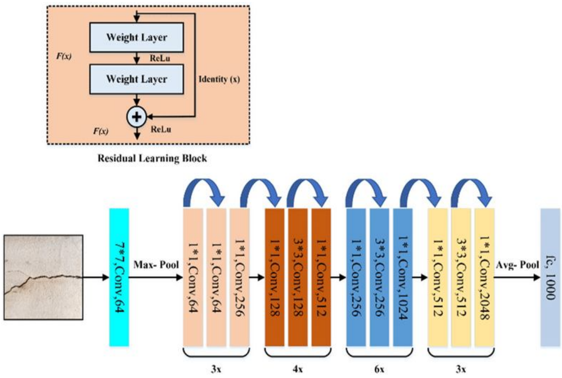

Figure 2. ResNet-50 Architecture

C. DenseNet169

In DL classification problems, the DenseNet-169 topology, which has 169 layers, is frequently used.Its trainable parameter count is significantly lower when compared to other DenseNet Architectures in fewer layers. DenseNet-169 and related DenseNet architectures are a group of highly reliable DL designs that prevent the gradient's vanishing problem, employ a strong feature propagation strategy, require few trainable parameters, and encourage feature reuse. PyTorandes or Tensorflow (Keras) both have DenseNet models that can be used [19]. In order to classify images, the DenseNet family for models was created, one of which is the DenseNet-169 model. The DenseNet-121 model differs primarily in terms of its size and its accuracy. When compared to DenseNet-121, which takes up about 31MB, DenseNet-169 takes up just under 55MB. They were rewritten by the authors to be compatible with Caffe* instead of the Torch training they were originally designed for. All of a DenseNet models have been pretrained on the ImageNet image database. For more details on this model family, please peruse the entire repository [20].

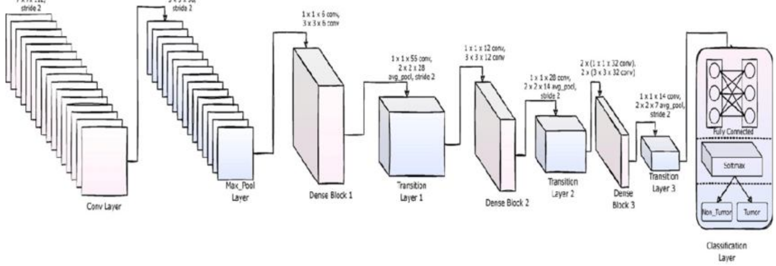

Figure 3. DenseNet-169 Architecture

IV. EXPERIMENTAL ANALYSIS

A. Perform EDA

The first stage (EDA) is exploratory analysis of data. Large datasets can be easily summarized and analyzed with the help for features like class and size distribution. Research findings are often presented visually. Figure 4 shows a plant image illustrating how frequently each Species kind occurs.

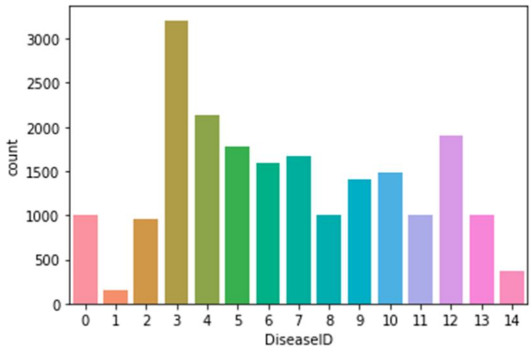

Figure 4. Frequency Histogram of Diseases Classes.

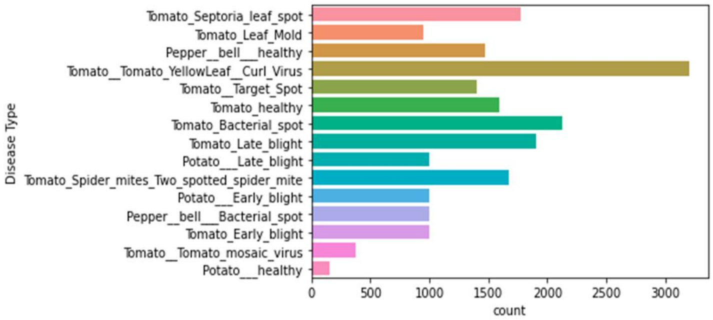

Figure 5. Frequency Histogram of Diseases Type.

B. Data preprocessing

Many tasks benefit from applying pre-processing techniques, such as cleaning up unwanted background noise, highlighting important visual cues for recognition, or even training DL models. Altering the image's height and width will cause a different aspect ratio. The image pre-processing strategy reduces the overall file size of each input image. In order for computers and algorithms to machine learning to be able to understand and evaluate data, a step called "data preprocessing" must be implemented during the data mining or analysis process. Unorganized text, images, and videos are typical of real-world data that has not been processed. It may not be well-designed or consistent, and it may also contain errors and irregularities at times.

C. Data Augmentation

Data Augmentation **-** The process of assembling groups for image data is referred to as "data augmentation" when discussing data processing. It increases stability and lessens the chance of generalization errors brought on by training. Professionals use this strategy to expand the available data for learning algorithms without the need to introduce new data sources. Next, start converting the tags into organized data.The intensity value for such a pixel is adjusted during image normalization by splicing together two or more pixels. For the most part, it receives images and transforms them into numerical info that depicts the scanned object way it would appear to human vision.

D. Data splitting

Using this technique, the data set is divided in half, with each half receiving half of the data. I divided the data into two after making sure it was clean, leaving 20% to the test data set or 80% to the training set. Models are trained or created using a training set in a simple two-part data split. The use for training sets has significant advantages for both parameter estimation or model evaluation. When the training phases are finished, the test set is used. The performance of the models is assessed by comparing data collected during the training and testing phases. In machine learning, data is typically classified into at least three categories.

E. Training and Testing

Our Sequential-built models were easily combined with layers from the VGG19, ResNet-50, or DenseNet-169 model for a performance boost via transfer learning. For this experiment, we focused on the VGG19, ResNet50, or DenseNet169 architectures because they proved to be the most effective at classifying images of plant villages. The discovered diseases are initially segmented using a succession of FC (fully associated) layers in order to categories them. An deep neural networks system to image analysis known as Convolutional Neural Network (CNN) is also referred to as "ConvNet." It greatly reduces the amount of time spent pre-processing by employing a multi-perspective structure. The suggested approach entails data collection and pre-processing, which eliminates irrelevant data.

ResNet50, DenseNet 169, and VGG19 Classification and Identification Using Convolutional Neural Networks It is possible to find and predict significant relationships & patterns in the data by using deep learning algorithms. Use 100 epochs to train each neural net while learning the data.

Figure 1. Shows Tomato Healthy & target Spot leaf

Shows below the VGG19 Result Graph and confusion matrix

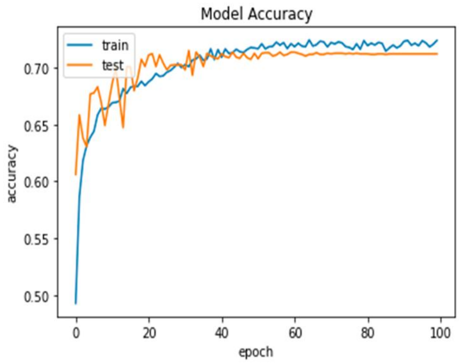

Figure 2. Shows confusion matrix graph of model accuracy of VGG19

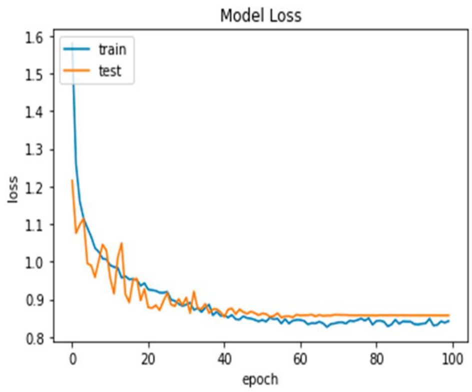

Figure 3. Shows the confusion matrix of model loss of VGG19

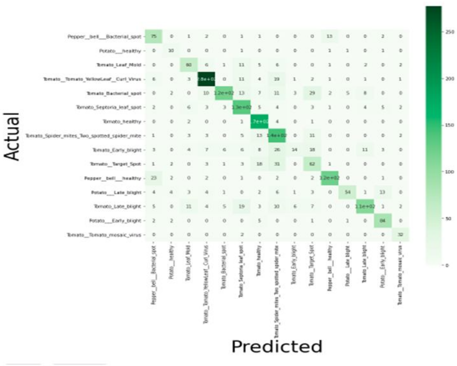

Figure 4. Shows the actual and predicted result of VGG19

Shows below the ResNet50 results Graph and confusion matrix.

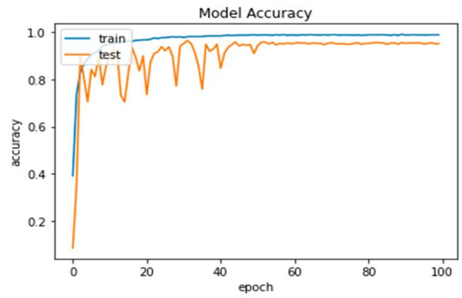

Figure 5. Shows the model accuracy matrix graph of Resnet50

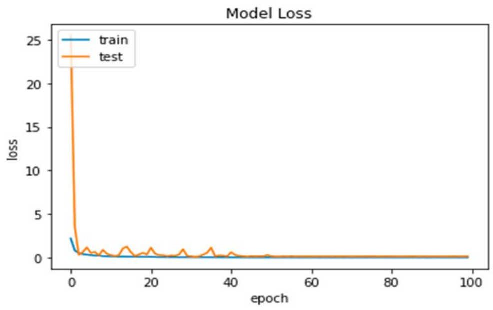

Figure 6. Shows the model loss graph of Resnet50

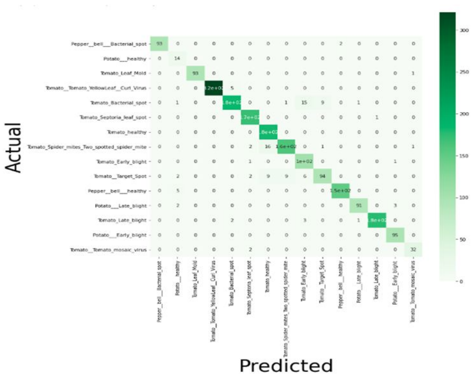

Figure 7. Shows the actual and predicted result of ResNet50

Shows below the DenseNet169 Results Graph and confusion matrix

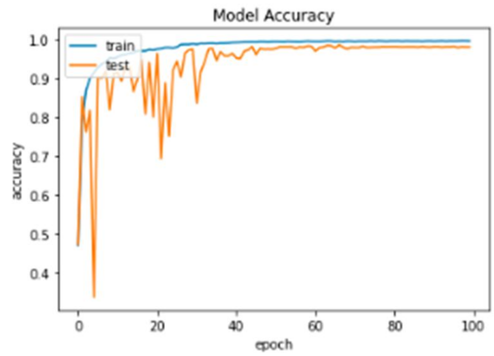

Figure 8. Displays the DenseNet169 Model Accuracy Matrix

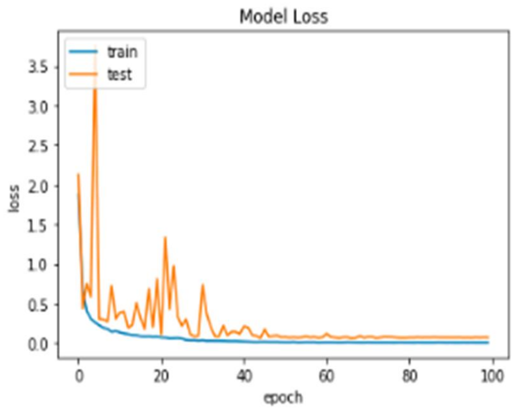

Figure 9. displays the DenseNet169 model loss curve

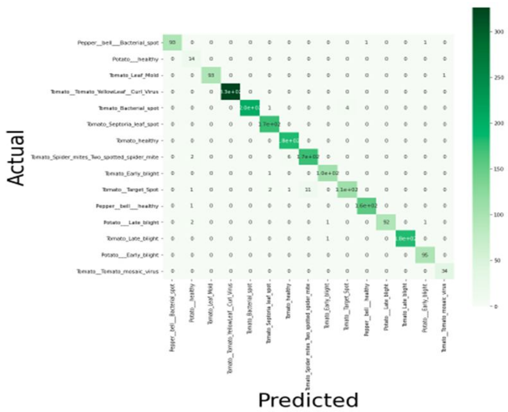

Figure 10. Shows the actual and predicted result of DenseNet169

Table -1 shows the performance evaluation of models such as VGG19, ResNet50 and DenseNet 169. We got the train accuracy and loss of VGG19 are 72.39 and 84.18, Resnet50 got 98.69, 04.31 and DenseNet 169 got 99.67, 1.12 and val accuracy and loss of VGG19 are 71.22 , 85.69, ResNet 50 got 94.96 ,16.86 and DenseNet 169 got 98.11 ,07.30.

Model	Train Acc	Train Loss	Val Acc	Val Loss
VGG19	72.39	84.18	71.22	85.69
ResNet50	98.69	04.31	94.96	16.86
DenseNet169	99.67	01.12	98.11	07.30

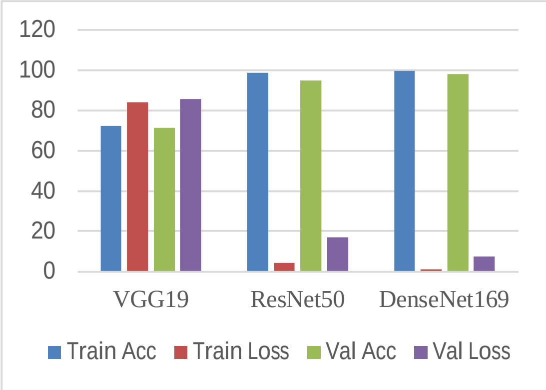

Figure 11. Performance Evaluation of Models

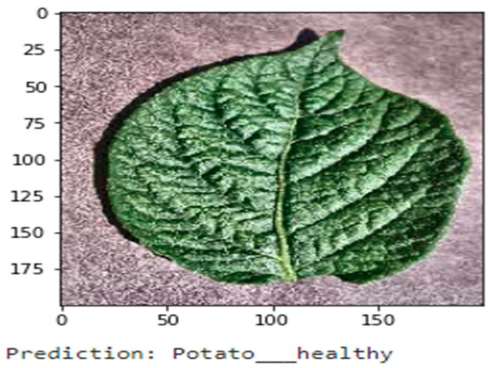

Figure 12. Shows Prediction results of Potato Healthy

V. Conclusion

The majority for deep-learning models to fully automated detection of illnesses underperform when applied to real-world, unexplored images. Here, we show that using only part of an image to train the ResNet 50, VGG19, or DenseNet169 models is feasible. Pre-processing images in and before training models in ResNet 50, VGG19, and DenseNet169 can be invaluable as better data sets become more widely available in the future. When a similar model is trained to use the segmented images as opposed to training using full images. In this study, the VGG19 ResNet 50, as well as DenseNet169 models' measuring performance training accuracy & loss were 72.39, 98.69, and 99.67 for accuracy and 84.18, 4.31, and 1.12 for loss

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Design Analysis on Wearable Patch Antenna for Wireless Applications

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***Abstract*— In today's world, the compactness of wireless systems has made possible the utilization of wearable patch antennas in plenty of programs and is currently one of the quickest developing technologies around the globe. In general, many of the wearable patch antennas use textile material as their substrate. In commercial terms, the available textile materials and their properties has a far larger influence on the functionality of wearable antennas. These antennas are intended to be a component for the clothing which can fulfill various communication applications such as mobile computing, tracking, public safety and navigation. The wearable antennas which use textiles as their substrate often has a lower dielectric constant compared to some others for its efficiency. The latest studies on such antennas have sparked significant interest regarding the usage of wireless body are network (WBAN) applications. This study discusses recent advancements in the area of antennas which can be worn, including their designs, materials employed, and effective results for diverse wireless applications.**

***Index Terms*— Wearable antennas, S11 parameters, VSWR, textile, wireless**

I. INTRODUCTION

Communication continues to keep individuals connected in a global community. In typical wearable systems, the major components that take up a lot of space are batteries and antennas. Nonetheless, the size and shape of the wearable computer system are reducing as electronic components have advanced in recent years. As a result, the antennas are now made out of textile materials. Furthermore, antennas embedded into garments utilizing fabric give an option to manufacturing with several rigid substrates (Mohamadzade et al., 2019). Moreover, wearable textile systems are also valuable for tracking, public safety and navigation (N. Singh et al., 2015). Because of the wide range of uses for wearable antennas, it may be viewed as another key stage in the widespread computing concept, in which information is easily available from everywhere.(Dutta, Chaudhury, et al., 2023; Dutta, Gupta, et al., 2023; Shukla et al., 2015)

Wearable textile antennas are microstrip antennas with a textile substrate. The wearable textile antenna is popular and widespread due to traits such as less weight, durability, smaller size, vibration resistance, and shock resistance (Daya Murali et al., 2014)(Watanabe & Iwasaki, 2012). However, this antenna has a limited bandwidth and is susceptible to temperature and humidity. Such disadvantages eventually diminish the gain of an antenna, and therefore its efficiency. The materials utilized in the design framework determine the construction regarding the fabric of wearable antenna, as shown in Fig.1.

As a result, because the substrate's qualities have an immediate effect upon the antenna's performance, good textile substrate selection is crucial to developing an effective antennaa(Abbas et al., 2020)(Mandal et al., 2013). In the

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future years, the wearable market is expected to increase at an exponential rate. The market is predicted to develop at a rate of more than 20% per year in the following five years, reaching more than 40 billion EUR by 2028. Wearable shipments are expected to reach 222.3 million per year by 2021, up from 113.2 million in 2017 and a total market value of $70 billion in 2019. Furthermore, the COVID-19 epidemic had a significant impact on the evolution of wearable devices, which was pushed by the adoption of various crowd-sensing and contact-tracing platforms. Wearables are likely to proliferate steadily over the next few decades.(Ometov et al., 2021)

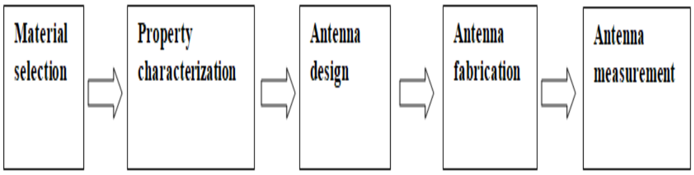


Fig.1 A typical approach for wearable and flexible antennas

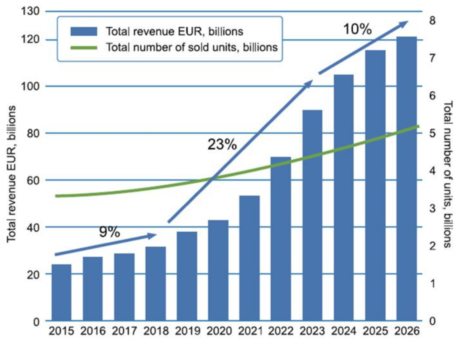


Fig.2 A wearable technology growth prediction (Ometov et al., 2021)

Wireless body area network (WBAN) technology possesses a chance to deliver a rare chance for widespread fitness monitoring in operating rooms, ambulances, emergency rooms, homes, clinics etc, thus allowing the prevention of several diseases with the help of early recognition and doctors to offer people with effective suggestions on how to enhance their health (Jayabharathy & Shanmuganantham, 2019; Patel & Wang, 2010). Over the past decade, in a range of fields, notably military, medical and entertainment, there currently are signs of growing concern regarding the dependability of WBAN frameworks, particularly wearable technology. The capacity to transmit wirelessly to or from the body utilizing amenable and wearable antennas is an important component of this wearable technology (Le & Yun, 2020; Yan & Vandenbosch, 2016). As a result, such antennas acts as an important part in on-body wireless communications also are receiving a lot of interest for research. Because these antennas work in near contact to a person's body, the load effect caused by the lossy characteristic of human tissues, along with their higher conductivity and dielectric constants, causes the creation of an extremely efficient radiation antenna difficult. This issue is complicated further by the need and demand for these antennas to have qualities that are light in weight, maintenance-free, inexpensive in cost, and easy to install.(Chen et al., 2022) The patch antenna is a significant research topic for wearable antennas for WBAN applications because to its comparatively strong directivity as a consequence of the broad level of the ground utilized in its construction. Aside from directivity, MPAs possess numerous significant benefits for on-body wearables, the most important of which are the low price, ease in manufacturing, and the relative isolation attained between the element that radiates and the body. The ground plane causes a substantial decrease in energy accepted by the element that radiates and the body. (Ramesh Garg, 2001). Patch antennas, on the other hand, have a poor bandwidth and could require to be rather big if they are to prove resistant against body disturbance (Ma et al., n.d.).

As wearable antennas have evolved, the majority of antenna research has been around flexible materials. The qualities of the components utilized can have an impact on the antenna's behaviour. The thickness of substrate and its permittivity, for example, affect the frequency range and effectiveness of a planar microstrip antenna. Prior to them being employed in wearable antennas, textiles need to be characterized (Ashyap et al., 2018; Potey & Tuckley, 2020). Electrotextiles comprise of conducting fabrics created by weaving conductive metals or polymeric threads into typical textiles. These materials are suitable for wearable applications because they are wearable, durable, and flexible. The conducting fabric is designed to have a low and continuous electrical resistance in order

to minimize losses. Since it's necessary for the antenna to remain folded over the fabric, its components also have to be flexible. Substrate selection is critical for a fabric or wearable antenna to prove durable for a certain applications. Textiles, in general, possess a low dielectric constant, that reduces surface wave losses hence enhancing the impedance bandwidth of the antenna (Ferreira et al., 2017; Gupta et al., 2010).
Metamaterials that consist of high impedance surfaces (HIS), artificial magnetic conductor (AMC) surfaces and electromagnetic band-gap (EBG) structures, nonetheless, have come forward as plausible proposals for wearable antennas (Najumunnisa et al., 2022; Turpin et al., 2014). Metamaterials are man-made materials with qualities that are not present in nature. They are made up of multiple discrete parts made of conventional small elements like polymers and metals, however the components are frequently arranged in recurrent designs (George et al., 2013). In broad terms, metamaterials have a number of enticing qualities. They have the potential to improve the total compatibility while decreasing radiation from small antennas, as well as lower the specific absorption rate (SAR) within the skull. This issue can be made use of to minimize the accepted power in the body's tissues.(Hwang & Chen, 2006).
The paper is further organized as follows: Section II, discusses and presents the characteristics of the textiles used as substrates for the antenna design. Section III focuses on the different patch designs used by researchers in the past for the efficient performance of wearable antennas. Finally in Section IV, the results obtained by the previous studies are discussed along with the conclusion of this paper.

II. Properties Of Substrate Textile Materials

Textiles frequently have dielectric value (r) values between 1 and 2 because they are extremely permeable substances with a relative permittivity that's near one. Surface wave losses induced by guided wave propagation via substrates are reduced by a low dielectric constant. Reducing the dielectric value raises the spatial waves, which enhances impedance bandwidth of the antenna. Furthermore, decreasing the substrate permittivity raises the resonance frequency of the antenna, allowing for an efficient and high-gain antenna (Atanasova & Atanasov, 2020; V. K. Singh et al., 2015). "Thickness" is another important feature in textiles(Di Natale & Di Giampaolo, 2020). The degree of thickness of an antenna's dielectric material is critical in the construction of wearable antennas. To maximize the bandwidth of a planar antenna with fixed relative permittivity, the thickness of the substrate is able to be raised. As a result, it can obtain greater profits Furthermore, the width of the material that acts as dielectric must be determined (Potey & Tuckley, 2018; B. Roy et al., 2013). An antenna's loss tangent (tan (δ)) has a significant impact upon its frequency response and gain. The gain of an antenna and the bandwidth of a MPA both decrease as the tangent loss increases. In general, a rise in loss tangent lowers the operational efficiency of a microstrip antenna (J.C Wang, 2016; P. Puttaswamy, 2014).
In Paper (Kumar et al., n.d.) , the researchers describe the simulation and the design of a wearable antenna employing a flexible textile substrate, as well as the evaluation of several antenna performance factors. This research aims to demonstrate a miniature UWB antenna layout with a general antenna size of 20mm x 22mm x 1.07mm. The planned dual-band antenna's resonance frequencies are 4.450 and 8.750 GHz, with a large fractional bandwidth of 103.50%within the ultra-wide frequency band. The microstrip patch textile antenna described here is small, durable, and flexible, making it an excellent pick for use as a on-body antenna for communication for WBAN applications and wireless health tracking systems. The textile substrate used in this study is “Jeans” having a dielectric constant of 1.7. Figure 3 depicts the proposed UWB antenna design.

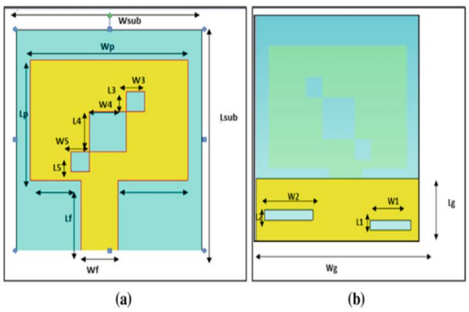


Fig.3 Antenna Design proposed. a) Slotted Patch antenna, b) Partial Ground Structure(Kumar et al., n.d.)

Another study (Wang & Li, 2018), made use of the textile “Denim” as their substrate. The antenna designed was a wearable dual band antenna within ISM band at 2.450GHz and 5.80GHz. When Denim was used as a substrate to design the antenna it was found to have a dielectric constant of 1.54 and a width of 0.05mm. The dimensions of the antenna taken were 46x16 mm. Fig.4 and Fig.5 below shows the layout of the proposed wearable antenna on the substrate.

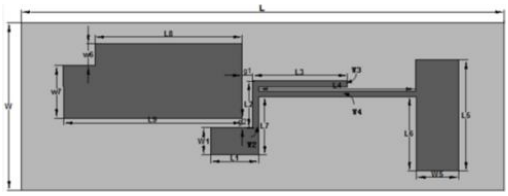


Fig.4 Layout of dual band proposed textile antenna (Wang & Li, 2018)

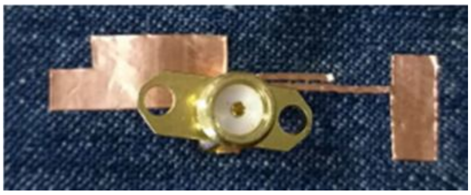


Fig.5 Fabricated antenna on denim (Wang & Li, 2018)

Another paper in 2018 (S.-H. Li & Li, 2018), experimented on the same ISM range and used “Denim” as their substrate but with a thickness of 25mm and the antenna having dimensions of 42x13 mm for wearable device applications.Fig.6 shows the fabricated design of the antenna on denim as it substrate and Fig.7 displays the model of a wearable antenna on a human body.

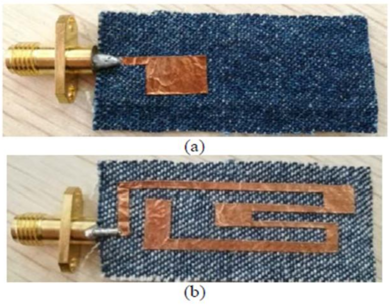


Fig.6a Top and b) Back view of the suggested antenna (S.-H. Li & Li, 2018)

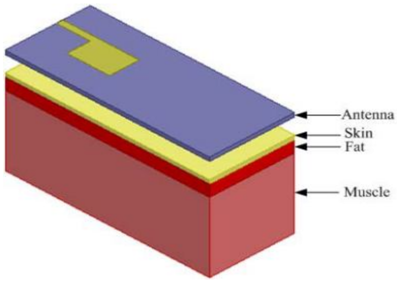


Fig.7 Model of a wearable antenna on a human body (S.-H. Li & Li, 2018)

Another study (Amit et al., 2019) presents us with the comparison of 3 textile substrates named - Jeans, flannel and cotton each having dielectric constants of 1.7 and thickness 1mm.The proposed antenna was designed with a dimension of 33x35 mm and at the frequency band of 3-10 GHz and 4-9 GHz. The antenna that is suggested is intended for use in health tracking applications. Fig.8 shows the UWB antenna, and it being placed on a human body phantom.

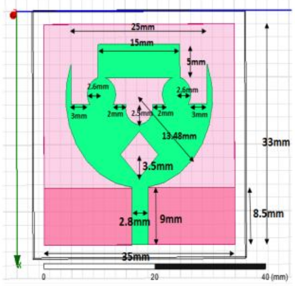


Fig.8 a) Proposed antenna.

(Amit et al., 2019)

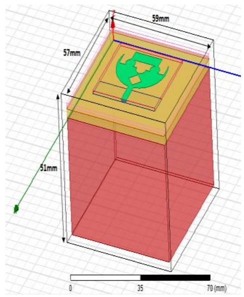


Fig.8 b) Proposed antenna on body phantom

(Amit et al., 2019)

A recent study (Chen et al., 2023), shows that for wireless body area networks (WBAN), a miniaturized textile microstrip antenna is proposed. The UWB antenna has a denim substrate to minimize surface wave losses. The monopole antenna, which is made up of a revised circular radiation patch and an off-centered defective ground construction, increases the impedance BW and enhances radiation distribution in a tiny 20x30x1.4 mm3 antenna. The frequency boundary impedance BW was measured to be 110% (2.850-9.810 GHz). At 6 GHz, he highest gain was calculated to be 3.280 dBi based on the measured values. The size of the antenna had decreased by 62.50% in contrast to standard wearable antennas of reduced sizes (R. Li et al., 2022). The textile antenna is made from a substrate named - "Denim" having width of 1.0mm. The denim fabric is distinguished by its ease of incorporation into human clothes. Due to a technical flaw, copper was unable to be printed upon denim fabric. The copper has been encased on a flexible board made up of FPC. Given a width of 1.0 mm, FPC exhibits a loss tangent = 0.00280 and a dielectric constant = 3.10.

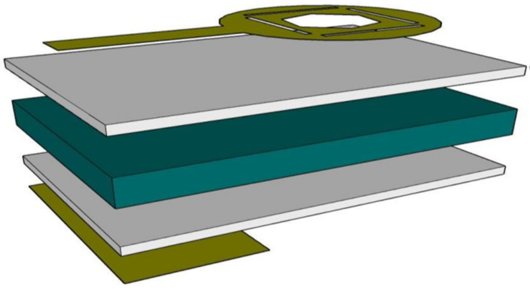


Fig.9 Layers of the wearable antenna designed (Chen et al., 2023)

The Table 1 below compares all the characteristics of the textile substrates used and dimensions of proposed antennas in the studies done in the past few years.

TABLE I COMPARISON OF SUBSTRATE PROPERTIES

Ref.	Substrate	Freq. Band (GHz)	εr	h (mm)	Application
(Kumar et al., n.d.)	Jeans	3.1-10.6	1.7	1	UWB Devices
(Wang & Li, 2018)	Denim	2.45 & 5.8	1.54	0.05	ISM & Wearable
(S.-H. Li & Li, 2018)	Denim	2.45 & 5.8	1.54	25	Wearable devices
(Amit et al., 2019)	Flannel Cotton Jeans	4-9 3-10	1.7	1	Monitoring of Health
(Chen et al., 2023)	Denim	2.850-9.810	1.6	1	Wearable & WBAN

In the above Table.1, It compares all the textile substrates along with their dielectric constant and width used in the previous literature studies and their applications. In a few studies, Denim has been selected as their substrate but the frequency band ranges are different for each such as 2.45-5.8 GHz, 2.85-9.8 GHz. Similarly, studies have also used Jeans having a dielectric of 1.7 with frequency bands being between 3.1-10.6 GHz.

III. WEARABLE PATCH ANTENNA DESIGN

In this section, the analysis of several patch antennas has been discussed which presents us a various different result. Each microstrip patch antenna can have a different dimension and slots etched into it to have the final parameters to be suitable and compatible to the applications it is intended to. By alternating through these shapes and substrates, results such as gain, bandwidth, field radiation and several other parameters can be enhanced or optimized.

Two different substrates were employed in this study (Mohan & Suriyakala, 2017)to present an analysis on the UWB antenna output attributes in accordance with the patch antenna having a rectangular structure. UWB antennas that are small in size for two substrates were developed in the proposed study, with a focus on inexpensive, fire-proof FR4 and denim substrates. Because these antenna configurations satisfied the UWB antenna specifications, it became apparent how the FR4-based antenna attained a reflection coefficient of (3.80-10.90) GHz, whereas with an omnidirectional radiation pattern, a return loss of (2.60-9.80) GHz was exhibited in a structure made of the material -“Jeans”. The antenna's structure is produced with the help of the FR-4 substrate having a dielectric constant of 4.40 with a substrate height of 1.60mm. The “Jeans” fabric has a dielectric constant of 1.670 and a width of 1mm. A 50.0-ohm microstrip line powers the radiator. In the shape of a staircase, two slots were inserted on each sides of the intended patch antenna. This is introduced to improve Bandwidth optimization. Figure 10 depicts an improved patch antenna that includes two slits.To increase the performance attributes of the proposed antenna, a notch is included.

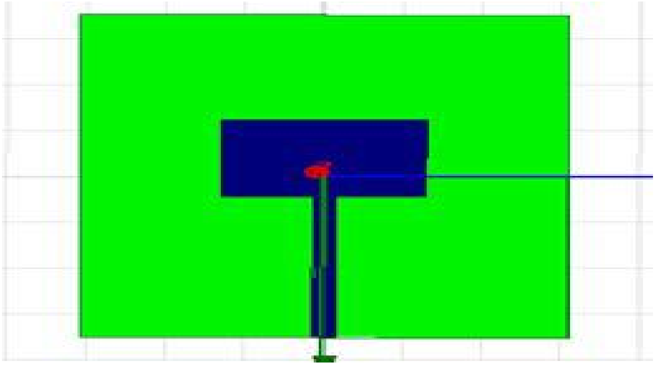


Fig.10 Rectangle Patch Antenna (Mohan & Suriyakala, 2017)

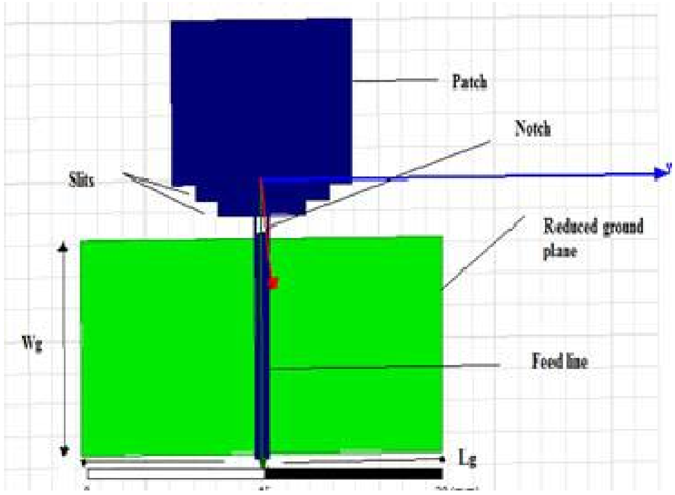


Fig 11 Proposed antenna after insertion of slits and Notches (Mohan & Suriyakala, 2017)

The notch is stated as altering the capacitance level between the patch and decreased ground plane to regulate the impedance bandwidth and return loss. Figure 11 depicts a patch antenna with a notch introduced.
Another study (Turkmen & Yalduz, 2018), displays an antenna that functions at frequencies ranging from 2.20-17.0GHz and within the UWB frequency range. Figure 10 depicts the layout of the planned antenna's front, rear, and bottom side perspectives, as well as detailed dimensions in millimeters. Jeans textile material with a dielectric constant (r) of 1.680, tangent loss (tan) of 0.01 and thickness of 1mm was chosen as a substrate. Copper having a thickness of 0.02 mm was utilized for the conducting components of the antenna (the radiator patch and ground plane). Figure 11a depicts the radiator patch as well as feedline structure from an antenna's front perspective. A microstrip feedline having a size of Wf x Lf (3.50 mm x 24.250 mm) that has a fifty ohm impedance and SMA port feeds the antenna. The geometric structure of the radiator patch comprises square and circular patches.

TABLE II MPA PARAMETERS

Description	Unit (mm)	Description	Unit (in mm)
Substrate width (Ws)	45.0	Feed width (Wf)	3.50
Feed length (Lf)	24.0	Ground length (Lg)	24.250
Thickness (h)	1.0	Ground Width (Wg)	45.0
Antenna Width (W)	22.0	Radius (r)	13.0
Antenna Length (L)	22.0	Wgs	3.60
Substrate Length (Ls)	60.0	Lgs	3.250

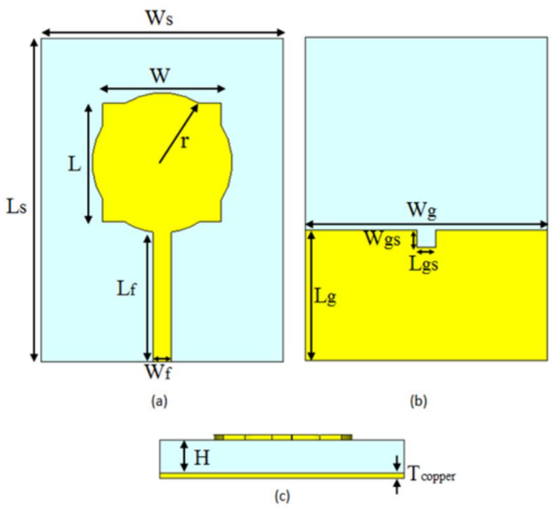


Fig.12 Designed Antenna a) Front b) Back c) Side view (Turkmen & Yalduz, 2018)

Similarly,(Yin et al., 2019) introduces a proposed antenna having an overall dimension of 40x32x1 mm and a simple structure. Figure 13 depicts the suggested monopole wearable antenna construction. The antenna's basic structure and planar characteristics make it easier to adapt to the human body. A Coplanar Waveguide (CPW) feeds the antenna, and the antenna's reception unit resembles a semi-circular metal patch having radius R1. Printing over the uppermost layer that covers the dielectric substrate produces both the receiving unit as well as the radiating patch, allowing for an a single-layered production technique. Table 3 and Figure 13 presents the parameters of the MPA.

TABLE III MPA PARAMETERS

Description	*W*	*W1*	*L*	*L1*	*L2*	*L3*
Unit (mm)	40.0	04.90	32.0	06.60	0.50	1.50
Description	*R1*	*R2*	*S*	*T*	*g*	*d1*
Unit (mm)	10.40	18.40	01.20	07.50	0.50	1.00

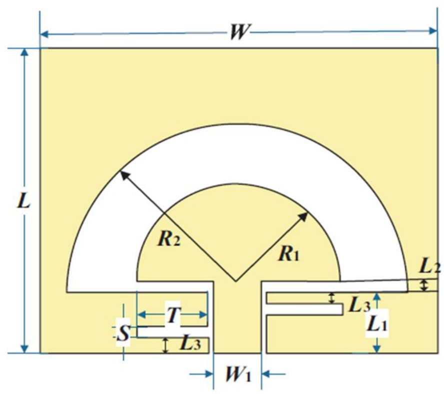


Fig.13 Dimension structure of antenna proposed (Yin et al., 2019)

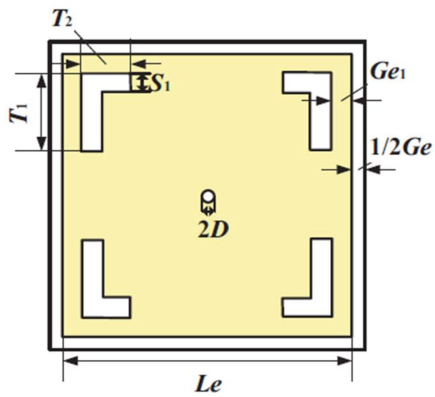


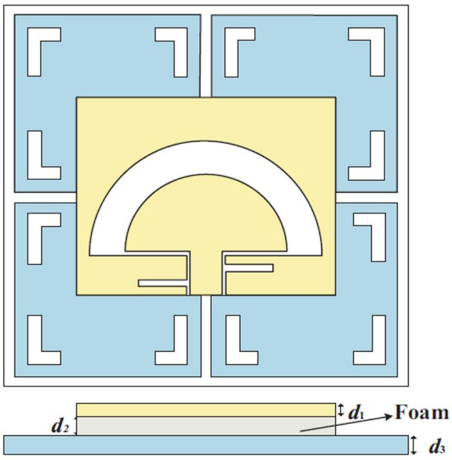
Fig.14 AMC Structure proposed (Yin et al., 2019)

To span the 2.450GHz ISM band, the antenna's impedance bandwidth is improved via merging of the circular and asymmetric slots. The antenna is composed of flexible polyimide material (r = 3.50, tan = 0.002). To optimize antenna performance, ANSYS HFSS adjusts the antenna structure using the finite element method. Table 4 and Figure 14 displays the AMC design parameters.

TABLE IV AMC PARAMETERS

Parameter	Ge	Ge1	Le	T1	T2	D	S1
Unit	1.0	2.0	28.90	8.0	5.0	1	2.0

Figure 15 shows the complete and proposed design of the wearable antenna with the AMC at the back of the MPA.



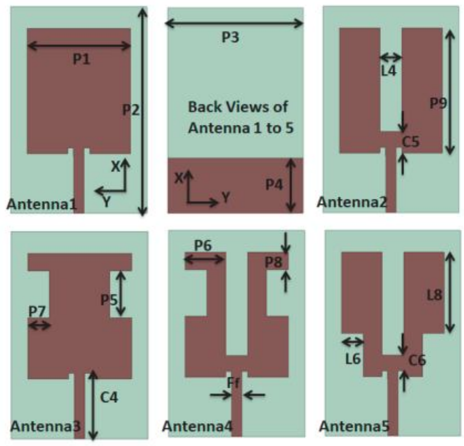


Fig.15 Final proposed antenna design

(Yin et al., 2019)

Fig.16 Proposed Antenna designs steps (A. Roy et al., 2023)

A recent study (A. Roy et al., 2023), demonstrates a wearable ultra-wideband antenna with a tiny notch band based on a jeans substrate. First, on a jeans substrate, a rectangle type antenna element is designed to function over a wide frequency range and supports mobile connections at 4.40-4.990GHz and exhibits notch functionality for WLAN channels.(Grandhi Venkata & Kalva, 2022). Antenna 1 is the designation of the antenna. Figure 4 depicts top and rear perspectives of the antenna. The analysis of this initial antenna reveals a band range of 2.70-4.630 GHz, which isn't considered to be appropriate. As a result,it has been modified to maintain the same ground plane. A slit in a rectangular shape is etched across the centre of the patch to expose a large portion of one side. Antenna 2 is the name given to the improved antenna. Figure 4 depicts the antenna's front perspective. According to the S11 (dB) curve, the frequency band above 2.650-4.760 GHz is likewise bad. As illustrated in the diagram, the third antenna is created by changing Antenna 1. It is discovered by severing two rectangular portions from the patch's upper right and left edges. It runs at frequencies ranging from 2.690 - 5.80 GHz. It even depicts the lack of an adequate band deployment. As a result, Antenna 4 is created, which is a hybrid of Antennas 2 and 3. Antenna 5 was built by redesigning Antenna 2. Both lower sides have two outside parts removed.

IV. PREVIOUS LITERATURE RESULTS

The results of the tests are shown in this section, previously discussed studies will be compared to display how, just by changing the substrate material or having a different design, the results of the antenna could vary greatly. By comparing the previous studies, it will help us gain insight on ways to increase the design's accuracy and efficiency of patch antennas for wearable applications in the future.

In the Table above, the various different results for the antenna parameters which has been designed previously have been compared where it presents that in (Kumar et al., n.d.; A. Roy et al., 2023; Turkmen & Yalduz, 2018), jeans have been used as the textile substrate and have shown return loss of -44.25dB at 8.75 GHz, -33dB at 5GHz and -35dB at 9.80GHz respectively. It is seen that as the resonating frequency increased the gain also increased to 4.81 dB with a bandwidth of 4.4-4.99 and 5.15-5.85GHz. In (Chen et al., 2023; S.-H. Li & Li, 2018; Wang & Li, 2018), Denim has been selected and has achieved return loss of -27dB, -32dB, -32.5dB respectively which is less than that of jeans but have a high resonating frequency. The bandwidth ranges are within the ISM bands. In (Amit et al., 2019; Mohan & Suriyakala, 2017; Yin et al., 2019), the substrates selected are Flannel, FR-4 and Polyamide respectively having return loss of -22dB,-30dB and -13.62 dB , within which polyamide shows the highest gain of 7.47 dB at 2.42-2.46 GHz of bandwidth.

TABLE V COMPARISON OF PREVIOUS STUDY RESULTS

Ref.	**Substrate**	**Return Loss (in dB)**	**Gain (in dB)**	**BW (GHz)**
(Kumar et al., n.d.)	Jeans	-44.25 (8.75GHz)	3.01	3.4-10.7
(Wang & Li, 2018)	Denim	-27.0 (2.75GHz)	-	2.4-2.48 5.7-5.85
(S.-H. Li & Li, 2018)	Denim	-32.0	6.34	2.42-2.48
		-35.0	4.7	5.72-5.85
(Amit et al., 2019)	Flannel	22.0 (at 5GHz)	-	4.0-9.0
	Cotton			
	Jeans			
(Chen et al., 2023)	Denim	-32.5 (8.20GHz)	3.280	2.85-9.81
(Mohan & Suriyakala, 2017)	FR-4	-30.0 (4.45GHz)	4.0	3.8-10.9
(Turkmen & Yalduz, 2018)	Jeans	-33.0 (5GHz)	-	3.4-10.7
(Yin et al., 2019)	Polyamide	-13.62 (2.45GHz)	7.470	2.42-2.46
(Kumar et al., n.d.; A. Roy et al., 2023; Turkmen & Yalduz, 2018)	Jeans	-35 (9.80GHz)	4.81	4.4-4.99 5.15-5.85

V. CONCLUSION

This paper presents an organized review on wearable antenna and the textile materials and designs used to design them. It has been discusses as how this technology has been used by researchers in the previous studies for various applications using various materials. This paper also discusses about the various approaches taken for designing the wearable antennas and how they have attained efficient results. These results can further be improved by choosing textile substrates having lower dielectric constants and combine other technologies/design such as the (Defected Ground Structure) technology to enhance the gain and bandwidth. Various different shape of slots could be etched into the patch along with the use of various different available feeding techniques.

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Comparative Study of Permissioned Blockchain Platform for Interoperability and Access Control of Electronic Health Record

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***Abstract*— Healthcare is one of the promising domains, where Blockchain technology can be used. As healthcare data contains personal and sensitive information of individuals, security to healthcare data has prime importance. Healthcare data breaches not only affect financial loss to medical institutions but also disturb the health of patients. The use of Blockchain technology can help to overcome this problem by providing security, efficiency, and authenticity to transactions. One of the major challenges that medical institutions are attempting is to select suitable and standard Blockchain platform to make secure and transparent transactions among various stakeholders. This paper presents comparison of existing permissioned Blockchain platform based on various parameter.**

***Index Terms*— Blockchain, Electronic Health Record, Corda, Quorum, Hyperledger Fabric**

I. INTRODUCTION

Electronic Health Record (EHR) is storing medical data and records of individual digitally, these records are collected from sensor data and electronic medical records (EMRs). As Healthcare is a data-intensive domain, large amounts of data is produced, stored, distributed, and accessed daily. For example, every time when patient goes to hospital, healthcare data gets created which can be by various stakeholders like doctors, caretakers etc. [1]
According to the survey done by Stanford Medicine [2], 153 Exabyte healthcare data were generated in 2013 and it was expected to reach 2314 Exabyte healthcare data in 2020. A survey reported that the healthcare analytics industries are growing at an exponential rate with a compound annual growth rate (CAGR) of 27.3% and this is anticipated to reach 29.84 billion USD by 2022 from 8.92 billion USD in 2017 [3]. Healthcare data contains personal and sensitive information that attract cyber criminals. Most common attack on Electronic Health Record (EHR) is ransomware attack. According to graph published by HIPPA [4] see Graph 1, average number of records breached every month is 6104761 and for every healthcare record which is breached, it costs around $380 USD per second. There are various ways to breach healthcare data like hacking, theft, unauthorised access etc. Figure 1 [6] shows the different ways for healthcare data breaches.
In the healthcare industry, various stockholders are Patients, Doctors, Insurance Company and pathology laboratories and Governing bodies etc. EHR contains sensitive and private health information, as it is often used by various stakeholders for following actions confidentiality and integrity of healthcare data needs to be protected from external attackers as well as from illegal access attempts inside the network [1].
For example, Insurance companies require patients' data for analyzing it properly and provide the services, but it

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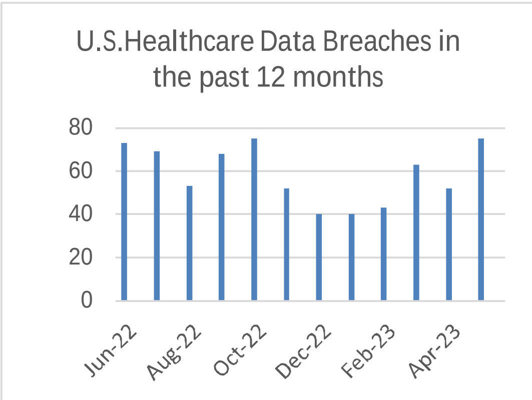
is frequently seen that data gets manipulated by the companies and leaked [5]
Therefore, security of the Electronic Health Record (EHR) is a very important but crucial and challenging task.
Hence, to preserve a definite trust between the various stakeholders, to defend the data from the misuse and to make Electronic Health Record (EHR) available for emergency on a common platform, a new system with seamless access, transaction, and storage management is needed.
Due to limitations of centralised systems like scalability and reliability, Digital world is moving towards distributed technology and Blockchain is most secured, rapidly growing distributed system which can be used for interoperability and access control of Electronic Health Record.
Many People consider Blockchain means public Blockchain or Bitcoin or cryptocurrency and can be used only for development of financial applications, but Blockchain can be private or permissioned and can be used for non-financial applications like healthcare domain.



Graph 1: Healthcare Data Breach in past 12 months [4]

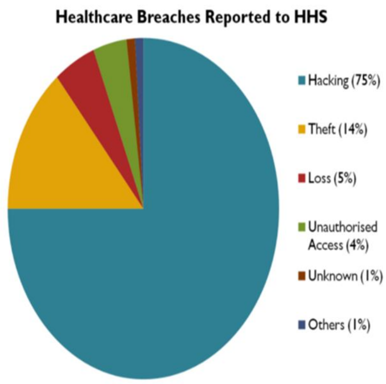


Figure.1: Different ways for Healthcare Breaches

A. Permissioned Blockchain

Permissioned Blockchain is closed network Blockchain where only designated parties can be involved and take part in consensus process. It is a fully decentralized network across known parties. It can be private or Consortium Blockchain. Private Blockchain is mainly designed for one organization and has centralized structure where a single entity has the full power to take decisions and validate the process. Whereas in Consortium blockchain, group of organizations can participate and only few nodes can take part in consensus process.
Compared to permission-less Blockchain, Permissioned Blockchain consumes less energy, can be implemented easily and faster in nature. Figure 2. shows permissioned and permissionless blockchain details.
As aim of this research theme is to handle access control and interoperability of electronic health record among various medical organization using Blockchain Technology, study of consortium Blockchain has been done and suitable platform is selected for implementation. During Survey, it is observed that Corda [8], Quorum [9], Fabric [10], Ripple [11] and Staller [12] are the popular permissioned Blockchain platforms. Out of these five permissioned Blockchain platform, Ripple and Staller deals for financial transaction only and hence not taken into consideration for comparison.

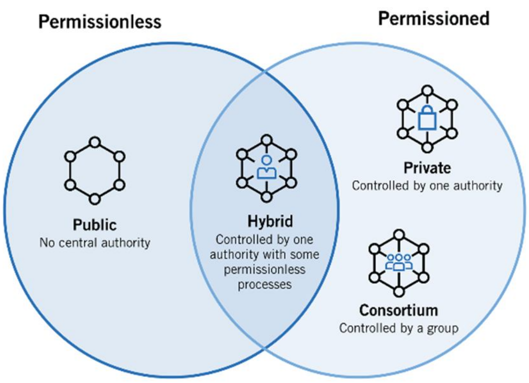


Figure 2: Types of Blockchain [21]

II. Parameters On Basis Of Which Comparison Of Blockchain Platform Have Been Done

This Section describes the parameters which are considered to compare existing popular Blockchain platforms i.e Quorum, Corda, and Hyperledger Fabric

A. Consensus

Validity of transactions and blocks are checked using a mechanism called consensus mechanism. Only valid transactions are added into block and only valid block is added into Blockchain. Consensus is one of the vital processes in Blockchain. Depending upon Blockchain Framework, consensus mechanism varies, hence it plays pivotal role in selection of Blockchain Network.

RAFT or IBFT are consensus mechanisms used in Quorum. RAFT and RBFT consensus mechanism are used by Corda. Hyperleder Fabric supports PBFT, KAFKA, RBFT, Sumeragi, and PoET consensus algorithms. In addition to this fabric also support plug and play consensus mechanism [23]

B. Modularity

Extent to which a software gets divided into smaller modules is referred as modularity. Modularity can specify the portability and future development of a product. It also supports the advance addition in the system, if required in future. As every business organisation wish to extend their business, it supports modularity. Modularity is considered in comparison as it predicts the extensibility of product.

C. Corda

Corda which is also known as R3 Corda is open source Blockchain platform developed by R3 Lab in 2017. It has two modules, Notary Pool, and Corda Node.

1. *Notary Pool*: It is Corda’s consensus service. It ensures that every transaction has unique input state. Notary service is established by a notary cluster, notary cluster is a group of one or more notary workers.
2. *Corda Node*: One party in a business network represents corda node. This party operate node which has CorDapps installed on it which is used to interact with other nodes in a network. CorDapps define operations and interactions of business network [13]. Corda Node also maintains the ledger.

D. Quorum

Quorum is open source Blockchain platform developed by JPMorgan Chase in 2016. It has three Modules. Quorum node, transaction manager and enclave. [14]

1. *Quorum Node*: It maintains the ledger and use as interface to communicate with client and other nodes
2. *Transaction Manager*: Transaction Manager store and verify the transaction. It manages privacy of transaction and provide access to encrypted transaction, but it does not have access to any sensitive private keys.
3. *Enclave:* Enclave are used to perform cryptographic operations. All the private keys of transactions are sealed in Enclave. All encryption/decryption operations are done within the Enclave. Figure 3 shows basic Quorum architecture.

E. Hyperledger Fabric [12]

Hyperledger Fabric is an open source Blockchain framework, initiated by the Linux Foundation in 2015. It has the following five modules.

1. Membership service provider
2. Client
3. Endorsers
4. Ordering service nodes
5. Committers.[9]

1. A membership service provider

It preserves the permissioned nature of Fabric. It is a mechanism that provides cryptographic identities to peers. It allows identity to be trusted and recognized by the rest of the network.

2. Client

A member or member application which initiates the transaction is called client. It sends transactions to the peers specified by the endorsement policy.

3. Ordering Service Nodes (OSN /orderers)

These are the nodes that collectively form the ordering service. Sequences of transactions are maintained by ordering services.

4. Endorsers

Nodes that execute Chaincode and endorse transaction are called Endorsers. It also prevents double spent of transaction.

5. Committers

All the node in hyperledger do not maintain copy of ledger. Nodes which maintain a copy of ledger are called committers. After the consensus process OSNs send block to committer and Committer nodes add block to the Blockchain.

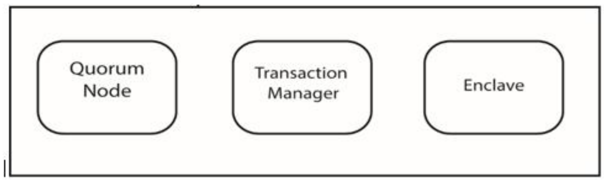


Figure 3: Basic Quorum architecture

C. Language Support

Language support indicates languages used to write smart contracts. Selected permissioned Blockchain framework are designed by three different companies and support different languages to write smart contract. Concept of smart contract was initially introduced in Ethereum Blockchain framework [16] and solidity is language used to write smart contract. However, there are handful of resources available which works on solidity. Proficient developers will be available for popular languages like Java, JavaScript and Python. Smart contracts in quorum are written using solidity. Smart contracts in Corda can be written using Kotlin or Java language and Chain code (means smart contracts) in Hyperleder Fabric can be written using GO, JavaScript, or Java language. As Chaincode in Fabric can be written using three languages maximum skilled developers can be available to work on Fabric platform Hence language support should also be taken into consideration while selecting suitable Blockchain Framework

D. Transaction Rate

Transaction rate means number of transactions executed per second. Transaction rate decides the speed of system. The higher the transaction rate, the faster the system which in turn will attract organizations to adopt the framework. Hence transaction rates are also taken into consideration while comparing Blockchain framework.
In Quorum, the Transaction rate varies between dozens to hundreds of transactions per second depending on configuration. Corda measures between 15 and 1678 transactions per second. Hyperledger fabrics do 3500 transactions per second [15] which indicates that Hyperledger fabric is faster than Quorum and Corda.

E. Cryptocurrency [18]

Currency used to validate transaction is one major filter to differentiate the platforms, different platforms support different cryptocurrency, but some platforms do not require any cryptocurrency module. As Quorum is built on Ethereum, it uses Ether as cryptocurrency, Hyperledger Fabric does not use any cryptocurrency and Corda uses traditional Fiat Money.

F. Security and Privacy

Private key is used to sign every transaction and gets verified with its public key. Every Block in Blockchain is encrypted with cryptographic hash function, so no one can read data without knowing hash value [23]. Zero knowledge proof (ZKP) technique is used by Hyperledger Fabric and Quorum to hide data from unauthorized users. Corda uses hardware security model for providing security and privacy to data [18]

G. Test Network [17]

Developers do not deploy code unless testing of code has been done. Test network is a Blockchain where working of applications can be tested. Test network can be public test network or private test network. Corda has a public test network whereas Hyperledger Fabric has a private test network. For using private test network, Developer needs to create their own set up for testing.
Table 1 shows comparison of permissioned Blockchain platforms based on parameter discussed above.

TABLE I: COMPARISON OF PERMISSIONED BLOCKCHAIN PLATFORM

Sr. No	Property	Quorum [9]	Corda [8]	Hyperledger Fabric [10]
1	**Governance**	JPMorgan	R3 Labs	Linux Foundation
2	**Consensus**	RAFT or IBFT	RAFT and RBFT	PBFT, KAFKA, RBFT, Sumeragi, and PoET
3	**Modularity**	**3 Modules** 1.Quorum Node 2.Transaction Manager 3.Enclave	**2 Modules** 1.Notary Pool 2.Corda Node	**5 Modules** 1.MSP 2.OSN 3. Client 4. Endorsers 5. Committers
4	**Language Support**	Solidity	Kotlin, Java	JavaScript, GO, JAVA
5	**Transaction Rate**	dozens to hundreds of transactions per second depending on configuration. (Had slow transactions [15])	Corda measures between 15 and 1678 TPS (Much faster transactions than quorum [15])	3500 TPS (Fastest Transaction [15])
6	**Currency**	Ether	Fiat money	None
7	**Test Network**	No	Public	Private

III. CONCLUSION

This Paper has discussed why Blockchain technology is necessary to execute healthcare applications and then presented a comparison of three Permissioned Blockchain platforms. This comparison is done based on various parameter valuable for a platform selection to build healthcare applications. We observed that Hyperledger Fabric is the most suitable platform to handle access control and interoperability of electronic health records due to following reasons.

- It has a higher transaction rate.
- It supports popular general-purpose languages for Chaincode implementation.
- It has large list of consensus algorithms, and it also supports plug and play consensus mechanism.
- It does not require currency to process transaction.

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A Review on Performance Evaluation using Convolutional Neural Network to Predict Cardiac Event

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***Abstract*— Cardiovascular diseases (CVD) may cause fatal medical conditions such as brain damage or stroke or even sudden cardiac death. These days, artificial intelligence based on machine learning and deep learning models are being commonly utilized to analyze and classify cardiac disease. Deep learning models have shown a promising performance in the healthcare field. These models have the potential to select high level features from the input data with the help of several hidden layers. Among the deep learning models, Convolutional neural networks (CNNs) are commonly used to process clinical images. This review is concentrated on exploring recent works for analyzing ECGs using CNN. The aim of this research is to investigate whether utilizing CNN provides better results and if patients can be diagnosed earlier before getting cardiac events.**

***Index Terms*— Cardiovascular diseases, Artificial intelligence, Convolutional Neural Network, CNN, ECG**

I. INTRODUCTION

Cardiac disease is caused by the change in heartbeat rate, regularity, origin of electrical impulses, and its symptoms range from little palpitation to the pain in the person's chest which may result in death also [1]. Abnormal intervals of heartbeats are caused by cardiac disease which can be detected and classified. There are many types of cardiovascular diseases like heart failure and coronary heart disease. Few of them cannot be healed completely but they can be regulated by monitoring the heart condition and accordingly implementing preventive measures [2]. Different methods like blood tests for troponin levels, electrocardiogram (ECG), chest X-ray, angiogram, and stress tests are present to access the heart of an individual [2]. Among all of them, ECG is preferred mostly for continuous heart tracking because it is highly accurate, non-invasive and it does not require any sophisticated machines [2]. The heart of a normal individual rhythms at a specific trend, hence any deviation in the ECG signal shows a cardiac issue [2]. The anomaly in ECG is the prime important factor that aids the detection of cardiovascular diseases in the individual [1]. The abnormality in ECG is an irregular indicator since the abnormal heartbeats arise in a small time, hence limiting its diagnosis in the hospitals. Also, the conventional monitoring of ECGs at hospitals is done by linking the person to the instrument with direct wiring while wireless sensors are utilized for wearable devices which monitor the cardiac activities without any influence on the daily life of the individual [1]. The ECG signals collected from internet of things (IoT) wearable devices like smart vest and chest strap should be investigated accurately to detect the cardiovascular diseases [2]. The wearable devices collect a huge amount of data which needs to be inspected by the clinician or cardiologists to detect any abnormality in the ECGs based on the rhythm of heart, rate of heart beats, and the variations in the heartbeat pattern. But investigating

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everyone's heartbeat increases the complexity of the inspection and limits the accuracy of the clinician [2]. Hence, heartbeat classification using ECGs at an early stage is necessary and it should be automated with continuous accuracy [1]. These days, artificial intelligence based on machine learning and deep learning models are being commonly utilized to analyze and classify heart disease [2]. Deep learning models have shown a promising performance in the healthcare field. These models have the potential to select high level features from the input data with the help of several hidden layers. Among the deep learning models, CNNs are commonly used to process the clinical images [2].

II. LITERATURE SURVEY

This work has reviewed the recent relevant research from 2019 to 2023. The reports from WHO show that non-disease deaths in the world are mainly caused by cardiovascular disease corresponding to 17.9 million people which accounts for 44% of all non-communicable disease fatalities in the world [3]. Hence, identifying heart condition earlier is important to save people from cardiac events. The ECG is a popular technique for evaluating a patient's heart activity [3]. ECG, stands for electrocardiograph, is a method commonly used by medical practitioners to diagnose cardiovascular diseases [4]. It is a simple non-invasive technique to utilize and provides a good understanding of cardiovascular health of the patient [4]. The prime symptoms of heart issues are abnormal heart rhythms also known as cardiac arrhythmias [4]. A normal ECG cycle (known as normal sinus rhythm NSR) consists of many parts (P wave, Q wave, R wave, S wave and T wave) as shown in Figure 1 [5]. Figure 1 demonstrates that ECG is shown using time domain features like duration, amplitude, interval, and segment [4]. The waveform of ECG consists of five peaks, P, Q, R, S, and T that indicate each feature (heartbeat) [5]. It is possible to detect the activity of heart effectively by evaluating each peak of ECG [3]. The ECG signal shows the information of the cardiac functions of any patient [3]. The main phase in ECG classification is the feature extraction which identifies the important characteristics in the images to obtain the best performance (accuracy) [3]. The classification of ECG wave is important to identify the normal and abnormal heartbeats [3].

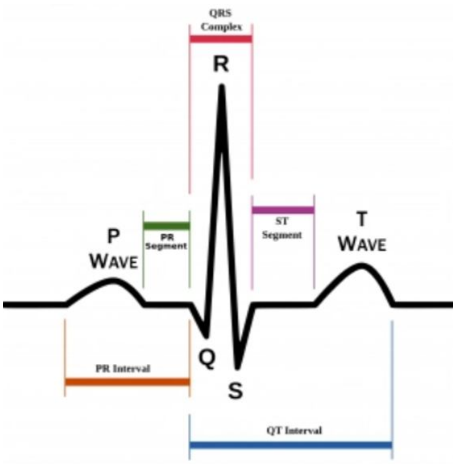

Figure.1 Normal sinus rhythm of heart or normal ECG cycle [5]

The analysis of heartbeat by a specialist requires a long-time examination consuming more time and exposed to low accuracy because of fatigue [1]. Hence, there is a necessity of the automated technique for classification of the heartbeats to diagnose the individual with cardiac issues [1]. There are different approached utilized for automatic ECG classification like support vector machine (SVMs), k-nearest neighbor clustering, classification and regression trees, hidden Markov models, convolutional neural network (CNN) and artificial neural networks [1]. Classifying heartbeats using these techniques saves time and provides better results helping in early diagnosis of the cardiac event. Improving the accuracy for the classification of ECG signals is a tough task to solve which has stimulated for the research to be carried out for development of different techniques [3].

Deep neural networks which learn from examples are utilized for ECG classification in this work [6]. Neural networks have attained success in increasing the accuracy for classifying ECG. This study [6] has utilized Telehealth network of Minas Gerais dataset and CNN has given a better performance for it compared to other machine learning algorithms with specificity around 99% and F1-score of 80%.

The leading cause of death in the world is cardiovascular diseases and ECG is the main mechanism to diagnose it which is very popular to access heart condition in medical diagnosis [6]. Till now, almost all the applications were utilizing supervised learning techniques to automate ECG classification as it learns from mapping input to output from examples providing better performance than a medical specialist. However, it requires a huge quantity of labelled data for medical application which introduces many challenges because of security and confidentiality issues for health information. Hence, recently, CNN has gained success in tasks like image classification and speech recognition, and it has a lot of expectations to improve health care. Convolutional neural network, CNN, is one of the deep learning algorithms developed by K. Fukushima from the original multi-layer network in the 1980s [4]. CNNs extract the features of the input image or video through its several hidden layers and generate the learnt output through its fully connected layer [4]. Implementation of CNN has provided better results compared to other machine learning algorithms [6].

There are different types of ECGs that doctors prescribe. The standard, short duration, resting 12-lead ECG is the commonly used examination for assessing the heart condition worldwide [7]. The exercise ECG, also known as stress ECG, evaluates the heart activity under physical conditions like exercise in controlled and monitored environment. The Holter exam type of ECG assesses the heart activities for a long period of time by wearing a device. The device records any abnormalities of the heart which may not be detected by shorter ECGs. The Holter exam provides details mainly about the heart rhythm and repolarization whereas the resting 12-lead ECG provides a complete assessment of the heart electrical activity which includes cardiac chamber hypertrophy, arrhythmias, acute coronary syndromes, conduction disturbances and the electrolyte disturbances and the effect of drugs [6]. Hence, the deep learning techniques for accurate performance of resting 12-lead ECG will have the maximum effect [6]. This resting 12-lead ECG is generally performed in primary health centers and emergency units, but many times it is not able to get analyzed and interpreted due to the lack of specialists which causes more than 75% of deaths related to cardiovascular diseases. Hence, there is the need for accurate automatic interpretation which can be performed through deep learning technique. This paper [6] demonstrates the CNNs performance for resting 12-lead ECG where CNN learnt the parameters using the training dataset and the best performance on the test dataset is obtained with F1-score above 80% and specificity about 99%. To attain the stability of the network, 10 different CNNs have been trained in this work with the same set of hyperparameters with different initializations. To compare the performance, the same dataset was assessed by many doctors and medical students for F1-score, where CNN outperformed the result obtained by medical people [6].

Electrocardiogram (ECG) signals have been used to evaluate the heartbeat using machine learning and neural network techniques which have been reviewed in this work [3]. The main parts in CNN are feature extraction along with classification [3]. The feature extraction obtains the important and useful characteristics from the images and classification precisely classifies the ECG signals utilizing the generated characteristics from the feature extraction [3]. The feature extraction method comprises of layers: convolution and downsampling that are explained in detail in the second chapter. Convolution layer improves the quality of the ECG signals by reducing the noise [3]. This work utilized the CNN model for ECG classification consisting of input, two fully connected layers, two down-sampled layers, a full connection layer, and an output layer [3]. The input for each neuron is coupled to the output of the preceding layer to extract the local characteristics [3]. This paper [3] has reviewed different works to predict the cardiac event from ECG signals using SVM and CNN. This review paper showed many works have used the MIT-BIH arrhythmia dataset consisting of 48-hour data for 47 patients and digitized at 360 samples per second per channel in a 10mV range with 11-bit resolution. The best accuracy reported in this work using CNN was 97.4% and using SVM was 96%. [3].

Another work using the same MIT BIH arrhythmia dataset has been implemented in this where beats were classified into five heartbeat types [8]. This work has proposed the ECG classification utilizing CNN which used feature extraction and classification together [8]. The experiment showed that this model obtained a superior performance of classification for the identification of cardiac events. The performance of ECG classification is measured using four metrics: accuracy, sensitivity, specificity, and positive predictivity. The best obtained accuracy from this model was 98.9% with a high sensitivity of 95.9%.

This paper [4] presented a technique to diagnose cardiac disorders by recognizing 17 different types of arrhythmias. Arrhythmia is the irregular heartbeat and the prime index of serious heart issues [9]. This work [4] included training and validating a 2D-CNN with ECGs from MIT-BIH database. The diagnosis of cardiac disorders is susceptible to human error due to the high variations in individuals at different phases of disease which can lead to loss of life also in some cases [4]. To obtain accuracy and consistency of detection, many works have been implemented in the field of machine learning to automatically detect and predict arrhythmias [4]. This work [4] developed a machine learning technique which helped diagnosis of cardiac arrhythmias rapidly with high accuracy. This work has achieved an accuracy of 96.67% with reduced processing time. It has proposed as future work that the further step for the research in this field can be the fusion of other data with ECG images to model more robust and thorough health diagnostic system that can help in deciding and scheduling the following stages of health plans for the patients [4].

This paper [10] has demonstrated a less complex and improved CNN model to distinguish types of cardiac events for European ST-T ECG dataset and achieved an accuracy of 99.23% better than many other works. The 2D CNN model used in this work had three layers and trained on 2D ECG images. The paper has also stated that this model can help in real time monitoring and can be integrated with wearable and portable devices like smartwatches and smartphones for collecting ECGs [10]. Then the collected images can be sent to a central place where the presented 2D CNN model will classify the ECGs, and this will encourage the users to agree on this as a support tool for improving health and quality of life. This model has presented stages in structured model as three layers: ECG signal acquisition, noise removal by preprocessing, detecting the points and waves in ECG image and distinguishing it into various types of arrhythmias. This work has utilized 2D CNN model instead of 1D model which mainly uses many different layers which makes it computational complex which increases more on increasing more layers [10]. More complex models yield relatively poor performance; hence this work has tried converting 1D ECG image to 2D image to train and evaluate 2D CNN model and to identify the arrhythmias and obtained a high accuracy of 99.23%. As a future work, this research has suggested using different datasets and integrating the ECG images with other data for monitoring the health of the individual's heart [10].

This work [11] has introduced a CNN classifier to detect the abnormalities of ECG signal by analyzing it as a 2D image. This technique has classified ECG image of European ST-T dataset as normal or abnormal by converting the single lead ECG signal to images and then implementing CNN classification and achieved an accuracy of 97.47% [11]. This work has employed the ECG signal recorded with a single lead only instead of 12-lead device and it is shown that both are equally effective in identifying arrhythmia. This work has reduced the requirement of pre-processing and feature extraction to detect cardiac issues hence reducing the complexity of the system. CNN is utilized to learn from ECG signals through enough training to improve the performance of detecting normal and abnormal ECG signal classification [11]. This CNN model consisted of 10 layers having 2 convolution layers. This work has provided a high accuracy of 97.47% with a sensitivity of 95.1%. This work helped in saving many lives because of early detection of heart attack and contributing to improvement the quality of life. This work has also proposed to integrate different datasets for further improvement as a future work [11].

1D-CNN approach has been implemented in this work [2] on MIT-BIH arrhythmia database to investigate ECG signals captured from IoT wearable devices and to predict cardiovascular disease with an accuracy of 99.46%. This 1D- CNN has data extraction and classification part where convolution, batch normalization, activation, and max pooling layers are included in extraction and Softmax layers, flatten, and fully connected are included in classification part [2]. This CNN model has 319 nodes that represent the length of heartbeat segments. This model has given an accuracy of 99.46% in 44 epochs. The future work mentioned in this paper states to add more different deep learning models to monitor the ECGs of the patients [2].

One more work [12] has been done on MIT-BIH arrhythmia dataset using CNN for implementation and analysis ECG images with an accuracy of 97%. This convolutional neural network is employed in the IoT devices to process the data. It has mentioned using Recurrent neural networks, RNN for implementation to check the performance as a future work [12]. Another work on MIT-BIH arrhythmia dataset is done in this work [12] using CNN with optimization technique. Many existing techniques for classification of arrhythmia meet with a challenge of varying classification accuracy hence there is need of automatic monitoring and classification techniques [12]. This work [12] has proposed the automatic classification of arrhythmia utilizing the optimization technique with CNN. The optimization algorithm known as Bat-Rider optimization algorithm is used with CNN. The features are extracted from ECG signals such that those features characterize the individual ECG features. And then the signals are provided to the optimization algorithm with CNN to identify the ECG signals as normal or abnormal one. This technique is analyzed on MIT-BIH arrhythmia dataset and the best performance obtained are accuracy of 93.19%, specificity of 95% and sensitivity of 93.98% [12]. In this work, classification of heartbeat is optimally done using CNN and is optimally tuned using an optimization algorithm. The next step of classification consists of feature extraction and feature classification. The proposed technique of CNN with optimization algorithm gave a better accuracy of 93.19% whereas without optimization algorithm, CNN provided accuracy of 92.26% and SVM gave an accuracy of 91.68%. The future work mentioned in this research is to use other optimization algorithms for better performance and to use more datasets to investigate the performance of models. More other research using CNN has been implemented on MIT-BIH arrhythmia dataset whose results are tabulated in Table 1.

This work [13] has implemented CNN on another publicly access database, PTB-XL dataset having 21837 clinical 12-lead ECGs of 18885 patients. Here two different neural networks were experimented with, one based on 1D CNN, and another based on 1D CNN with entropy-based features. The CNN model consists of 5 layers of 1D convolutions with LeakyReLU as activation functions and 1 fully connected layer with softmax as activation function [13]. Here, leakyReLU is utilized instead of ReLU to maintain the gradient loss for neurons yielding negative values. The other model is an extension of the first CNN model including entropies such as Shannon entropy, approximate entropy, sample entropy and others [13]. The CNN with entropy provided an accuracy of 89% whereas the CNN model without entropy gave an accuracy of 88.2%. So, it can be noted here that adding entropies did not help in getting better accuracy for a CNN model [13].

Many papers have mentioned integrating different datasets together for more accurate performance as seen above [1][2][4][10]11][12]. On investigating and researching more, a few works integrating different datasets have been found which are discussed here.

This paper [14] has researched breast cancer patients and proposed a novel model integrating clinical information and Hematoxylin and Eosin (H&E) slide images to evaluate the risk of metastatis in breast cancer patients. After resizing the complete H&E staining images of breast cancer patients to 512x512 pixels, CNN was implemented on those images to extract image features and combined them with the clinical data. This joined dataset is used with machine learning model to predict breast cancer in patients with an area under curve of 0.72 whereas the clinical dataset only showed a ROC of 0.57. Hence it showed that H&E images with clinical information provide better results than individual dataset. This paper did not talk about any other performance metrics than ROC [14].

This paper [15] has worked on Covid-19 patients for prediction of survival using clinical data and radiomic features obtained from chest CT images. The modelling was implemented separately and in combination of both data. The area of radiomics enables one to extract important information from images using different features, according to which they are correlated to clinical data. The experiment showed the combined data of images and clinical records provided accuracy of 94% while separately accuracy of 87% is obtained. This work showed the combination of images and clinical data effectively improves the performance of model [15].

This work [16] showed the prediction of pulmonary venous obstruction implementing machine learning models by using clinical data and CT images together. CNN was used to extract features from CT images and logistic regression was implemented to clinical data. The final model was obtained by integrating the two data obtained features. It showed that joint clinical data and CT images improved the performance compared to the models built on each individual dataset. The joint dataset gave a high sensitivity of 82.8% and AUC of 0.94 [16].

A. Conclusions

Below Table 1 shows the recent work done in the cardiac field using deep learning techniques. It can be seen from the Table that many works have been carried out on MIT-BIH arrhythmia dataset and achieving a high accuracy of 99.84% using CNN. Few works have been done on other dataset also. As seen in the literature review above, many papers have mentioned integrating different datasets together for more accurate performance [1][2][4][10]11][12]. On investigating and researching more, a few works integrating different datasets have been found which are discussed here. The last three works mentioned above [14,15,16] have utilized the clinical data and images jointly to obtain the best performance but none of them have shown how the joint data was implemented using machine learning algorithm to obtain the results. These latest works are in different areas and to my knowledge, the cardiovascular field lacks research integrating both clinical and image datasets. Hence, for future work, research can be carried out for the implementation of joint data of clinical records and ECG images for cardiac patients.

TABLE 1 SUMMARY OF LITERATURE REVIEW FOR DIFFERENT DATASETS

Papers	Dataset	ML Techniques used	Best Result
[1]	MIT-BIH arrhythmia	CNN	Accuracy, specificity and sensitivity of 93.19 %, 95 %, and 93.98 %
[2]	MIT-BIH arrhythmia	1D CNN	Accuracy of 99.46%
[3]	MIT-BIH arrhythmia	CNN and SVM	accuracy of CNN: 97.4% accuracy of SVM: 96%
[4]	MIT-BIH arrhythmia	CNN	accuracy of 96.67%
[6]	Minas Gerais	CNN	specificity of 99% & F1-score of 80%
[8]	MIT-BIH arrhythmia	CNN	accuracy of 98.9% & sensitivity of 95.9%
[10]	European ST-T	2D CNN	accuracy of 99.23%
[11]	European ST-T	CNN	Accuracy of 97.47%
[12]	MIT-BIH arrhythmia	CNN	Accuracy of 97%
[13]	PTB-XL dataset	1D CNN	Accuracy of 88.2%
[14]	HER2-postive breast cancer patients	CNN	AUC of 0.72
[15]	Covid patients	CNN	accuracy of 94%

[16]	pulmonary venous patients	CNN & logistic regression for joint data	sensitivity of 82.8% & AUC of 0.94
[17]	MIT-BIH arrhythmia	CNN	Accuracy of 98.33%
[18]	MIT-BIH arrhythmia	1D CNN	Accuracy of 97.1%
[19]	MIT-BIH arrhythmia	CNN	Accuracy of 97.41%
[20]	MIT-BIH arrhythmia	CNN	Accuracy of 95%
[21]	MIT-BIH arrhythmia	CNN	Accuracy of 97%
[22]	MIT-BIH arrhythmia	1D CNN	Accuracy of 99.8%
[23]	MIT-BIH arrhythmia	CNN	Accuracy of 99.45%
[24]	MIT-BIH arrhythmia	CNN	Accuracy of 99.84%
[25]	MIT-BIH arrhythmia	CNN	Accuracy of 95.2%
[26]	MIT-BIH arrhythmia	CNN	Accuracy of 99.01%
[27]	MIT-BIH arrhythmia	CNN	Accuracy of 98%
[28]	MIT-BIH arrhythmia	CNN	Accuracy of 97.38%

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Landscape Soil Moisture Analysis with Machine Learning using Weather Parameters

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***Abstract*— The correlation coefficient between soil moisture and weather variables such air temperature, precipitation, rainfall, and surface temperature is proposed by this study. The region of mid Asia was subjected to the model. The findings demonstrated a strong inverse relationship between soil moisture and surface temperature, a corresponding inverse relationship between soil moisture and air temperature, and a strong inverse relationship between soil moisture and precipitation. The soil moisture derived from NASA's LPRM_AMSR2 data was observed to have a correlation coefficient of 0.45 with gridded rainfall, and -0.59 with air temperature and ground temperature. The Aphrodite's Water Resource was employed to conduct this analysis, and the resulting meteorological factors taken into consideration were from there. Applying various weather parameters as the corresponding input to make a prediction about soil moisture and then measuring the accuracy with an LSTM model.**

***Index Terms*— Soil moisture, long short-term memory, Correlation, Prediction, Remote sensing.**

I. INTRODUCTION

The characteristics of the soil have been a crucial component in studies on resource management, agriculture, and climate change. There has been a significant demand for research and the provision of tools for analyzing and evaluating geographic topography's ongoing evolution. Numerous studies demonstrate that simply recognizing the need for change and introducing the affluent components will not be sufficient; a thorough investigation and evaluation will be needed to track these improvements. We consider data from climate models, existing soil records of various terrains, weather anomalies, and socio-economic events in order to illustrate the problem, and we then analyze how the soil's characteristics are altering a given specific topographic area [1-4]. We would require data to keep a periodic analysis of soil terrains as the generation evolves with science and technology to a fully digital era. Our research was considered as part of the evaluation to ascertain the degree of association between NASA's surface soil moisture data and Aphrodite's weather characteristics.

II. MATERIALS AND ANALOGIES

A. Study Areas

Parts of central Asia and the Indian subcontinent are included in the region that we studied for our correlation. The region includes a variety of topographical features, including plains, plateaus, mountain ranges, tiered terrain, and deserts. This region offers a suitable field of view for research into the relationships between numerous parameters

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making it a viable topic of study for figuring out the correctness of various factors and grids efficiently [5,6].

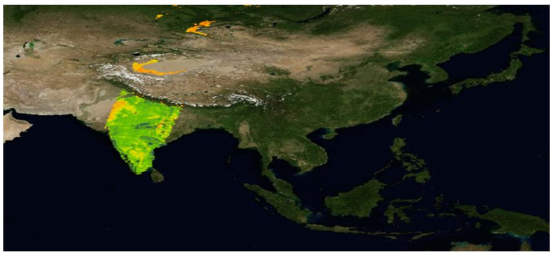

Figure 1 Soil Moisture Plot. (Rendered on SNAP)

B. Data

Both passive microwave remote sensing data and interpolated gridded data are used in this investigation. The daily mean and EOD (End of Day) average gridded fields were taken from Aphrodite's Water Resource.

TABLE I DATA DESCRIPTION

Data	Spatial Resolution	Temporal Resolution	Resource	Utilization
Soil Moisture	25 km x 25 km	Daily	National Aeronautics and Space Administration, (NASA) U.S.A.	Input for Model, Accuracy Verification
Surface Temperature	25 km x 25 km	Daily	National Aeronautics and Space Administration, (NASA) U.S.A.	Input for Model
Precipitation (V1801_R1)	25 km x 25 km	Daily	Aphrodite's Water Resource. Japan.	Input for Model
Daily Precipitation Rate Adjusted (V1901)	25 km x 25 km	Daily	Aphrodite's Water Resource. Japan	Input for Model
Atmospheric Temperature (End of Day)	25 km x 25 km	Daily	Aphrodite's Water Resource. Japan	Input for Model

Interpolation of gauge observations from a ground station was used to create this gridded collection in advance. The average daily product is the 'mean' of climatology. The weather, rain, and Aphrodite's water resource were taken into consideration. NASA's AMSR2/GCOM-W1 surface soil moisture (LPRM) repository served as the source of the remote sensing data utilized.

Data preprocessing included: (1) utilizing gridded patterns to show data points using SNAP (Sentinel Application Platform) software to cross-reference AMSR and SMOR data. (2) Segmenting data from NetCDF into manageable CSV chunks using Pandas and NumPy for better gridded data handling. (3) plotting the acquired data using Plotly.

III. METHODS

Long Short-Term Memory (LSTM) model was the best option when choosing a model for processing time-based analysis. For this type of data provision, GIS is an official system of record, clustering more choices for feature engineering and data exploration that could improve the precision and depth of the model [7].

A. Spearman's Correlation Coefficient

The association between the meteorological variables and soil moisture was examined using Spearman's Correlation Coefficient. Two things with a nonlinear relationship can be related using the Spearman's correlation coefficient. The correlation coefficient's equation is depicted in the equation below.

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

ρ = Spearman's correlation coefficient.
di = Difference between observations of the two ranks.

n = No. of Observations

B. Long Short-Term Memory (LSTM)

Hoch Reiter & Schmid Huber first introduced the LSTM in 1997, and it is effective with long-term dependency. It can analyze order dependence between things and was further improved and customized to satisfy specific requirements and goals. The learning curve for forecasting better predictions for time series data seems promising rather than having context-specific and fixed difficulties.
The main equation and representation of the LSTM for a single time-step, as well as its input and output, are shown in Figure 2. The input of the LSTM, which was derived from the output of CN, is represented as x(t). The output of the LSTM for this timestep is o(t), and the inputs and outputs from the previous timestep are h(t-1) and c(t-1). For the following timestep, c(t) and h(t) are formed in the setting of multiple timesteps.

C. Selection of Model Parameters

Three parameters related to soil moisture and climatic weather exist according to the model. Land surface temperature and land surface soil moisture, which were obtained from remote sensing data, were taken from the gridded data for the pre-processed NASA's AMSR taken into consideration in this study, while meteorological system parameters included average temperature and atmospheric precipitation.

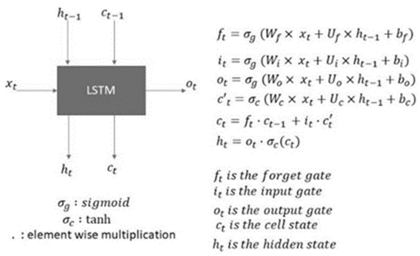

Figure *2*. Base structure of LST

The correlation coefficient was determined using the aforementioned parameters, and then parameters with moderate to high correlation were derived and chosen to take part in modelling. According to the findings, there was a significant negative association between surface temperature and the climatic variables.

IV. Results

The following chart illustrates the relationship found between various meteorological variables and soil moisture at various geographic locations.
We can say that there is a strong correlation between land surface temperature and soil moisture because their correlation is close to one, or -0.868, which means that as one of the parameters rises, the other falls, making them inversely related.

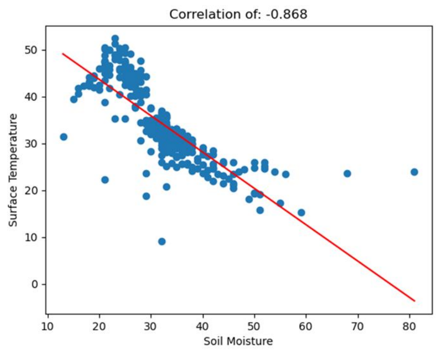

Figure 3. Correlation between Surface Temperature and Soil Moisture

Similar to this, there is a moderate negative correlation between atmospheric temperature and soil moisture, with a value of -0.868 indicating that there is a negative association between the former and the latter.

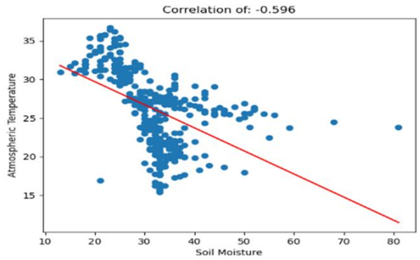

Figure 4. Correlation between Atmospheric Temperature and Soil Moisture

Precipitation has a positive coefficient of 0.450, which indicates a moderate association between soil moisture and precipitation, in contrast to the preceding two correlations.

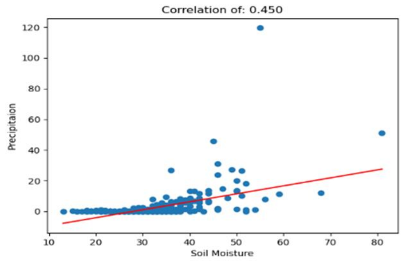

Figure 5. Correlation between Precipitation and Soil Moisture

Inferring from the obtained results that meteorological variables support a strong association with soil moisture, it is more obvious that this relationship should be used as a model input for predictive analysis.
When incorporated into the model, the predictive analysis that was determined utilizing the parameters produced results with moderate to high accuracy. The model inputs were split into two sections, each of which was evaluated in relation to soil and weather separately. A portion of the atmospheric temperature, precipitation (V1801_R1), and precipitation (V1901) for general distribution were the meteorological parameters employed. The made prediction has an 84% accuracy rate.
The graph below displays the discrepancies between the anticipated outcomes and the precipitation outputs as they relate to the two different versions that were employed.

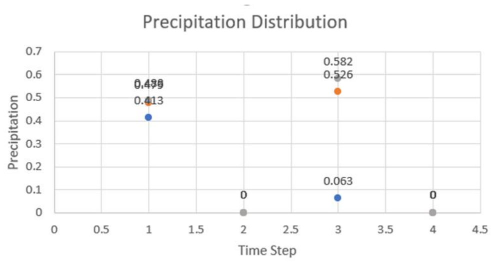

Figure 6. Predictive Distribution of Precipitation Over 3 Timesteps

The addition of temperature as an attribute, along with the two types of precipitation, is seen as habitually predicted because it has occurred consistently under a variety of different circumstances.

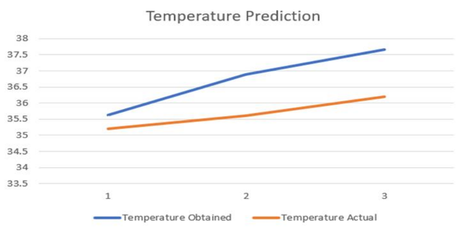

Figure 7. Three time steps of Predicted Temperature

One of the most important factors in evaluating soil moisture is the meteorological variables that have a greater association. Soil moisture, surface temperature, and air temperature are also the next set of inputs for the model, and they serve as the parameters for the following assessment segment.

V. Conclusion And Future Work

Through the use of LSTM and weather parameters, this study estimates the predictability of soil moisture. To examine the association, two segments were considered. Weather parameters from the first segment featured two different adjusted precipitation, which was a distinctive property. Using the same configuration, the following segment's soil moisture, surface temperature, and air temperature were assessed.

Initial findings showed a negative link between soil moisture and surface temperature as well as a positive correlation between soil moisture and precipitation, making soil moisture an ideal measure. The model is trained on numerous sites scattered over various terrains, taking segment one parameter into account for one instance and segment two parameters into consideration for the other. This led to a thorough investigation of the predictable factors of soil moisture and its relationship to the environment, including weather and surface temperature. Given the size of the study region, the conclusions we have drawn are only adequate when considering the previously indicated factors. The scheme's potential for use in the future could result in even more accurate relational analyses of usage statistics and data patterns via collective reproduction.

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Secure Data Communication in a Clustered Network in Wireless Sensor Networks using AES Cipher

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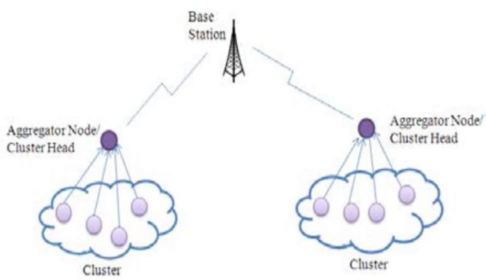
***Abstract*— Data is collected and forwarded to the cluster head by sensor nodes in the Wireless Sensor Network (WSN). Ensuring the confidentiality and integrity of the data that must be provided to the base station is tough. We recommend using a simple Caesar cipher and Advanced Encryption Standard (AES) technique at the cluster head node level for effective communication from the cluster head to the base station with little power consumption.**

***Index Terms*— WSN, Caesar Cipher, AES, Cluster head, Base Station**

I. Introduction

Wireless sensor networks (WSN) research is one of the main areas in computer science. WSN is used in many modern applications, including those in robotics, agriculture, the military, healthcare, and residential settings, among others. The WSNs can be used to track enemy intrusion, forest fires, and floods, as well as to monitor network traffic flows and environmental pollutants. A wireless sensor network is made up of many sensor nodes that all read environmental data. A sensing device, a microcontroller, an RF module, and a limited quantity of battery power are all included in each sensor node. The sensor nodes are set up to send the base station the data they have gathered.

WSNs resemble ad hoc networks with a large number of sensor nodes. However, because wireless sensor networks lack a stable infrastructure, the sensor nodes can be set up and run in an ad hoc manner. To track real-time data



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flow, the cluster head uses a bare minimum of precise software. The cluster head will send the sensed data to the backup data center for further processing and analysis. The fundamental architecture of a typical wireless sensor network is shown in Fig. 1.1, and it includes the cluster head.

Security is one of the WSNs' main drawbacks. WSNs are frequently put in remote locations and run unattended, making the privacy of the data collected at each node and the prevention of attack critical considerations. The classification for the sensed data and the security countermeasure strategies are of interest. The difficulty in this direction is ensuring secure data transmission in wireless sensor networks.

II. LITERATURE REVIEW

In recent years, a number of security issues have been discovered. Two categories [1] of security threats can be made from them:

1. Active attacks

Attacks in which the attacker changes the information in the detected data are referred to as active attacks. Active attacks include, but are not limited to, wormhole attacks, compromised node attacks, and node replication attacks.

2. Passive attacks

Passive attacks occur when a network is being watched by the attacker to ensure that data is being communicated. Eavesdropping is an example of a passive attack, which compromises the privacy of the data.

The nature of wireless sensor networks is dynamic because nodes often join and depart the network [2]. The writers have also covered the many types of attacks that could be launched against sensor networks. The low-level security of mobile sensor networks has been discussed.

The threats against broadcast services in wireless sensor networks have been covered by Seonho Choi et al. [3]. The most devastating effects on power and other resource limits will result from these attacks. The sensor nodes will just waste their energy and memory on broadcasting and buffering those erroneous packets as they propagate through the sensor nodes without being filtered out. For sensor networks, they suggested a brand-new, secure broadcast authentication. Their research suggests that this authentication method can be used to identify erroneous packets and separate links that originate from compromised nodes, increasing resilience to various security assaults, including DoS attacks. Lightweight Neighbor Authentication Protocol (LNAP) and Predictive Hash-Based Broadcast Protocol (PHBBP) are the two parts of their study. LNAP is used to verify whether a packet is actually from a neighbor or not when it is received. Each sensor node can use this protocol to verify whether a packet they receive is coming from a neighbor or not. The PH technique and size selecting the forwarding approach are the foundations of the PHBBP protocol.

A solution for the security of concealed data aggregation (CDA) and broad private data aggregation (PDA) has been proposed by the authors in [5], which also discusses the safety framework for protecting privacy in data aggregation in wireless sensor networks. The authors claim that both private-key and public-key based CDA/PDA constructions are covered by the security model. But in order to prevent active attacks, suitable security measures are needed for end-to-end communication.

In [6], a light-weight security protocol (LiSP) is put out that has key renewability and strikes a balance between resource usage and security. In addition, the authors suggested a combined authentication and recovery algorithm for rekeying, in which the key server regularly broadcasts a new key before it is used for encryption or decryption, and a client node authenticates the received key before recovering the previously lost keys. Figure 2 depicts the key hierarchy that was employed in LiSP.

The main issues with wireless sensor networks are wormhole-based attacks [7]. The authors claim that in wormhole assaults, attackers establish a low-latency link between two network nodes. The attacker gathers the data packets, transfers them via the low-latency link, and then replays them at the other end after the link has been established. Wormhole attacks change the way data flows across the network before tricking the base station. The authors reviewed wormhole attacks and provided examples of the most recent advancements in wireless sensor network wormhole attack detection. The authors covered a range of wormhole assaults, including those that use encapsulation, high-quality/out-of-band channels, high power transmission capabilities, and protocol distortion. They also talked about the mechanisms for detecting wormhole attacks, including connectivity - based, distance - bounding/consistency - based, synchronized clock-based, multi-dimensional scaling-visualization, trust-based, localization-based, secure neighbor discovery, and radio fingerprinting approaches.

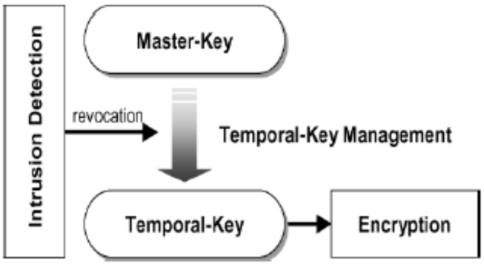

Figure 2. The key hierarchy used LiSP

Riaz Ahmed Shaikh et al. provided an integrated privacy, security, and trust solution for WSNs in [8], which is required to achieve the security solution's fullness. In order to better understand how different components interact with one another, they also provided integration details for the privacy, security, and trust components. They conducted theoretical analyses and assessments of memory usage, communication overhead, and other topics. Their memory usage result is shown in Figure 3.

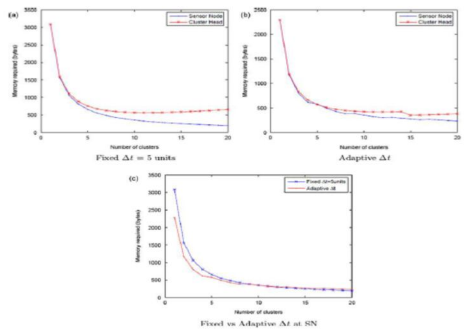

Figure 3. Memory consumption

The outcome in terms of communication overhead when moving data from the cluster head node to the base station is shown in Figure 4.

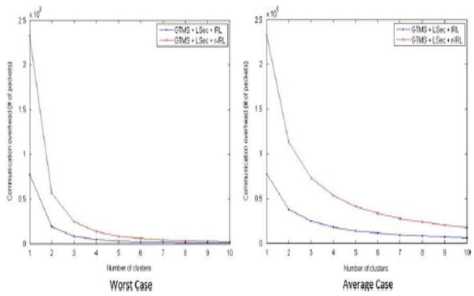

Figure 4. Communication Overhead

The authors' idea uses the AES, DES, and m-RSA algorithms to combine the benefits of symmetric and asymmetric encryption systems [9]. The plain text is separated into three parts for the encryption scheme, with the first portion being encrypted using AES, the second using DES, and the third using m-RSA. Through the use of MATLAB 2017a's parallel Computing Toolbox function, these are applied simultaneously. The three cipher messages are combined to create the ciphertext, which is sent to the recipient.

The symmetric encryption and decryption mechanism in wireless sensor networks was mentioned by WeiZhou et al. [10]. They also mentioned wireless sensor networks for data transmission. The authors claim that by utilizing the symmetric key technique, the security of data transmission in wireless sensor networks can be significantly improved. In order to increase the overall transmission performance of the wireless sensor networks, the transmission performance of the wireless sensor networks is further examined in light of this.

Tanveer Zia et al. highlighted the many security problems that could impair the data flow in wireless sensor networks in [12], along with workable solutions to these problems. They also identify a number of wireless sensor network restrictions, including node, network, and physical restrictions.

There are two primary management strategies: distributed and centralized strategies [13]. A reliable third-party key distribution center (KDC) is used by the centralized method to distribute and manage keys. In contrast, the generation and updating of keys are entirely carried out in a distributed way under the distributed approach.
Using homomorphic encryption, Soufiene Ben Othman et al. [14] examine the confidentiality and integrity of data aggregation in WSN. The system uses homomorphic encryption with symmetric keys to safeguard the privacy of the data and combines it with homomorphic signature to verify the accuracy of the aggregated data. They demonstrated that their system had lower overheads for processing and communication compared to currently used techniques.
A security architecture against the selfishness problem for cluster based WSN was proposed by Zeba Ishaq et al. [15]. They demonstrated how, particularly when a cluster head node becomes selfish, the selfishness attack (also known as a passive attack or insider attack) in cluster based WSNs can result in major performance disaster. They bring forth a security architecture that uses a novel clustering technique in addition to a reputation system at nodes to curb selfishness and encourage cooperation and integrity.
Puneet Azad et al. talked about choosing cluster heads in [16]. They chose to choose the cluster heads using a fuzzy multiple attribute decision-making approach. They took into account factors including residual energy, the quantity of neighbors, and the separation between the base station and the nodes while choosing the cluster leaders.
Since symmetric encryption methods require little energy, they are frequently used to achieve the fundamental security of data transfer. Nodes could go dark if energy intake and consumption are out of balance. A plan was put up by Jong Min Kim et al. [17] in which, based on an energy threshold, switching between symmetric-key and public-key encryption allows the level of security to be balanced against the necessity of energy-saving.
To counter malicious node attacks on WSNs, Turki Ali Alghamd et al. introduced a convolutional approach in [18] that creates security bits using convolutional codes. Different security codes were generated at various hops, with the findings demonstrating a reduction in computational cost when compared to current methods.
For WSN, Cheng-Kang Chu et al. [19] suggested using practical-ID based encryption. It divides the encryption procedure into an offline step and an online step. All of the complex calculations are carried out in the offline portion without knowing who the receiver is. In the online stage, the recipient's identity and the plaintext message are all that are needed, together with simple computations like modular operation and symmetric-key encryption.
In the WSN, symmetric encryption and the blockchain process are discussed by Alma E. Guerrero-Sanchezin et al. [20]. Based on the security benefits offered by blockchain technology and the usage of cryptographic tools, they proposed an approach that aids in protecting data availability and integrity. Their findings demonstrated that their approach is less vulnerable to several of the key attacks.

III. Methodology

A. Data Aggregation

The data from the numerous sensor nodes are gathered through experimental study. Utilizing MATLAB and changing numbers of sensor nodes, the LEACH algorithm is developed. The cluster head is where the present work collects and obtains sensor readings. The graph displays the energy used by the sensor nodes. The cluster head is located, and the amount of energy used there is measured. For the purpose of data aggregation, the LEACH algorithm is taken into consideration.

B. Encryption

The fundamental encryption algorithm should be used to encrypt the sensed data acquired at the cluster head, and the cluster head's energy consumption is noted. The effective method is now being further implemented after this initial work has been completed. In the cluster head node, the AES algorithm is used. A graph is created showing the energy used by each node.

IV. Results And Discussions

A. Data Aggregation

A wireless sensor network is built using MATLAB. Six sensor nodes, two cluster heads, and one base station are shown in a wireless sensor network model in Figure 5.
Then, 50 nodes are added to the wireless sensor network. Initial energy is taken into account when building a wireless sensor network as 10 units, measured in Joules. It is assumed that $50*10^{-9}$ units of Joules per bit are needed to power the circuitry for the transmitter and receiver. The necessary number of sensor nodes are setup in the WSN. As shown in Figure 6, we have chosen a node count of 50 for the demonstration. The zone division is completed after the necessary number of sensor nodes has been determined. We have set the zone size for the

present implementation at 400x400. Anywhere in the zone is suitable for the sink node. The sink node's position needs to be specified. In this approach, the sink node is located at coordinates 210x210. The LEACH method is used, and the outcomes are displayed below. Additionally, the direct approach is used, and the sensed data is relayed straight to the base station. The graph in Figure 7 compares and plots the output of these two algorithms.

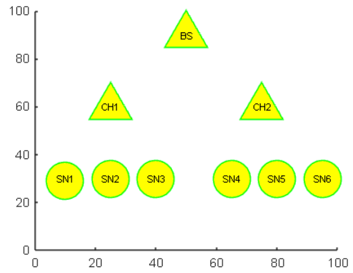

Figure 5. Basic Configuration of WSN with two cluster head and six sensor nodes with Base Station

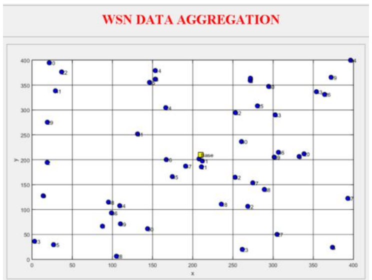

Figure 6. WSN with 50 nodes with Base Station

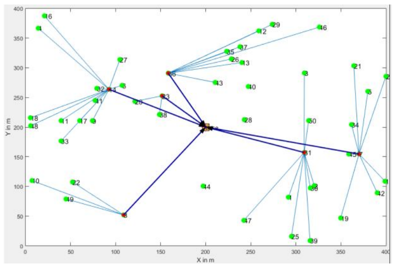

Figure 7. Simulation Results

According to the findings, the LEACH algorithm uses less energy when compared to sending sensed data directly. The outcome is displayed in Figure 8.

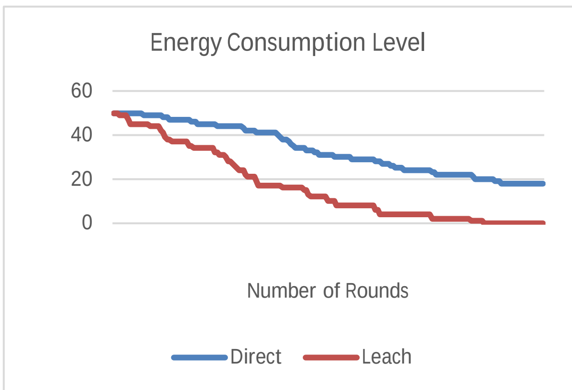

Figure 8. Average Energy Consumption

The average amount of energy used by the algorithm is calculated in a similar way, and the findings indicate that LEACH has better energy usage. The graph in Figure 9 displays the comparison of outcomes.

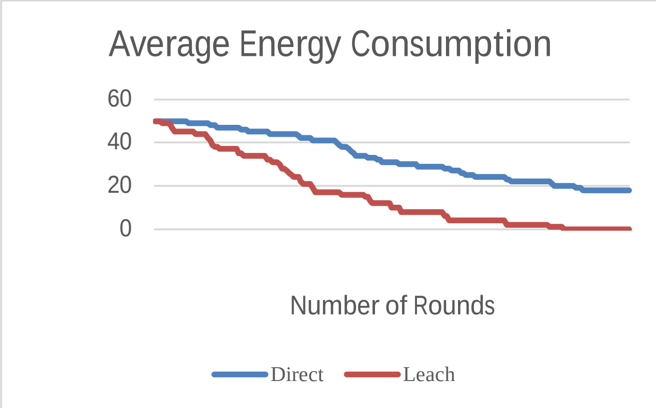

Figure 9. Average Energy Consumption

The average energy consumption is shown in Figure 9 above. The results show that energy is reduced as the round goes on.

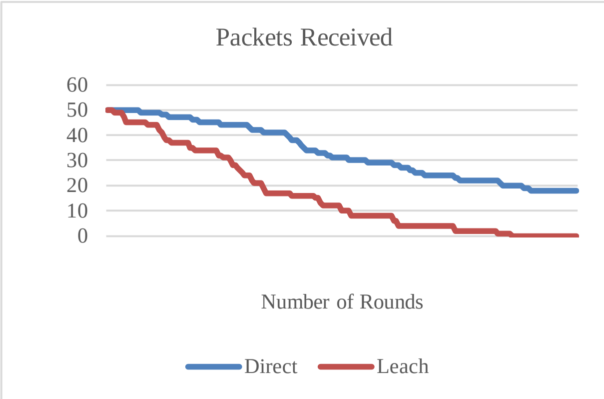

Figure 10. Packets received at the base station using the direct method and the LEACH algorithm.

As the round progresses due to energy limits, the overall number of nodes will decrease. This is depicted in Figure 11, which we can see in the round.

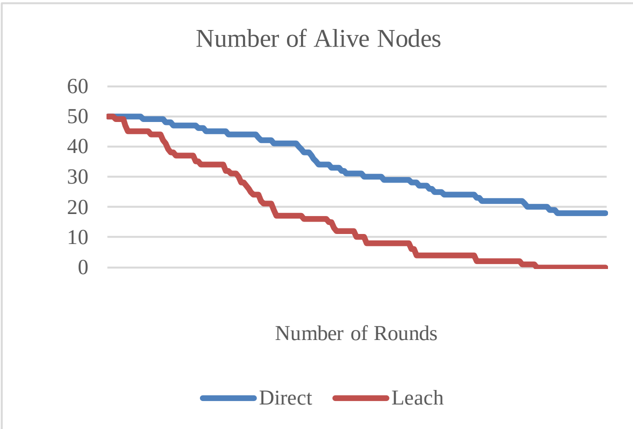

Figure 11. The total number of alive after simulating into 200 rounds.

Most of the nodes in the direct method are not participating in any transmissions because they are outside of the service area. As a result, they are still alive 200 rounds later. We obtained the results as LEACH created the improved transmission rate because there were more nodes involved in the data transfer.
After using the LEACH method to encrypt the data before transmitting it to the base station, the AES technique is used at the cluster node level. We used the fundamental encryption algorithm (Caesar Cipher) at the cluster head

in order to compare the outcomes. When using the AES method, energy consumption is higher, whereas when using the Caesar cipher, energy consumption is lower because the Caesar cipher requires less computation. The comparison findings are displayed in Figure 12.

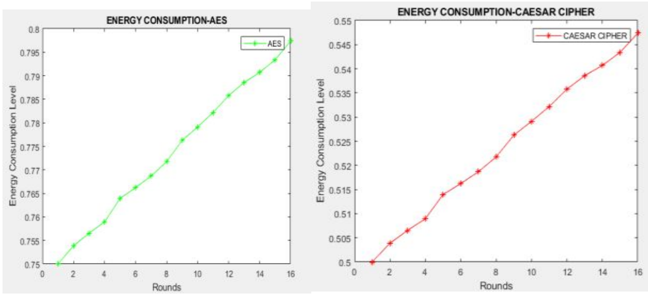

Figure 12. Comparison of AES and Caesar cipher

V. CONCLUSION

Implementing the AES algorithm has produced results and the same have been acquired and plotted. The analysis reveals that the Caesar cipher uses less energy than the AES method. In comparison to the conventional Caesar cipher approach, we have shown that the AES algorithm performs better.

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Genre & Subgenre Classification of Videos for Indexing &Retrieval

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***Abstract*— In today's world, people have access to a huge amount of videos, both on the internet and television. But the amount of video data is large and it is increasing day by day as the technologies grow. So video data storage, classification for indexing, filtering,, and retrieval is a big issues. So it is very difficult for a human being to go through all the videos to search for a particular video and it is time-consuming, but the user wants a particular category of video or video genre within a short span. So that there is a need to classify the videos based on their genre, and subgenre, research has begun on automatically classifying videos.**

Many works has been done for the classification of videos in certain categories or genre and sub-genre, by filling the semantic between low level features of video and high level concepts, so that user can find their specific interest of video within a narrow domain. There are different techniques have been developed for good understanding of video content and various video features have been recognized for best representation of videos. There are different techniques have been developed for a good understanding of video content and various video features have been recognized for the best representation of videos. Such as Gaussian Mixture Model (GMM), Neural Network (NN), Bayesian, Hidden Markov Model (HMM), and Support Vector Machine (SVM).

Object-based video classification method has been adopted in our work. The video classification system can be roughly divided into two major components: a module for extracting video features from keyframes and another module to find feature similarities between video frames and the object from the database. Here the proposed project work is to classify the videos from the repository by the method of extracting regions of interest from each key frame of an input video clip. Then these regions of interest kept as features, are compared with features of objects for video recognition using the MSER algorithm. Finally, we retrieve the videos from the repository by understanding the constrained user text query is presented. The method is evaluated by experimentation over a dataset containing different types of videos i.e. cricket, football, cartoon, news, and movies.

I. INTRODUCTION

In today's world, Digital videos can be automatically classified into various categories or various genres & subgenre is an important issue in the field of video analysis. As the technology grows in video broadcasting control, video classification based on their content is very important for web multimedia administration; website can basically classify and filter a large amount of videos based on their content. It also takes advantages in HDTV (High Definition TV) and VOD (Video On Demand) applications.

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There are various approaches for automatic video classifications have been attempted; approaches are divided into 4 groups.

i. Text based approach

ii.Audio based approach

iii.Visual based approach

iv.combined text, visual, and audio features

Most of the works reported on text based classification, but visual and audio based classification of videos work is less. So that our work is concentrated on classification of videos based on the content of input videos i.e. object based classification of video (object is a small Element in an image).

Content based video classification is continuously needed for many applications for example creating automatic video summarization, detecting specific action, for retrieving video sequence or activities in a video surveillance. Due to the increasing semantic gap of videos, there is a need for computation tools to classify these videos into different genre. Accurately classifying the videos for good representation and efficiently retrieving the video data. So classification task is carried out effectively.

A. Need for Video Classification

In this world, today's generation have accessing huge amount of videos both on internet and television. But the amount of video data is large and it is increases day by day as the technology grows. So the data storage, classification for indexing, filtering and retrieval is big issue. So that it is very difficult for a human being to go through it all to search a particular video and it is time consuming, but the user want particular category of video or genre within a short of span. So that there is a need to classify the videos based on their genre, subgenre, research has begun on automatically classifying videos.

B. Problem Definition & Proposed Approach

Video classification is a crucial task when classifying the videos from large repository. The video classification system can be roughly divided into two major components: a module for extracting video repository by understanding constrained user text query is presented. The method is evaluated by experimentation features from key frames and another module to find feature similarities between video frames and the object from the database. Here the proposed project work is to classify the videos from repository by the method of extracting regions of interest from each key frames of input video clip. Then from these regions of interest kept as features, are compared with features of objects for video recognition using MSER algorithm. Finally we retrieve the videos from over dataset containing different types of videos i.e. cricket, football, cartoon, news, and movies.

II. Related Work

Many research studies have been done to develop efficient video classification system. Each system follows different method of implementation. The survey seeks to provide a brief overview of researches done by many researchers on video classification for indexing and retrieval based on visual information such as graph matching, image, object, color, edge, motion etc. This section summarizes several techniques to provide historical perspective.

MPEG-1 videos can be classified using Decision Tree classifier presented in [1]. But the decision tree is useful for optimal solutions only to the local, not to the global ones, thus the construction of decision tree is inaccuracy.

Gaussian Mixture Models (GMMs) that can be used to classify the videos into different categories & it also makes video classes according to their genre and PCA is used to reduce the dimensionality of video & audio features presented in [2], but it is not proper classify the videos.

A video classification model is built based on Hidden Markov model (HMM) presented in [3]. But this approach takes a comparatively low level simple features and it takes very large amount of training data for building a classification model, which includes heavy workload and time consuming. So that it is to improve the performance of the video classification algorithm, there is a need to re-examine the features of videos according to their video genres, and the classification policies must be compared to decrease complexities and improve the performance of video classification.

Bag of Visual Words as a model for identifying the local image features and improve the performance of image representation is presented in [4][5].But this approach has 2 disadvantages

First being ignored the spatial information of an image, so that the location information of an image block is ignored. Second one is Performance of the accuracy of image classification is decreased, because each & every image block is represented by same visual vocabulary and it is not correct.

To segment and locate each & every moving objects in a video, an Efficient Motion Segmentation method is presented in [6].This method allows segmenting and locating on any number of moving objects in a each & every videos in an appropriate manner. And it also extracts the features of each tracked objects and then filtered & indexed in a database. But this system takes a long time for indexing if the video size is large. Because the each & every moving objects has to track in a video. Even though this system requires lot of information on specific objects for retrieving a particular video of interest.

To classify the videos using pre-defined class labels of text is presented in [7] [10]. This method is useful for searching the particular video clips, and it is some sort of similar to the traditional video search engines i.e. text-based. However, this system has advantages only when the images of a video clips, that have been already seen and it is attached properly with pre-defined class label. This system requires reprocessing of all the video clips again, when adding new class label, which is consumes lot of time and also extra space required.

Content based video retrieval approach is presented in [9] by using JSEG segmentation method.

In which every I/P frame is segmented into regions in that 10 largest segmented regions have been selected as objects, then color & texture features of tracked objects are used to describe the video clips. However this system is useful only when content based video retrieval. But this system includes extra step of segmentation of I/P frames. And it also takes extra time for processing of video clips which is provided as input for retrieval purpose, which is not efficient.

In today's world user also needs fastest video retrieval system, and they can search their video in narrow domain. But the existing popular video searching engines in [11] [12] are based on text annotations and descriptions of the video clip which is provided as a input by user. But these engines require extra time for matching user input keywords against largest database of text annotation. However, this system always requires intensive man power and extensive time to describe and to annotate those video clips.

A multimedia(videos, audio, image) data mining framework for extracting of events of soccer goal in soccer videos, by using decision tree and analysis of multimodal features is presented in [13] [15]. This system also proposed a common framework for filtering & indexing and also for summarizing sport videos (cricket, football, soccer, table tennis).

To classify the videos & for efficient searching of frequent and rare video events, a robust GMM classifier is build is presented in [16]. This classifier identifies the real time incoming events for indoor surveillance.

The system presented in [17] [18] which employ a multimodal video indexing. It covers different aspects and issues in video indexing and the approaches that are used. But Multimedia data (video) does not have a single unique semantic, so this approach does not address this challenge.

A. Requirements for region detection

- For detecting the regions in a frame, translation, scaling, rotation i.e. transformations should be considered are illumination changes and full affine transform (i.e. from a different viewpoint a region should correspond to the same pre-image. Changing Viewpoint can be approximated locally by affine transform if assuming locally planar objects and orthographic camera that is ignoring perspective effects).
- Region detection should be repeatable and stable, and capable to discriminate between different regions.

Fig. Detection of Regions

B. Maximally Stable Extremal Region

- MSER –It is a method for detecting distinguished regions in a gray scale image.
- It extracts a number of covariant regions called MSER's from the gray scale i.e. 2D image.
- These regions have taking through the same wide range of threshold i.e. intensity function of extremal property, inside the region and its outside the boundary.
- All pixels below the given threshold are marked as whiteand and above or equal are marked as black.

- ➢ If we are shown a threshold image ‘I’ with frame corresponding to the threshold ‘t’, then black image will seen first ,after that whitespots related to the intensity of local, minima will appear then grows higher.
- ➢ These whitespot merges until & unless whole image is white.
- ➢ The connected of all components in a sequence is a bunch of extremal regions.
- ➢ Elliptical frames attached to the MSER’s by finding ellipse to the regions. These regions
- ➢ descriptors are as features.
- ➢ The word extremal refers to the property of the pixels within the MSER’s that have higher or lower intensity than the pixels on its outer boundary.
- ➢ This operation is carried out by performing first filtering all the pixels by the value of gray & then increasingly adding all pixels to the connected component by changing threshold, the area is monitored ,regions are varied wrt the minimal threshold are defined as maximally stable.
- ➢ let’s make all the pixels below the threshold are marked as white and remaining are black.
- ➢ As we increasing the threshold, we seen sequence of threshold image sweeping from black to whitespots, we observe black image to image where whitespots appear will grows larger by merging up to the final image.
- ➢ Over the greater range of threshold the binarization is stable & will appear some invariance’s to the affine transformation of image intensity and scaling.

C. MSER Processing

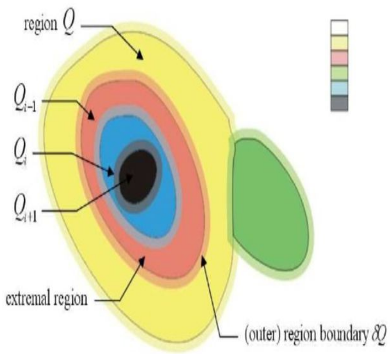
The MSER extraction implements the following steps

1. Perform a simple luminance thresholding of the image for sweeping a threshold of intensity from black to white.
2. Then extracts all connected components i.e. regions of extremal.
3. Identifying the threshold when a regions of extremal becomes “Maximally Stable” i.e. region grows slowly after some range its growing stop and its region shape approximately become ellipse.
4. Those region descriptors are kept as features.

However it might be rejected, even if an extremal region becomes Maximally Stable if

- i. It is too large (parameter MaxArea).
- ii. It is too small (parameter MinArea).
- iii. It is too variations i.e. unstable.
- iv. It is similar to its parent MSER.

Margin = the number of thresholds for which the region is stable



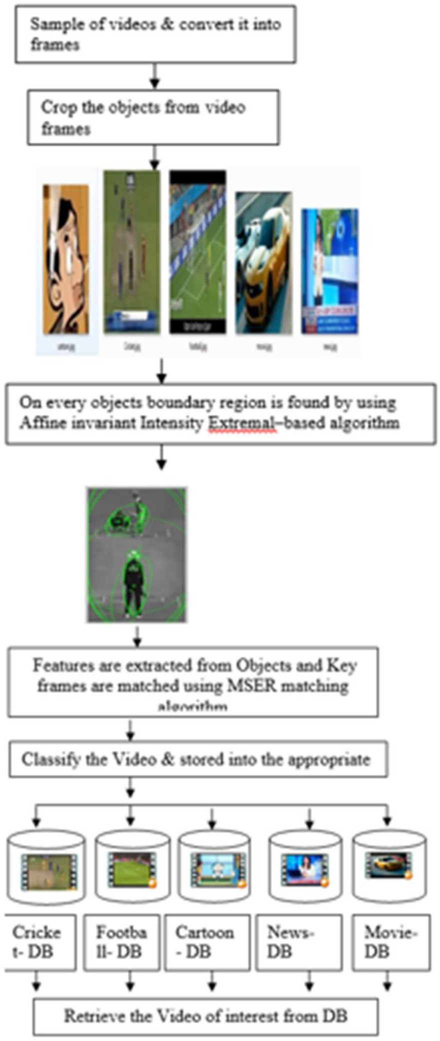
$$Q_{i^*} : i^* = \arg\min_i \left|Q_{i+\Delta} \setminus Q_{i-\Delta}\right| / \left|Q_i\right|$$

Fig. Identification of internal & external regions

III. Proposed Algorithm

Step 1: Read the user input video archive.
Step 2: In the next step the videos from video archive are converted into frames (one video at a time is converted into number of frames).
Step 3: Each frame is then compared with the previous one and motion is detected. Frames with significant motion differences are separated as key frames.
Step 4: On every extracted key frame boundary region is detected by using Affine Invariant Intensity Extremal–based algorithm, and then the features are extracted around the boundary region.

Step 5: Crop the Objects from different video frames and these objects are stored in a database.
Step 6: Then the features of key frames are matched with the stored objects by using MSER matching algorithm. If it is matched then corresponding video is stored in the appropriate database.
Step7: Otherwise it will matches with the next stored objects.
Step 8: User text input is then matched with video name to identify which videos the user is asking for, if match is found retrieve the specified video.



A. Key frame identification/extraction

Key frame extraction and Video segmentation are the bases of video processing, for analysis & retrieval purpose. To provide a correct video summarization for genre and sub genre classification of videos for video indexing, filtering and retrieval, A Key frame extraction, is an essential part in video analysis. By using key frames which reduces the amount of data required in video classification for indexing & retrieval and for dealing with the content of video it also provides the framework.

Here the proposed method works on group of key frames extracted from a frames of video. It takes a list of key frames in particular order in which they will be extracted based on motion descriptor that specify whether two video frames are similar or dissimilar. It's main function is to choose smaller number of video representative of frames. It starts from 1st frame from sorted list of files. If consecutive frames are having same motion description, then two frames are similar. Repeat process till frames are similar, delete all similar frames & take 1st as key -frame. Start with next frame which is outside threshold & repeat the same procedure for all frames of video. The below figure shows the snap shot of key frames for cricket video.

Fig. simple snapshot of Key frames of cricket video

B. Identification Of Boundary Regions

- For detecting the regions in a frame, translation, scaling, rotation i.e. transformations should be considered are illumination changes and full affine transform.
- Region detection should be repeatable and stable, and capable to discriminate between different regions.
- Color image i.e. 3D image can be converted into gray image i.e. 2D image.
- Using MSER method for detecting distinguished regions in a gray scale image.
- It extracts a number of covariant regions called MSER's from a gray scale i.e. 2D image.
- These regions have taking through the same wide range of threshold i.e. intensity function of extremal property, inside the region and its outside the boundary.
- All pixels below the given threshold are marked as whiteand and above or equal are marked as black.
- If we are shown a threshold image 'I' with frame corresponding to the threshold 't', then black image will seen first ,after that whitespots related to the intensity of local, minima will looks, then grows higher.
- These whitespot merges until whole image is white.
- The set of all connected components in a sequence is a set of all extremal regions.
- Elliptical frames attached to the MSER's by finding ellipse to the regions. These regions descriptors are as features.

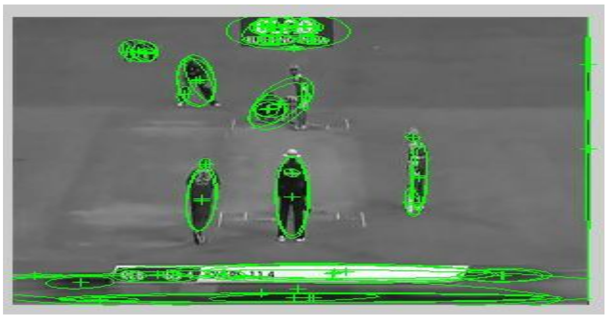


Fig .Simple Snapshot Of Boundary Region Detection

C. Feature Extraction

The feature extraction method implements the following steps using MSER algorithm

1. Perform a simple luminance thresholding of the image for sweeping a threshold of intensity from black to white.
2. Then extracts all connected components i.e. regions of extremal.
3. Detecting a threshold when a regions of extremal becomes "Maximally Stable" i.e. region grows slowly after some range its growing stop and its region shape approximately becomes ellipse
4. Those region descriptors are kept as features.

IV. DATASETS

We have collecting 100 of videos from YouTube website (www.youtube.com) and that will be used as datasets for performing experiments on it. These videos contain the different categories of objects such as cricket, football, cartoon, news and movies. The sample snapshot for the input videos of the proposed system is given in Figure.

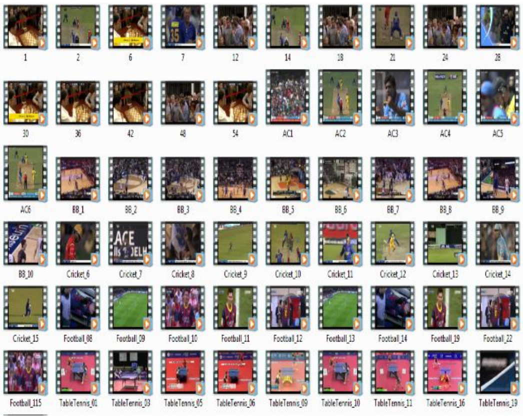


Fig. Sample Snapshot of User Input Dataset

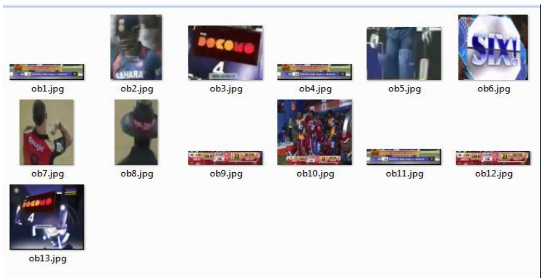


Fig 5.2 Simple Snapshot of Cricket Video Objects

A. Performance Analysis

The performance of the proposed system is measured on the input dataset using the accuracy rate. Fig 5.5 shows the graph of accuracy rate, for performance analysis, videos from each category are given to the proposed system and results are evaluated which are shown in table 5.1 as follows.
It is also important to know the accuracy of the proposed system which is measured as

$$\text{AccuracyRate} = \frac{\text{No. of times correctly videos classified}}{\text{No. Of tests conducted}}$$

TABLE V.1 EXPERIMENTAL RESULTS

VIDEOS	**ACCURACY**
Cricket	96
Football	80
Cartoon	92
News	90
Movie	86

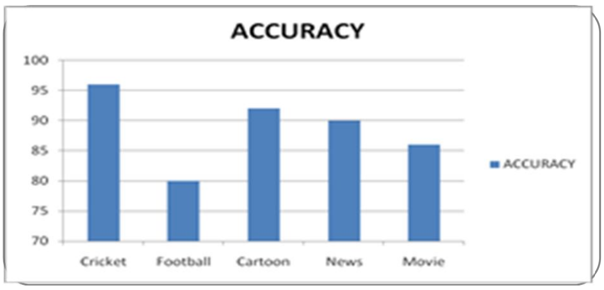


Fig. Graph showing experimental accuracy rate.

The above calculated accuracy rate may differ as the number of videos in the dataset increases. In the proposed work user query text is case sensitive.

V. CONCLUSION

In this proposed system, videos are classified into different categories or genre that can be used for indexing and retrieval purpose. First sample of video can be converted into frames, Each frame is then compared with the previous one and motion is detected. Frames with significant motion differences are separated as key frames.
On every extracted key frame boundary region is detected by using Affine Invariant Intensity Extremal–based algorithm, and then the features are extracted around the boundary region. Crop the Objects from different video frames and these objects are stored in a database. Then the features of key frames are matched with the stored objects by using MSER matching algorithm. If it is matched then corresponding video is stored in the appropriate database. Otherwise it will matches with the next stored objects. User text input is then matched with video name to identify which videos the user is asking for, if match is found retrieve the specified video.
Experimental results show that this algorithm performs well in the object based video classification.

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Detection of Cardiovascular Diseases using Artificial Neural Networks

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***Abstract*— Abnormalities in normal blood flow from the heart cause several types of heart disease known as cardiovascular diseases. Over more than 17.5 million Global death occurs due to cardiovascular disease and 75% of death occurs from low- and middle-income countries. Early detection can save a lot of people's lives. ECG signals reflect the electrical activity of the heart. Thus, heart rhythm disorders or alterations in the ECG waveform are evidence of underlying cardiovascular problems, such as arrhythmias. However, manual analysis of electrocardiogram (ECG) signals is a laborious and prone-to-error task, even for a specialist with many hours of experience.**
This work focuses on identifying the five diseases of a dataset with the help of an artificial neural network. We have used a sequential model in keras with 5 dense layers. Then the ANN keras model is trained from the selected parameters of dataset and then test dataset is used. The classification report tells us how well the model has identified the diseases.

***Index Terms*— ECG signal, signal detection, artificial neural network, machine learning**

I. INTRODUCTION

The electrocardiogram (ECG) is the most widely used non-invasive technique in heart disease diagnoses. Since it reflects the electrical activity within the heart during contraction, the time it occurs, and its pattern provides much information about the state of the heart.
Each heartbeat constitutes a cardiac cycle, which is reflected in the ECG graph: a P-wave, a QRS complex and a T-wave. In addition, a small U-wave may be visible in certain ECGs. The line voltage ECG base is also known as the isoelectric line or baseline. Normally, the baseline is the portion of the stroke that follows the T-wave and precedes the next P-wave.
The paper is organized in the following format. The first part of the paper gives the need or motivation for the work to be done. It provides a brief introduction to the problems related to the heart. The Second part of the paper provides details regarding the working mechanism of the system proposed. In short, the methodology of the work is discussed here. The next part shows the implementation. The last part of the paper shows the results obtained and the thoughts on the results.

II. LITERATURE REVIEW

The dataset has 5 diseases which have been diagnosed with 95% accuracy. This review paper helped in understanding the analysis of ecg signals and how it helped in identifying the five diseases present in the dataset. [7]. We see how artificial neural networks improve the use of other existing models in the paper [1]. ANN models

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such as LSTM were used but the model didn't work properly due to abundance of numeric input in the data [2].
Neural networks are initialized randomly. So different neural networks have different results. Hence, to stabilize our artificial neural network, we have trained it with same parameters[5]. This work has 5 layers of Artificial neural network when compared to convolutional neural network of 12 layers which focuses on micro classes of heart diseases [6].
Seeing how commonly employed features such as morphological, statistical, and frequency domain features, as well as more advanced techniques such as wavelet transforms, time-frequency analysis, and nonlinear dynamics measures were chosen has helped in this paper.[8]
Understanding how different types of papers in artificial neural network work lets us know how to make this work better. NN-based classifier, The ResNet34-LSTM3 model and PNN used for classification of signals along with the ANN model were some of the types we came across in our literature survey.[9][10][11]

III. Methodology And Implementation

An ECG dataset is taken. The source is physionet MIT-BIH arrhythmia dataset . Preprocessing is done for noise removal. The ECG dataset obtained after preprocessing is split into test dataset and training dataset. Eighty percent is used for training and twenty percent is used for testing. Artificial neural network is used for detection of various heart diseases. Hardware required is a fully functional laptop and the software used is jupyter notebook.
ECG dataset will be pre-processed (noise removal). Then the model is trained using machine learning algorithm. 60% is used to train the model and 40% to test the model. Then it will give identified ECG diseases classification. The model uses classification algorithm which will identify all the 6 diseases. Fig.1 shows the framework of the system used.
The model has 5 layers:
The first layer is a dense layer with 32 units and uses the ReLU activation function. It has an input shape of (20,), which corresponds to the 20 features selected by the ANOVA F-test.
The second layer is a dense layer with 64 units and uses the ReLU activation function.
The third layer is a dense layer with 128 units and uses the ReLU activation function.
The fourth layer is a dense layer with 64 units and uses the ReLU activation function.
The fifth and final layer is a dense layer with 5 units, which corresponds to the 5 classes of ECG signals. It uses the softmax activation function to produce the class probabilities.

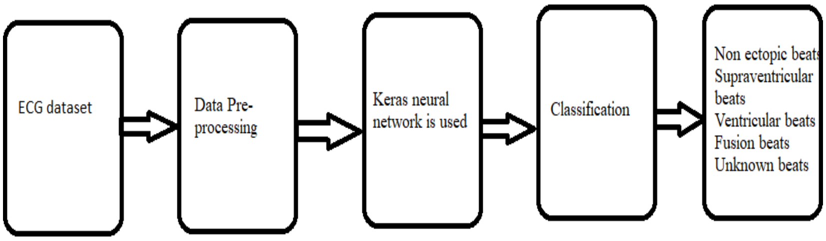

Fig 1: System Framework

Our paper focuses on detecting the five types of heart diseases based on the ecg signals from the dataset. Non ectopic beats, Supraventricular ectopic beats, Ventricular ectopic beats, Fusion beats and Unknown beats.
Non ectopic beats mean normal heartbeats. The rhythmic contraction and relaxation of heart muscles are known as heartbeat. Your pulse rate, also known as your heart rate, is the number of times your heart beats per minute. A normal resting heart rate should be between 60 to 100 beats per minute.
Generally, a lower heart rate at rest implies more efficient heart function and better cardiovascular fitness. Although there's a wide range of normal, an unusually high or low heart rate may indicate an underlying problem. Fig. 2 shows a normal heartbeat.
Supraventricular Ectopic Beats indicates atrial irritability. Isolated Supraventricular Ectopic Beats are generally not significant in nature, but a high frequency can represent more risk. An increasing trend in Supraventricular Ectopic Beats may be an indicator or sign for atrial fibrillation. Atrial Fibrillation is considered to be significant as it can lead to heart attack or stroke. Fig 3 shows supraventricular ectopic beats.
Ventricular ectopic are a type of arrhythmia or abnormal heart rhythm. It is caused by the electric signals in the heart starting in a different place and travelling a different way through the heart. The ECG features of these beats include Broad QRS complex (≥ 120 ms) with abnormal morphology and Discordant ST segment and T wave changes. Fig 4 shows ventricular ectopic heartbeat.

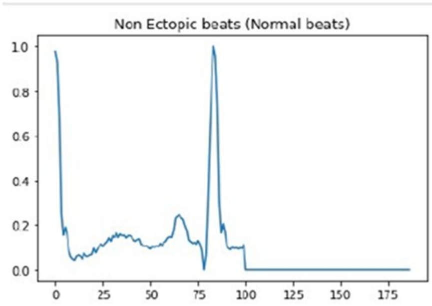

Fig 2: Non-Ectopic beats

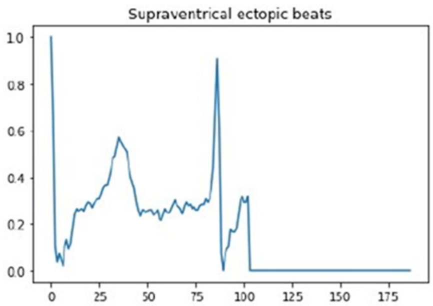

Fig 3: Supraventricular Ectopic beats

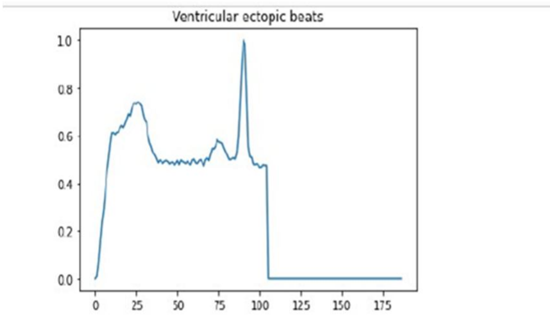

Fig 4: Ventricular Ectopic beats

A fusion beat occurs when electrical impulses from different sources act upon the same region of the heart at the same time~~.~~. If it acts upon the ventricular chambers, it is called a ventricular fusion beat, whereas colliding currents in the atrial chambers produce atrial fusion beats. The fusion beats are of intermediate width and morphology to the supraventricular and ventricular complexes. Fusion beats are seen with Ventricular Tachycardia and Accelerated idio ventricular rhythm (AIVR). Figure 5 shows fusion beats.

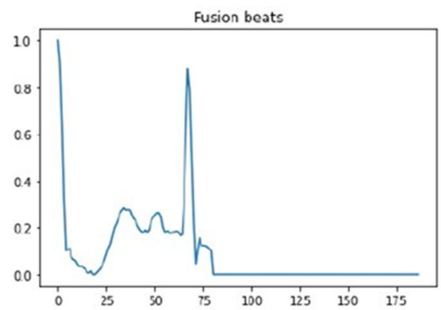

Fig 5: Fusion beats

Unknown beats are seen in myocardial infarction. Myocardial infarction (MI), colloquially known as "heart attack," is caused by decreased or complete cessation of blood flow to a portion of the myocardium. Myocardial infarction may be “silent," and go undetected, or it could be a catastrophic event leading to hemodynamic deterioration and sudden death. Hyper acute T wave changes are seen with increased T wave amplitude and width; ST elevation in ECG signals can be seen. Figure 6 shows unknown beats.

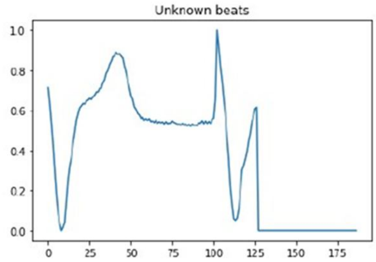

Fig 6: Unknown beats

As the type of diseases are discussed as above, the signals are plotted. Then, label encoding is done to handle the categorical variables in the data. Finally, our model is initialized. Our code creates a sequential neural network model. The model has 5 layers including the input layer. The first four layers are dense layers with ReLU activation function. The last layer has 5 neurons and a softmax activation function to output a probability distribution over 5 classes. The input shape for the first layer is (187,), meaning that the input has 187 features.
Our code compiles the previously defined neural network model in Keras. The model is compiled with Adam optimizer. The optimizer is the algorithm used to update the model's weights during training, "Adam" is a popular choice for its efficiency The loss function is used to evaluate the model's performance during training. Categorical_crossentropy is a common loss function for multi-class classification problems. The evaluation metric, "accuracy", is used to monitor the model's performance during training and testing.

IV. RESULTS

We see here that the model does as well as it did on the validation set, this indicates that the model has learned to generalize. We have a total accuracy of 95% on the test data. Also, we have to pay attention to precision and recall. We don't have the numbers we had with the validation set but still it does very well. This classification report shows several metrics for each class, including precision, recall, f1-score, and support. Precision is the ratio of true positives to the total number of predicted positives. In other words, it measures how many of the predicted positive instances are positive. For example, the precision for "non-ectopic beats" is 0.96, which means that 96% of the instances predicted as "non-ectopic beats" are actually "non-ectopic beats”. Recall is the ratio of true positives to the total number of actual positives. In other words, it measures how many of the actual positive instances are correctly identified by the model. For example, the recall for "Supraventricular ectopic beats" is 0.54, which means that only 54% of the actual "Supraventricular ectopic beats" were correctly identified by the model. F1-score is the harmonic mean of precision and recall. It is a single metric that combines both precision and recall into one value. For example, the f1-score for "non-ectopic beats" is 0.98, which is a high value and indicates good performance of the model in identifying "non-ectopic beats". Fig. 7 shows the Confusion matrix.
From the confusion matrix we can identify the diseases that, 81.550% of “non-ectopic beats”, 1.378% of “Supraventricular Ectopic beats”, 5.363% of “Ventricular Ectopic beats”, 0.402% of "Fusion beats" and 6.792% of “Unknown beats” are present in the given dataset.
In summary, the model performs very well in identifying "non-ectopic beats" and "Unknown beats", but not as well in identifying "Supraventricular ectopic beats" and "Fusion beats".

V. CONCLUSIONS

The prediction of heart disease at an early stage can prevent many mishaps. The use of an efficient algorithm can help physicians in detecting the possible presence of heart disease before it manifests. The overall accuracy of the model is 95% after 20 epochs. The model accuracy doesn’t change after 20 epochs hence the model accuracy is 95%.

Two graphs are plotted to track the model's performance. Loss graph and accuracy graph are the graphs plotted. The loss graph measures how bad the model performs. Therefore, the lower the loss, the better the model performance is. Fig. 8 shows the loss is less, proving that our model has performed well.

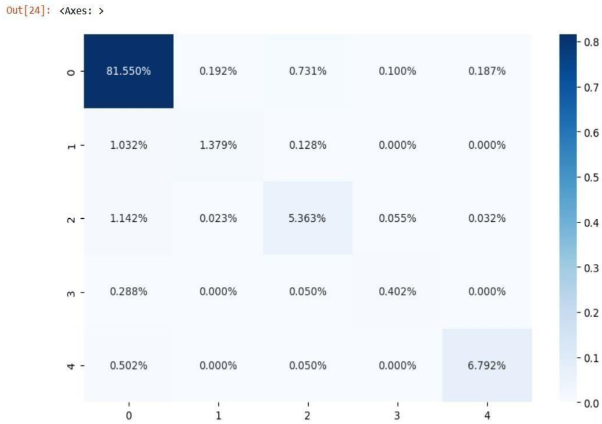

Fig 7: Confusion Matrix

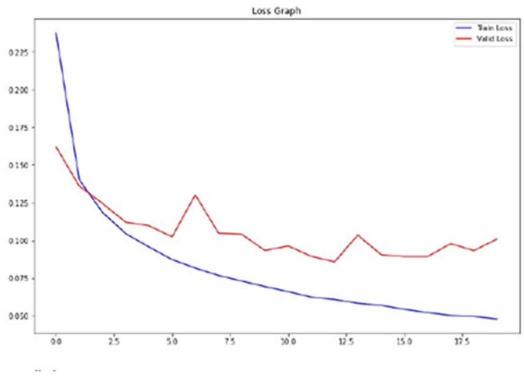

Fig 8. Loss graph

Accuracy graph has both training and validation accuracy of the model. Fig. 9 shows the accuracy graph.

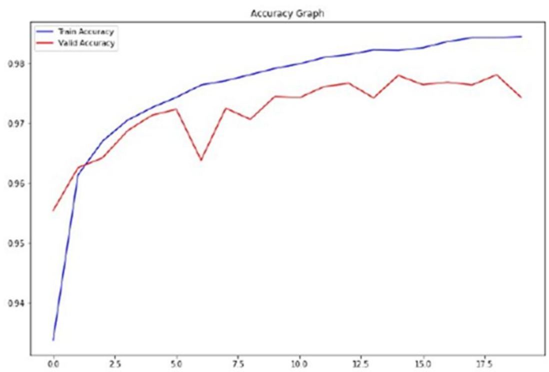

Fig. 9: Accuracy graph

The gap between the training and validation accuracy indicates the amount of overfitting. The gap between train accuracy and valid accuracy here is little indicating less over fitting. Less over fitting is recommended as it means the model can generalize the new data well.

The code at the end selects 10 samples from the test set and plots the corresponding ECG signal along with its predicted and actual labels. We can see the comparison of actual versus predicted signal graphs here. The below sample is an example. Fig 8 is one random sample. The actual class is supraventricular ectopic beats which the model has predicted correctly. The random index is the index of the sample which has been selected randomly.

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Enhancing Web Security: An Efficient URL Phishing Classifier based on Deep Learning

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***Abstract*— To procure sensitive data such as account Identification details, usernames, passwords, etc Attackers often develop new strategies, such as phishing, to fool users by utilizing fake websites. This paper presents and illustrates various methods for addressing phishing detection. To enhance user security and privacy, a web application is developed to determine if the URLs are malicious or benign. Malicious website detection can significantly decrease the probability of phishing attempts. In this paper, two distinct feature extraction techniques, Natural Language Processing (NLP) and TF-IDF vectorization, are employed to capture the intricate patterns within URLs. Evaluation and training are carried out by feeding the NLP features into Convolutional Neural Networks (CNN), Multilayer Perceptron's (MLP), Long Short-Term Memory Networks (LSTM), and Deep Neural Networks (DNN). Initial experimentation with NLP features yields promising results, achieving up to 98.78% accuracy with CNN and 95.32% with LSTM. An accuracy of 94.03% and 94.64% is obtained by exploring TF-IDF vectorization using CNN and MLP models respectively. Precision, F1-score, recall, ROC and various metrics for evaluation provide a holistic assessment of the model's performance. Oversampling and class weight adjustment techniques address the implications of class imbalance. To enhance model generalization, Hyperparameter tuning, cross validation, and ensemble methods are emphasized. Overfitting concerns are mitigated using regularization techniques such as dropout. This approach involves Principal component analysis (PCA), a feature reduction technique to lower the number of features present.**

***Index Terms*— URL phishing, Phishing attack, Deep learning, Cybersecurity**

I. INTRODUCTION

Nowadays, phishing has gained a primary concern for security researchers as creating fraudulent websites look similar to genuine ones. It can be difficult to determine whether a website is fraudulent or not, especially for those who are not experts in the field. It's important to be cautious and aware of the signs of fraudulent websites. Phishing attacks hit an all-time high in 2022, with over 4.7 million attacks and 1.35 million in Q4 alone, according to APWG's phishing activity trend report. This represents a 150% growth rate per year since
2019. The success of phishing attempts is increasing as a result of user ignorance. It can be challenging to combat phishing assaults since they often exploit user vulnerabilities. However, it is crucial to continuously improve phishing detection methods. An efficient intrusion detection solution is required to recognize and mitigate the impacts of phishing. Machine learning and deep learning techniques are being implemented to enhance cybersecurity. These techniques require past data to decide or predict future data. Artificial intelligence (AI) is a rapidly evolving intelligence method that helps oversee cybersecurity and provide protection for computer

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activities. It has become an essential component due to its broad spectrum of abilities, ranging from pattern recognition to security. The advancements in deep learning have made it possible for machines to learn on their own and extract features automatically without human intervention making the entire process more efficient and cost-effective. Deep learning has revolutionized the way to approach complex problems by providing faster and more accurate solutions, especially while dealing with large datasets and tasks in phishing detection. It is not an easy task to choose the appropriate algorithm or method for any application. It is crucial to highlight that while deep learning offers numerous benefits, the selection of the appropriate algorithm plays a pivotal role in maintaining accuracy and efficiency. This is particularly important in phishing detection, a task that demands continuous adaptation and evolution due to the ever-changing tactics employed by attackers to exploit system vulnerabilities and users. By making algorithmic choices, the potential to protect against phishing threats could be increased. In combating the growing threat of Phishing, deep learning mechanisms have proven to be an effective solution. Through learning by example, deep learning trains machines to imitate human brains, enabling them to perform classification tasks on large data sets, including text, sound, and image. In contemporary times, different strategies have been put forth to combat fraudulent websites through the extraction of URL features for classification purposes. Deep learning algorithms have demonstrated immense robustness, enabling them to identify patterns in vast datasets and make precise predictions. In this paper, a real-time phishing detection system has been proposed, utilizing deep learning algorithms like Multilayer Perceptron, Convolutional Neural Network, Long Term Short Memory, and Deep Neural Networks by collecting a significant amount of authentic and deceitful web page URLs. From this data, three distinct feature sets: NLP feature, TF-IDF, and hybrid features are defined and tested to assess the efficacy of the proposed system.

II. RELATED WORKS

With regard to the detection of phishing URLs, we found a few publications concerning URL-based phishing. In this paper [1], an approach to classify URLs automatically based on their host and lexical features was explored. Incorporating labels as predictive features enhances the efficiency and effectiveness of the classification systems in their tasks. This model boasts a high degree of accuracy and is capable of detecting numerous phishing hosts while keeping false positives to a minimum.

Mehmet Korkmaz et al. (2020) [2] discussed a phishing detection system that utilizes machine learning algorithms to analyse URLs and compare results from three datasets. The system leverages anomaly detection, which is particularly efficacious for identifying zero-day attacks.

Buket Geyik et al. (2021)[3] developed an anti-phishing method to detect various phishing attacks and prevent intrusion using the WEKA tool.

An anti-phishing system [4] utilizing seven distinct classification algorithms and features on basis of natural language processing (NLP) was put forth in real time, employing feature-rich classifiers. Based on the results obtained from the implemented algorithms, the Random Forest algorithm achieves the highest performance.

In order to identify phishing websites and their targets,

Huaping Yuan et al. (2018) [5] utilized lexical features extracted from the webpage links, URL & web page content, including the textual content & title. Moreover, the researchers explored multiple machine learning models for phishing detection and identified that the Deep Forest model delivered the most competitive performance.

Kudirat Oyewumi jimoh et al. (2022) [6] presented a system that utilizes rules to classify phishing websites. This system accurately identifies and categorizes websites as either phishing or non-phishing by analysing specific design and implementation-related features.

A recent study incorporates natural language processing techniques [7] to identify visual similarities. As phishing attacks can be quite intricate, the system addresses the semantics-based attack that exploits users' vulnerabilities. Deep learning frameworks and neural networks can be utilized to detect inappropriate language that is indicative of phishing attacks. This led to the development of a system called Phishector [8], which takes an email as input and determines the accuracy of predicting whether the email is genuine or fraudulent. The system's effectiveness was tested on two benchmark datasets, SpamAssassin and Ham Spam, utilizing various machine learning techniques. During the testing process, neural networks outperformed other techniques.

Another system to detect phishing attacks is CBR-PDS [9]. Its adaptive and dynamic nature confers a significant advantage over other classifiers. It has proven to be highly accurate.

Mohammad Siful Islam Mamun et al. (2016) [10] proposed a lightweight approach to detect and categorize malicious URLs based on their attack type. The approach uses lexical analysis for proactive detection. The study also examines the impact of obfuscation techniques on malicious URLs.

CANTINA is a novel method for identifying fraudulent websites, utilizing the TF-IDF algorithm. Additionally

CANTINA+ uses an extensive feature-based approach that incorporates eight innovative features. These results were compared to a classification model proposed by Routhu Srinivasa Rao et.al (2018) [11] which is based on deriving heuristic features from the URL.
PhishWHO[12] is a phishing detection technique that leverages the disparity between the actual and target identities of a webpage.
URLNet[13] is an innovative deep learning framework that directly learns a nonlinear URL embedding technique. This advanced feature allows the model to capture different types of semantics that were previously unattainable with existing models.
A new framework called the Hybrid Ensemble Feature Selection (HEFS) [14] is proposed by Kang Leng Chiew et al. (2019). It uses Cumulative Distribution Function gradient (CDF-g) to generate subsets for predominant features in the initial phase. Subsets for subordinate features are produced by utilizing previously obtained subsets in the data perturbation ensemble.
Ankit Kumar Jain et al. (2019) [15] proposed a new method that analyses hyperlinks in HTML source code to identify fraudulent attacks. This method employs 12 categories of features that are specific to hyperlink in order to train Machine learning algorithms, resulting in high accuracy. It is independent of language and is capable of detecting websites that use any language.
PHISH-SAFE[16] utilizes URL features to detect fraudulent websites. The system is designed to evaluate websites as either fraudulent or genuine by employing fourteen features. The results demonstrate that SVM achieved a high degree of accuracy.

III. Proposed Methodology

The proposed model consists of various stages such as preprocessing, feature extraction, feature reduction and Model classification using different deep learning techniques. The architecture of the proposed model is given in Fig 1.

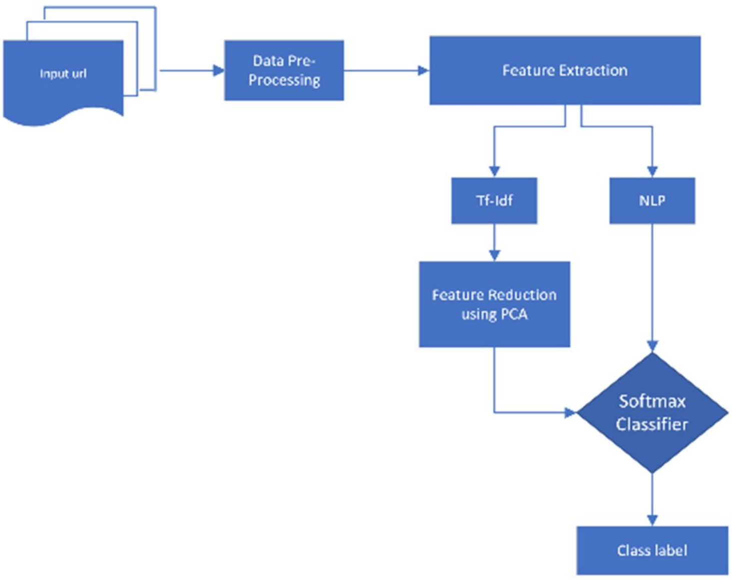

Fig 1. General architecture of the proposed model

A. Pre-processing

The data preprocessing phase includes the detection of null values, conversion of URLs to lowercase, the removal of non-alphanumeric characters and digits from URLs, and so on. This stage also involves operations like removing "https://", "http://", "www." and so on. Consequently, every word is collected from a URL before being processed as part of the data pre-processing phase and then evaluated at each stage of execution. This is followed by a series of experiments conducted on the MLP, LSTM, CNN, and DNN models.

B. Feature Extraction

This methodology offers a comprehensive analysis of the URL's structure and content by using two different feature extraction techniques such as NLP & TF-IDF.

1. Natural language processing features

In this decomposition process, the URL was first parsed while accounting for special characters like "?","/",".", ",", "=" and "&". Attackers may employ a variety of strategies to trick users. Based on the attack type, brand names like Google, Apple etc., or some crucial phrases like login, secure, account, server, etc. are used. The proposed system uses ten NLP features, and they are detailed as follows.

- Raw-word-count: The total number of terms in the URL. This could be an indicator of URL complexity or length.
- Spitted-word-count: It refers to amount of words after splitting the URL.
- Average word length**:** It is the mean length of words in the URL.
- Longest-word-length**:** It refers to the length of the longest word in the URL. This gives insights into the presence of long strings, which could indicate obfuscation.
- Shortest-word-length: The length of the shortest term in a URL. This gives insights into the presence of short strings, which could indicate obfuscation.
- Std word-length: The standard deviation of length of a word. This captures variations in word lengths and could be indicative of unusual structures.
- Compound word-count**:** The number of terms grouped under a specific criterion (e.g., length greater than 7).
- Keyword count**:** The number of keywords extracted from the URL.
- Brand name-count**:** The amount of brand names extracted from the URL.
- Negligible word-count**:** The number of terms considered negligible based on some analysis (e.g., determined to be not informative).

These features provide additional insights into the structure and content of the URL thereby distinguishing between legitimate and phishing URLs.

2. TF-IDF

TF-IDF involves converting each URL into a numerical vector representing the frequency of each word in the URL relative to its frequency in the entire dataset of URLs. The output vector can be used as input to a deep learning algorithm for classification. TF-IDF process involves:

- Calculate Term Frequency (TF): It is imperative to take into consideration the frequency of specific terms that appear within contents. This metric, referred to as Term Frequency is determined by dividing the count of the word or token by the total amount of terms in that document.

$$TF(t) = \textit{Number of times term t occurs in a document /Total number of terms in the document} \quad (1)$$

- Calculate Inverse Document Frequency (IDF): Inverse Document Frequency calculates the rarity of a word or token in whole dataset or corpus. It is calculated as logarithmic ratio of overall number of documents to the quantity of documents containing the term. The goal of IDF is to give more weight to terms that are rare across documents:

$$IDF(t) = log\_e(T/N) \quad (2)$$

where T = Total number of documents & N = Number of documents containing term t

- Compute TF-IDF Scores**:** The TF-IDF score for a term in a specific document is the product of its TF value and its IDF value. TF-IDF scores capture the importance of terms within a document while also considering their rarity across the entire dataset:

$$TF - IDF\ (t, d) = TF(t, d) * IDF(t) \quad (3)$$

C. Feature Reduction

Dimensionality reduction is an essential technique for improving model performance and preventing overfitting. These techniques enable the model to focus on the most important features, resulting in improved accuracy and efficiency. Principal component analysis is a method used for dimensionality reduction. In this work, the top features for TF-IDF are selected using PCA. It is observed that accuracy of proposed model increases with the PCA value upto 100, after which the accuracy remains stable, resulting in no further significant improvement in accuracy. These features serve as valuable input for machine learning models, allowing them to learn and make accurate predictions based on the unique characteristics of the URLs.

IV. Experimentation And Results

A. Dataset

In this paper, we aim to obtain a dataset that is globally acceptable. Ebbu2017 Phishing Dataset, 2017 is utilized. In total, this dataset contains 36,400 genuine URLs and 37,175 fraudulent URLs.

B. Training and Testing

The data set is segmented into 20% for testing purpose and 80% for training. Various parameters are taken into account, including but not limited to the number of layers, neurons within each layer, batch size, learning rate, dropout rate, epochs, activation function, and optimizer.

C. Results

Four distinct Deep Learning Algorithms are used to perform each test set and statistical measures are used to calculate algorithm efficiency by applying the values from the confusion matrix.

1. NLP feature

In this paper, a total of 10 NLP features are used to classify URL. Fig 2 illustrates the relationship between predicted and actual class labels of NLP feature confusion matrix. This serves as a foundation for calculating various performance metrics. According to Table I, the Convolutional Neural Network (CNN) algorithm with NLP features demonstrated strong capabilities in detecting phishing URLs by exploiting local patterns, achieving an accuracy of approximately 98.78%. Meanwhile, MLPs leveraged their depth to capture complex relationships between features, achieving a competitive accuracy of around 90.56%. LSTM showcased its effectiveness in handling sequential data, contributing to an accuracy of 95.32%, While DNN has the lowest classification performance with an accuracy of 74.50%. Deep learning algorithm models shows better accuracy than machine learning models like Logistic regression & XGBoost with accuracy of 61.6% and 90.04%. Fig 3 and 4 represent accuracy, precision, recall and F1 score for various classification algorithms using NLP.

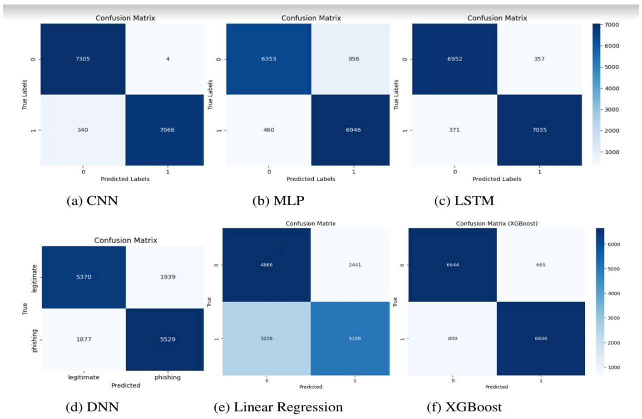

Fig 2. NLP feature confusion matrix

TABLE I TEST RESULTS OF CLASSIFICATION ALGORITHMS FOR NLP FEATURE

Algorithm	Features	Precision	Recall	F1 Score	Accuracy
CNN	NLP Features	0.989	0.985	0.986	98.78%
MLP	NLP Features	0.889	0.928	0.908	90.56%
LSTM	NLP Features	0.952	0.954	0.953	95.32%
DNN	NLP Features	0.770	0.687	0.726	74.50%
Logistic Regression	NLP Features	0.60	0.567	0.579	61.6%
XGBoost	NLP Features	0.908	0.892	0.899	90.04%

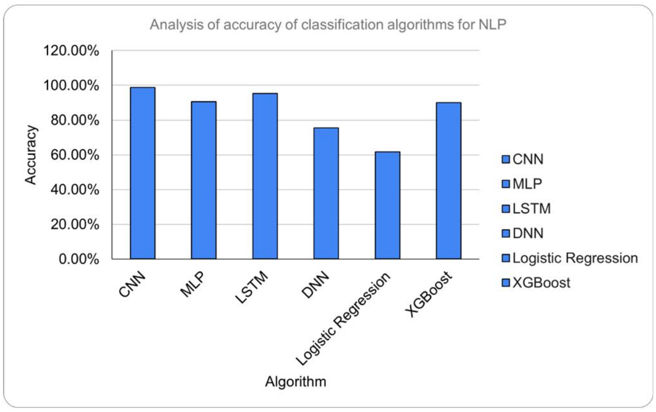

Fig 3. Analysis of accuracy of classification algorithms for NLP.

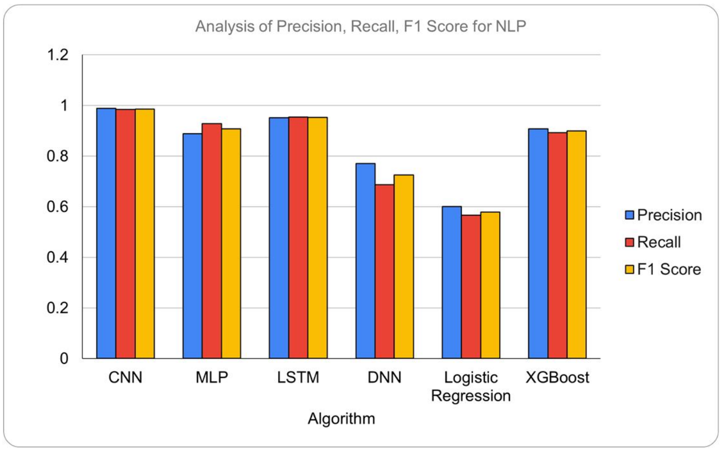

Fig 4. Analysis of various evaluation metrics for NLP.

2. TF-IDF Feature

Performance metrics for several deep learning classification algorithms with TF-IDF features are presented in Table II. The TF-IDF feature extraction technique gives a performance of 94.03% and 94.64% upon using Convolutional Neural Network and Multi-Layer Perceptron respectively. However, LSTM and DNN models lack a sufficient complex or deep architecture to capture the intricate patterns with a limited accuracy of only 50%. Several potential reasons for this discrepancy exist. One factor to consider is the limited size of the dataset, which may not provide enough examples for these models to generalize effectively. Fig 5 and 6 represent accuracy, precision, recall and F1 score for various classification algorithms using TF-IDF.

TABLE II TEST RESULTS OF CLASSIFICATION ALGORITHMS FOR TF-IDF

Algorithm	Feature	Precision	Recall	F1 Score	FeaturesPrecisi Accuracy
CNN	TF-IDF	0.939	0.943	0.941	94.03%
MLP	TF-IDF	0.933	0.963	0.948	94.64%
LSTM	TF-IDF	0.50	1.00	0.66	50.33%
DNN	TF-IDF	0.50	1.00	0.67	50.33%
Logistic Regression	TF-IDF	0.912	0.918	0.915	91.1%
XGBoost	TF-IDF	0.942	0.969	0.955	95.5%

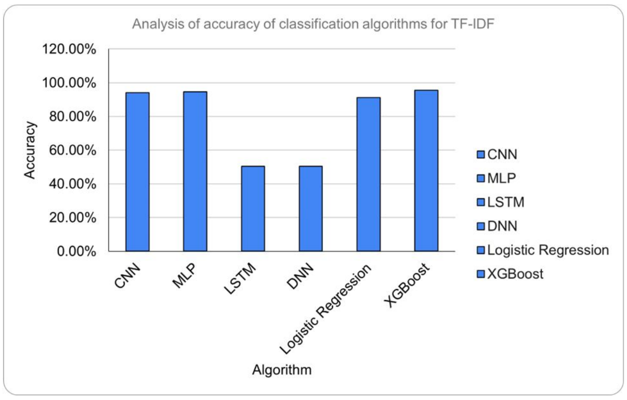

Fig 5. Analysis of accuracy of classification algorithms for TF-IDF.

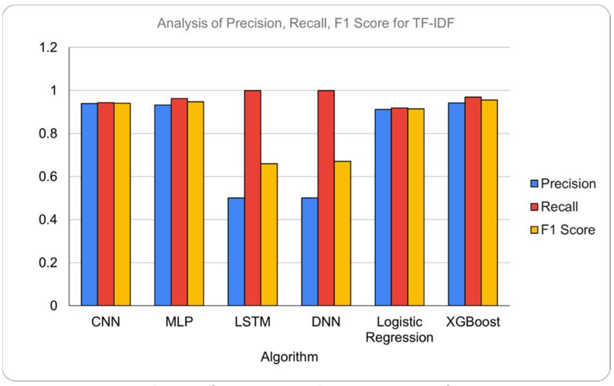

Fig 6. Analysis of various evaluation metric for TF-IDF.

Overfitting is also a critical concern, as it can lead to a model performing well on training data but poorly on new data. This may be particularly relevant to those models, especially if their architectures are excessively complex given the limited amount of data available. Furthermore, the vanishing gradient problem, which can present significant challenges for LSTM networks, may be impeding the learning process. Differences in data representation and preprocessing techniques also contributes to the lower performance of model. The classification results indicate that the NLP feature Deep learning models have a significantly better performance overall. This table gives valuable insights into a model's strengths and performance of constructed models using NLP features and TF-IDF.

3. NLP & TF-IDF features

Natural Language Processing (NLP) and TF-IDF (Term Frequency-Inverse Document Frequency) features are used for text analysis and classification of URLs. The raw URL data is transformed into text data using NLP techniques (stopwords removal and tokenization) and then the processed text data is converted into TF-IDF features using the "TF-IDF vectorizer."

TABLE III NLP & TF-IDF FEATURES TEST RESULTS OF CLASSIFICATION ALGORITHMS

Algorithm	Precision	Recall	F1-Score	Accuracy
CNN	0.954	0.970	0.962	96.18%
MLP	0.956	0.969	0.962	96.22%
DNN	0.973	0.910	0.939	94.23%

These features are used for dimensionality reduction (PCA) and training machine learning models like CNN, MLP & LSTM to classify URLs as legitimate or phishing. From Table III, Algorithms such as MLP, CNN and DNN show promising results with a good accuracy of 96.22% ,96.18%, and 94.23% respectively. Fig 7 represents precision, recall, F1 score for NLP & TF-IDF.

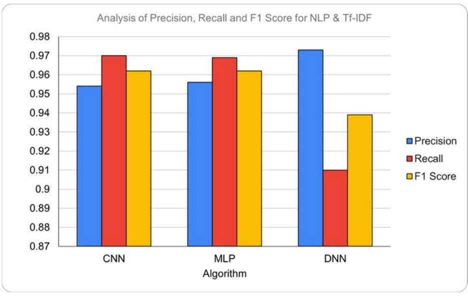

Fig 7. Analysis of various evaluation of metrics for NLP & TF-IDF.

V. COMPARITIVE ANALYSIS

The Existing model [4] uses various machine learning algorithms, among which the random forest algorithm with NLP feature achieved an accuracy of 97.98%. Comparatively, our proposed model obtains a higher accuracy of 98.78% using CNN with NLP feature, also resulting in a lower response time. From the Table IV, it is observed that there is a huge reduction in the number of features in our model which is a noteworthy aspect of our novel approach.

TABLE IV COMPARITIVE ANALYSIS OF EXISTING MODEL

Model	Dataset	*NLP features*
Ozgur.et.al (2018)	(ebbu 2017 Phishing dataset, 2017)	40
Proposed Model	(ebbu 2017 Phishing dataset, 2017)	10

VI. CONCLUSION

The potential of combining deep learning and feature ex traction techniques for URL classification is demonstrated in this study. Increasing sophistication of phishing attacks demands robust and accurate detection mechanisms, and using deep learning models has proven to be a promising approach. Specifically, we have designed real-time phishing detection system that employs two crucial feature extraction techniques: NLP and TF-IDF. NLP enables the capture of linguistic patterns and context, while TF-IDF facilitates the numeric representation of text features. These features were used as inputs for various Deep learning and Machine learning architectures. According to the experimental results, Adopting NLP features with CNN classifier yields better performance compared to another classifier. Experiments were conducted using these models, and their performance was evaluated meticulously. This paper emphasizes on achieving high accuracy, precision, recall, and F1-score values, all essential metrics for phishing attack detection. As cybersecurity evolves and phishing attacks become more sophisticated, there are several avenues for future enhancement by incorporating more advanced deep learning architectures, such as Transformer-based models like BERT or GPT, that offer improved feature extraction. Additionally, integrating this work with ensemble learning techniques, combining the strengths of multiple models could enhance overall accuracy and robustness. Finally, real-time deployment and integration of the developed models within web browser extensions or email clients could provide users immediate protection against phishing threats, contributing to a safer online experience.

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Vertical Hydroponics System using IoT

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***Abstract*— With the use of modern technology and intensive farming practices, production can be greatly increased. With the shortage of water, the effects of climate change, the manpower shortage, and the shrinking amount of fertile land, hydroponics farming is emerging as a solution. In areas where access to fresh produce is limited, hydroponics farming offers a job opportunity, helps the community economy, and produces nutritious food. The fundamental goal of hydroponic farming is to promote healthy plant growth without the need of traditional soil. It is an innovative way of making the agriculture smarter. Instead of using soil to produce plants, hydroponics uses a water solution rich in vitamins and minerals. With the use of modern technology and intensive farming practices, production can be greatly increased by vertical farming, thereby contributing to agriculture. Integrating hydroponics with IOT may surely make farming more easy for the farmers by automating and perfecting every stage in the farm. For a plant to grow, it needs specific nutrients, some water, and sunlight. IoT device can monitor those needs automatically and regulate hydroponic systems and operate effectively in any environmental conditions. This will allow the farmer or the user of the hydroponic system effectively by generating alert whenever needed.**

***Index Terms*— IoT; soil-less farming; vertical farming; deep water culture; hydroponics.**

I. Introduction

At least ten million hectares of arable land are eroded and abandoned annually throughout the world, according to a report by David Pimentel and his colleagues from ten years ago (1998). [1]. As a result, a significant amount of replacement land is taken from forests and other sources for agriculture and human habitation to make up for this loss. The natural landscape of the world has been rapidly converted to agriculture, and it is now known that this use of natural resources will soon exceed its carrying capacity by permanently harming its natural ecology. Due to a lack of food production, several nations may experience economic catastrophe. The preservation of water resources and the maximization of profit per square foot of land are problems that must be solved in order to provide higher quality and quantity yields that, either directly or indirectly, benefit farmers or the national or regional economy. [2]-[3].The use of innovative or cutting-edge technology in the agricultural industry may greatly increase agricultural productivity and sustainability.
One such innovative technique is hydroponics. The majority of terrestrial plants may be grown using hydroponics, a farming method that doesn't require soil and simply uses water and nutrients. Using aqueous mineral fertilizer solutions, hydroponics is the practise of growing plants typically agricultural or therapeutic plants without soil [4]. The fundamental goal of hydroponic farming is to promote healthy plant growth without the need of traditional soil media. Instead of using soil to produce plants, hydroponics uses a water solution rich in vitamins and minerals. Tomatoes, peppers, cucumbers, strawberries, lettuces, and cannabis are plants that are typically grown hydroponically for commercial purposes.

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In order to reduce agricultural production inefficiencies and increase performance, the integration of IoT technology into alternative farming techniques has received significant attention [5]. Internet of Things (IoT) can monitor and regulate hydroponic systems and operate effectively in any environmental conditions. In order to execute the appropriate levels of control, a grower does not need to be present all the time. This is made feasible through wireless IoT connectivity. As comparison to plants grown on soil, plants grown in nutrient solutions can mature up to 25% quicker and produce up to 30% more yield [6]. A crucial component of attaining these types of outcomes is wireless IoT systems. With hydroponics gardening, the crops yielded are healthier and requires comparatively less amount of space, water and is easy to implement. Thus, this is an approach to enhanced agriculture with the use of modern technologies like IoT.

II. Design And Operation Of Hydroponics

A. Why Hydroponics?

Plants often grow on soil because it is the most accessible growing medium. For the successful development of plants, it provides nutrients, air, water, and other elements. The expense of switching from one soil to another development media is usually high. A system for growing plants known as hydroponics or soil-less culture lessens some of the problems encountered in typical crop development. In the tropics, where these living things' life cycles continue to progress and the risk of invasion increases, it provides strategies for controlling soil-borne diseases and annoyances [7]-[8].

B. Requirements of Hydroponics?

1. A constant supply of water enriched with nutrient along with good air circulation.
2. Good amount of light for healthy growth of plant.
3. The temperature and humidity of the environment should be appropriate for plant.

TABLE I. Requirements Of Hydroponics

pH requirements	5.8-6.5
Light requirements	13-16 hours per day
Temperature Requirements	20 °C -30 °C

III. Proposed System

A. *Main Components*

1. NodeMCU 2. Microcontroller Module 3. Arduino UNO 4. Ultrasonic Sensor 5. Water Level Sensor 6. DHT11 Sensor 7. pH Sensor 8. Relay Module

B. Flow Chart

The overall system flowchart is shown in Figure 13. The Hydroponics framework is connected with the IoT devices. Different sensors are deployed to monitor the condition of the plants and notify the user accordingly. If the nutrient level of plants goes below the threshold value, the user is notified via the mobile application and the motor is turned on. Similarly, if the temperature and humidity falls below the threshold, the user is notified and the fan gets turned on. Based on the requirement of the plant, the light is provided. pH of the plant is also checked and regulated if needed. The system is monitored continuously and the values are displayed in the mobile application, making it convenient for the user to track the growth of the plant.

C. Experimental Setup

The setup consists of a frame structure which holds two different plants - lettuce and coriander which are grown vertically. The frame has six solution containers having nutrient solution and on top of it net pot is embedded to hold plants. A 12V pump is attached to the frame to supply nutrient solution from the nutrient tank. The frame also consists of fan, LED light and the IoT setup to monitor the growth of the plants. The water pump motor, electrical components and sensor, and their supporting system are also shown in Fig14.

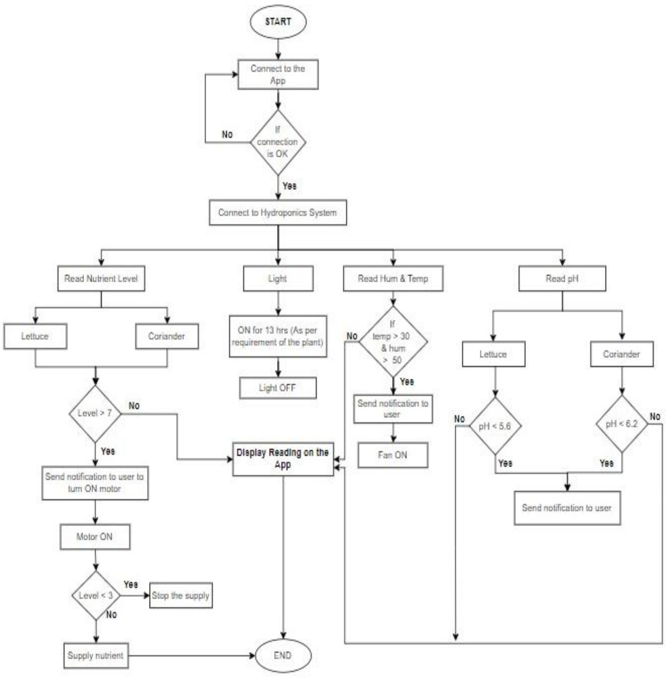

Fig 1: Flow Chart

Fig 2: Setup of Vertical Hydroponics

The setup consists of a frame structure which holds two different plants - lettuce and coriander which are grown vertically. The frame has six solution containers having nutrient solution and on top of it net pot is embedded to hold plants. A 12V pump is attached to the frame to supply nutrient solution from the nutrient tank. The frame also consists of fan, LED light and the IoT setup to monitor the growth of the plants. The water pump motor, electrical components and sensor, and their supporting system are also shown in Fig14.

D. *Environmental Condition for Plants*

The hydroponics system consist of Lettuce and Coriander plants:

a. Lettuce

The hydroponic lettuce crop grows in about a month and expands very quickly. In addition to being very easy to grow hydroponically, the crop itself is highly versatile in the kitchen. The small seeds are able to grown quickly in a hydroponic system that uses only nutrient-rich fluid by first germinating in a soil-less medium. Studies show that some lettuce kinds, particularly leafy types and in addition to those with deeper or redder colors contains bio-active substances with anti-inflammatory, cholesterol-lowering, and even anti-diabetic activities. [13].

TABLE II REQUIREMENTS OF LETTUCE

pH requirements	5.5-6.0
Light requirements	Between 10 and 14 hours of light per day.
Temperature Requirements	20 °C -24 °C

b. Coriander

Coriander sprouts easily and fast. Within 7–10 days, it will be prepared for transplantation into your hydroponic system. In comparison to other common hydroponic crops like peppers and tomatoes, coriander is a plant that is simple to produce. Like lettuce, Coriander doesn't take up as much room, uptake as much food, or require as much space as other common hydroponic plants. Coriander leaves have extremely good vitamin A and C preservation. Coriander leaves are a pot of nutrients, including dietary fibre, iron, manganese, calcium, vitamin K, phosphorus, and others. [14]

TABLE III. REQUIREMENTS OF CORIANDER

pH requirements	5.5-6.7
Light requirements	Between 12 and 15 hours of light per day.
Temperature Requirements	25 °C -30 °C

E. Data Gathering Procedure

The different sensors used in the system are Ultrasonic sensor, Water level sensor, pH sensor, Temperature and Humidity sensor. The process in which these sensors gather the data are as follows:

1. The ultrasonic sensor is calibrated according to the level of the nutrient tank being used. Once it is done, the threshold is set and the sensor is placed on top the nutrient tank.
2. The threshold of water level sensor is set based on the container size, and is submerged inside the container holding plant with nutrient solution.
3. The pH sensor is calibrated with the solution whose pH is already known. After this, the pH is submerged in the container to check the pH value of the nutrient solution is as per the requirement of the plant.
4. The temperature and humidity sensor is directly attached to the frame to calculate the temperature and humidity of the environment in which the plants are kept.
5. These sensors continuously gather the data and the reading is displayed on the mobile application.
6. If the ultrasonic sensor reading does not match with the threshold, the notification is sent to the user.
7. If the water level sensor, shows low reading, then the user is notified to turn on the motor pump, which will supply the nutrient solution from the tank to the container.
8. If the value of the pH changes, the user is notified to adjust pH of the nutrient solution.
9. If the temperature and humidity goes beyond threshold, it is adjusted by turning the fan on.
10. This process is done until the complete growth of the plants.

F. Android Application

The vertical hydroponics Gardening system can be monitor using Mobile Application. This mobile application is developed using React Native. The list of plants that we can monitor will appear when we start the application. A new screen with buttons to ON or OFF the fan, light, and motor will appear after choosing plant. Besides that, the readings for nutrient, PH, temperature, and humidity will also be displayed here. Using postman we can read the data of blynk using API and send it to our application. According to the notifications that are received on the application, the user can monitor motors, lights, and fans. The user can remotely control and monitor the vertical hydroponic system using this mobile application.

Fig 3: Screenshot of Application

G. *Blynk Cloud*

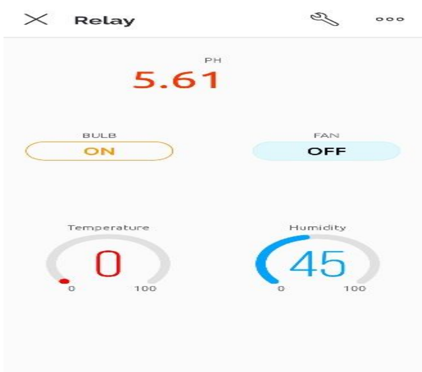

Fig 4: Screenshot of Blynk Dashboard

Blynk IoT Platform is a complete software package which is used to prototype, install, and remotely manage any type of connected electronic device. It can store data, visualise it, show sensor data, remotely operate devices, and perform many more useful tasks. Also, it is possible to share a project with friends or even clients so that they can access the associated devices but cannot alter the project [15].

The platform consists of three main parts:

1. *Blynk App* - allows you to use the many widgets we offer to build attractive interfaces for your projects.
2. *Blynk Server* - is responsible for monitoring all hardware-to-smartphone connections. You have the option of using our Blynk Cloud or setting up your own local Blynk server. It can even be started on a Raspberry Pi, is open-source, and has no trouble supporting thousands of devices.
3. *Blynk Libraries* - enable connectivity with the server and handle all incoming and outgoing commands for all major hardware platforms.

IV. Result And Discussion

The data collected by the sensors will be displayed at the mobile application as well as the Blynk Cloud. The Blynk Cloud can be accessed by both laptop and the mobile. The reading of the sensors is varied according to the changing environmental conditions and is displayed on the application as shown in the Fig 17. The user of the system monitors the plants using the application and control the system based on the conditions. As the reading goes above or below threshold, the user is notified by the push notification as shown in the Fig 18. Depending on the notification, the user can take actions.

Fig 5: Screenshot of Reading

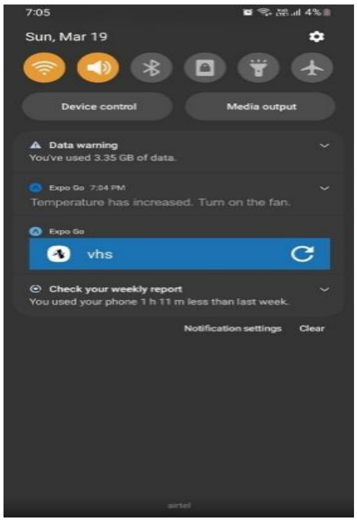

Fig 6: Screenshot of Notification Panel

Hydroponics system saves more that 50% water than the traditional farming, this is because plant's root absorb only 0.1 percent of the water, rest is lost by evapotranspiration. But in hydroponics, the water is re-circulated from the fixed tank. The usage of fertilizers and insecticides is eliminated, thus producing nutritious and healthy plants. Growing plants hydroponically is 30-40 % faster as the roots gets nutrient directly from the nutrient solution. Taking up nutrients from the soil can be slower. The summary of these details is shown in Table 4.

TABLE IV. TRADITIONAL VS HYDROPONIC SYSTEM

Parameters	**Traditional Soil System**	**Hydroponics Soiless System**
Water Used	20L per kg	10-12 L per kg
Productivity (%)	100	120
Fertilizer (%)	100	0
Growth (%)	60	24

This method of growing plants soil-less is relatively new and is being explored. The integration of hydroponics with IoT which may make farming undoubtedly more convenient. The word vertical means growing the plants vertically one above the other, this saves a lot of space and varied other crops can be grown in parallel. With hydroponics gardening, the crops yielded are healthier and requires comparatively less amount of space, water and is easy to implement. Crops will be preserved from severe weather and other calamities like hurricanes, floods, droughts, snow, and which will reduce the efforts required by the farmer in protecting the crops. Thus, this is an approach to enhanced agriculture with the use of modern technologies like IoT. Hydroponics is thus an innovative way of making the agriculture smarter. The system has a very extensive future scope. AI can be used with hydroponics to enhance the system [16]-[17]. The integration of this system with AI can develop disease resistant plants and can prevent the spoilage of plants at an early stage. [18]. Furthermore, the system can be extended to grow rare farming plants such as saffron, which requires extreme special conditions for their growth [19].

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Performance Comparison of Deep Learning Models for Real Time Sign Language Recognition

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***Abstract*— Communicating with speaking/hearing impaired people has been one major issue throughout the years. Deaf and Dumb people use Sign Language consisting of various hand gestures as a means of communication. But, normal people fail to understand, as learning sign language is a tedious task and such language is required only in rare situations when we come across such people. Understanding what is conveyed is very important to convey back the message of doing the needful. There is a need for technology, which can reduce the problem of communicating with speaking/hearing impaired people. Survey shows an urgent requirement of robust real time sign language translators. So we aim to build a machine learning model which recognizes the hand gestures in real time through real time video processing and gives the meaning of the hand gesture as the textual output which can be further played as an audio signal. Through this research paper, we suggest the process to create dataset of Indian Sign Language and then using that dataset we have trained two models, YOLOv5 and YOLOV7 and carried out a comparative study on the same to learn about the differences in both models with respect to object detection, accuracy, precision, recall and more. The proposed YOLOv5 system attains accuracy of 87.6% while YOLOv7 system attains accuracy of 96.5% while being tested over locally created database for small phrases and sentences.**

***Index Terms*— Object detection, Real time, Indian Sign language detection, OpenCV, YOLOv5, YOLOv7**

I. INTRODUCTION

Communication is the act of conveying or sharing thoughts, sentiments, or information. In order for two individuals to communicate, they should be able to speak and comprehend the same language. Deaf and dumb persons, however, have been deprived of equal status in the society as they fail to express themselves to the normal people. The hearing/speaking impaired people use a different method of communication which is understandable by only those who have learnt it. They express themselves using visual sign language using body, face, and hand movements. This kind of people we come across rarely and find ourselves handicapped to communicate with them. If given a chance, they can live independently and can do wonders for themselves and for the society.
Currently, there are more than 300 distinct sign languages throughout the world. Even though there are numerous distinct sign languages, only a small portion of the community is conversant in any of them, making it challenging for people with special needs to freely interact with the general public. Indian Sign Language Detection gives people a way to communicate in sign language even if they don't know it.
Hence, there is a need for technology, that can address these issues in real time so that when there is a need we can use such translator tools to understand the sign language and also to communicate back to the Deaf and dumb

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persons. Developing such solutions is a very challenging task as it involves the need for recognizing the sign language as it is being played, the numbers of gestures are large in number and they are formed using combinations of body, face, and hand movements. Similarly the other way round, playing the normal spoken language for deaf and dumb to make them understand what a normal person is saying is equally complicated. These applications need complex technology of video processing, audio processing, gesture recognition, Natural Language Processing, Speech Synthesis, etc, and a platform for the real time mobile application to make the dream of equality come true.

In this paper we propose to work on the challenge of developing an app that can process the real time continuous video frames to recognize the sign language and play the audio of the corresponding words and small highly used sentences. The paper presents the literature survey in section II, proposed solution in section III. Sections IV V and VI concentrate on the data set prepared for the experiment, preprocessing operations and the recognition system respectively. The results and analysis are presented in section VII and the section VIII gives the conclusion and future work of this research application.

II. Previously Related Work

Towards this, we surveyed various technologies used in research works by various researchers and analysed the technologies for their capabilities, limitations, and the recognition accuracy.

In [1],‘Sign Language Recognition and Converting into Text’, Tabassum and Raghavendra R(2022) built a human-computer interface to identify the 26 American sign language letters and produce text output that reflects the meaning of the letter. To identify and learn letters, the system employed CNN (Convolutional Neural Network) and LSTM (Long Short Term Memory) networks on custom made dataset and achieved 98% accuracy.

In [2], The authors developed a system that works with real-time input provided by the user. Support vector machines (SVM), convolutional neural networks (CNN), and other necessary techniques are used to recognise letters.

In [3], Convolutional Neural Networks were used by the authors to create a real-time system that combined image processing and machine learning to recognise 24 English alphabets of a custom dataset and achieved an accuracy of 83%.

In [4], the authors used neural networks to create a real-time method for finger spelling-based American Sign Language. Their method involves passing the hand through a filter first, then a classifier, which examines the category of hand motions. The model had a 96 percent accuracy rate for each letter.

In [5], multiple deep learning architectures for hand segmentation, local and global feature representations, and sequence feature globalisation and recognition were proposed by the authors as part of a system for dynamic hand gesture recognition. The King Saud University Saudi Sign Language (KSU-SSL) dataset of 40 dynamic hand motions was used to assess the proposed system, and they were able to attain an accuracy of 87.69%.

In [6], American sign language (ASL) motions are captured using a computer's webcam by the authors' desktop which then instantly translated them into text and voice. They employed CNN and achieved 95% accuracy in gesture identification.

In [7], the authors created system for speech and text translation from sign language in real time. They have created an Android application to show the vision-based method of converting sign language to text and voice without the need of any sensors and solely by photographing the hand motions. In the system proposed by them, they used SVM [Support Vector Machine] and Principal Component Analysis model is used to identify 26 English alphabets along with the first 10 numerical digits in dataset consisting of 1000 samples per symbol. They have quoted an accuracy of 92%.

In [8], through a gadget that makes use of an Arduino Uno board, a few flex sensors, and an Android application to promote user involvement, the author hopes to address this particular issue of communication with hearing/speaking impaired people. The wearer's motions and gestures are detected by the flex sensors, and depending on the parameters for the various values produced, the appropriate messages are delivered through a Global System for Mobile (GSM) Module to the user's Android handset, which converts the text message to speech.

In [9], the study used MATLAB to demonstrate sign language recognition of 26 Indian sign language hand movements. The suggested system had four modules, including feature extraction, sign recognition, sign to text, and pre-processing and hand segmentation. The gesture was recognised using the Linear Discriminant Analysis (LDA) technique, and the detected gesture was then transformed to text and speech format.

In [10], The authors created a system for the real-time definition of hand gestures using a registered neural network framework and network weights. The system uses a convex hull algorithm to determine the skin colour for a

specific frame for hand use, the convex hull algorithm to determine the hand gesture, and finally the registered neural network system and network weights. The real-time system has a 98.05% accuracy rate.
In [11], The authors described a technique that used support vector machines (SVM) and artificial neural networks to translate Bengali Sign language into text. The hand gesture made in front of the camera is the input, which is captured by Microsoft Kinect. Once joints and wrists have been identified and the shapes have been evaluated, the collected hand sign is finally recognised. To classify the sign, a contour feature is taken and processed through an SVM..They achieved an accuracy of 84.11%.
We observed that, while Neural Networks have been used successfully for Sign Language letter recognition in the past, majority of those need a three-dimensional capture component with motion-tracking gloves or a Microsoft Kinect, which limits the scalability and feasibility of these solutions. There are currently relatively few goods on the market that assist deaf individuals in interacting with hearing people. Existing items are difficult to get. ASL Translator and iCommunicator can only convert English words into sign language video representations. So yet, there are just a few sign language items available. The apps that are currently available are for learning sign languages and don't have the facility of real time conversion of sign into plain text. Due to these challenges, it is difficult to build and find an efficient application that converts live input of signs into text and has a real time functionality.

III. Proposed System

The figure given below, Fig.1, represents block diagram showing the working of a real time sign language detection system. As shown, the proposed system takes the real time video as the input, extracts the frames, detects the hand and tracks it in the real time video. It then segments the hand portion, performs pre-processing and uses the pre-processed image for the wanted regions of the hand which is then used for the sign recognition. The recognized output can be displayed on the screen or can be played as audio. These steps are further explained in detail in the following subsections.

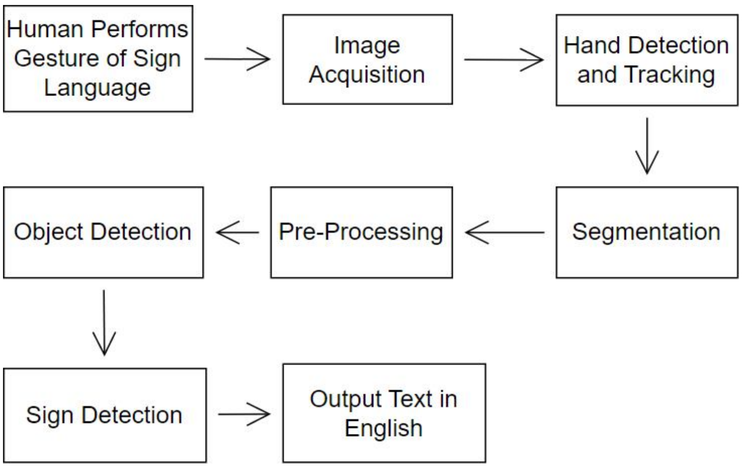


Fig.1. Block Diagram Representing working of Real Time Sign Language Detection System

IV. Dataset

Through the survey, it is observed that, although many data sets are available, they are mainly for alphabets and numbers. Also, it is observed that the sign language varies from region to region. Hence we chose to work on creating our own database which consists of common phrases and words in the Indian Sign Language as there are very limited applications which support ISL.For creating the dataset videos of each person was captures and images frames were extracted using the time module in python.
Time module in Python allows for the representation of time in code using a range of different types, including objects, integers, and texts. Time can also be used to wait while executing code or to assess the effectiveness of the code. It is utilized in this instance to introduce pauses between shots to allow for motions. The names of the picture files were generated using the uuid library. 128-bit ids help create random objects while ensuring uniqueness because they are generated based on time and computer hardware.
The existing data sets majorly concentrated on sign languages of alphabets. As we wanted to work on real time requirements of understanding the phrases and sentences conveyed by the deaf and dumb persons, for the

experiments, we created our own data sets. The generated dataset consists of 20 gestures for the following phrases and short sentences from the Indian Sign Language.

1.	Bright	2.	House	3.	Loan	4.	Thanks
5.	Child	6.	How Are You	7.	Love	8.	Toilet
9.	Difficult	10.	Indian	11.	Namaste	12.	Understand
13.	Good	14.	What Is The Time	15.	Sorry	16.	Vegetarian Food
17.	Hello	18.	Where	19.	Teacher	20.	Water

For each gesture, we prepared 12 videos of 12 different people from which later the frames were extracted. We extracted these images from videos in real time using tools developed using openCV and python and stored in their respective folders. This way we created a dataset consisting of a total of 1746 images for our experiments.

V. Pre processing

As we created our own dataset, each image has its own issues and so we performed extensive preprocessing operations on them to make them suitable for feature extraction.
Pre-processing is performed using the open CV tools. The operations performed in the sequence are:

- Orientation correction,
- Isolate Objects- segmentation
- Background Elimination,
- Flip: Horizontal and Vertical,
- Rotation: Between -17° and +17° ,
- Shear adjusted between ±15° Horizontal, ±12° Vertical,
- Brightness adjusted between -25% and +25%, Exposure between -25% and +25%
- Static Crop between 2-48%
- Horizontal Region between 9-75%
- Vertical Region Auto-Adjust
- Contrast enhancement using Adaptive Equalization
- Gray scale conversion: Applied

In preprocessing, we first extracted the images from the videos present in the dataset to create a more comprehensive dataset with all image data points. We checked the orientation of all data points to ensure there were no disimilarities. We then isolated the objects which in our case is the sign being performed and eliminated the background noise present. Then, we performed standard augmentation steps to increase the diversity in the dataset by applying flip, rotation shear and brightness. Then this newly augmentated data was put under static crop as well as horizontal and vertical adjustment to fit the frame. Lastly we applied contrast enhancement and grayscale to overcome any problems that may arise due to the camera quality, light reflections, shadows or any such real time dependencies.

VI. Recognition System.

For object detection in the given image, we proposed to use YOLO which stands for "You Only Look Once". We chose to use the versions of YOLO technologies as they are popular real- time object detection system used in computer vision applications. Here's a step-by-step explanation of how YOLO works for image recognition:
a. The input image is divided into a grid of cells. Each cell has a fixed size and aspect ratio. For each cell, YOLO predicts a fixed number of bounding boxes (usually 2-3). Each bounding box is defined by four parameters: x and y (the centre of the box), width, and height. For each bounding box, YOLO predicts the probability that the box contains an object and the class of the object. YOLO uses a softmax function to produce class probabilities for each bounding box. YOLO applies non-max suppression to eliminate overlapping bounding boxes with lower confidence scores. Only the highest-confidence bounding box is kept for each object. The final output of YOLO is a set of bounding boxes, each with its corresponding class and confidence score. YOLO can be trained on large datasets such as COCO or VOC to learn to recognize different classes of objects. During training, the model adjusts the weights of its layers to minimise the difference between predicted and actual bounding boxes. In order to improve the accuracy and speed of YOLO, various modifications have been proposed, such as YOLOv2 and YOLOv3, which use different architectures and training techniques.
b. The major update that has been done is to change the number of classes which was initially 7, has been updated to 20 signs . A total of 1746 data points were added in a dataset and the model will be trained on the same. After

setting up and updating the configuration, the model was trained in 10000 steps. After training, the model is loaded from the latest checkpoint which makes it ready for real-time detection.
c. After setting up and updating the configuration, the model will be ready for training. The trained model is loaded from the latest checkpoint which is created during the training of the model. This completes the model making it ready for real-time sign language detection.
Following the hand gesture data creation for the gesture recognition experiments, a labelled chart is created which is a representation of all the objects within the model, i.e., it contains the marker of each sign along with their id. The id will be used as a reference to look up the class name and all the information and path names are saved in a data.yaml file.

VII. RESULTS

A. Setup For The Experiment.

The dataset is created using Indian Sign Language where the signs are common phrases used in our daily lives. The dataset is created using the data acquisition method mentioned in Dataset section IV. This experimentation was carried out on a system with Windows 10 and above or a macOS BigSur 11.6.4 or later along with an Intel HD Graphics 6000 1536 MB graphics and 1.8 GHz Dual-Core Intel Core i5 processor. We also need a HP TrueVision HD camera with 0.31 MP and 640x480 resolution and programming environments such as OpenCV, Google Colab, GitHub API and Ultralytics API. OpenCV primarily provides functionality for real-time computer vision. It accelerates the use of machine vision in commercial products and provides common infrastructure for computer vision-based applications.

B. Implementation Details

1. For YOLOv5 Model

The same team that created the original YOLO algorithm released YOLO v5 in 2020 as an open-source project, which is now maintained by Ultralytics. The success of earlier iterations is built upon by YOLO v5, which also includes a number of enhancements and new features. In contrast to YOLO, YOLO v5 uses a more intricate architecture called EfficientDet, which is based on the EfficientNet network architecture (architecture illustrated above). YOLO v5 can achieve greater accuracy and better generalization to a larger variety of item categories because to the use of a more complicated architecture. The training data used to develop the object identification model differs between YOLO and YOLO v5. The PASCAL VOC dataset, which has 20 different object categories, was used to train YOLO. using the other hand, YOLO v5 was trained using D5, a larger and more varied dataset that consists of a total of 600 object types. The anchor boxes are created using a new technique in YOLO v5 called "dynamic anchor boxes." The ground truth bounding boxes are first grouped into clusters using a clustering method, and then the centroids of those clusters are used as the anchor boxes. As a result, the anchor boxes can match the size and shape of the identified objects more closely. The idea of "spatial pyramid pooling" (SPP), a kind of pooling layer used to lower the spatial resolution of the feature maps, is also introduced in YOLO v5. Since SPP enables the model to view the objects at various scales, it is employed to enhance the detection performance for small objects. SPP is used by YOLO v4 as well, however YOLO v5 makes a number of changes to the SPP design that enable it to perform better. Google Colab, which offers no-cost access to potent GPUs and doesn't require configuration, was used to train the model. We used a Roboflow.ai notebook that is built on YOLOv5 and employs pre-trained COCO weights. In order to train the upper layers of the model to recognize our classes, we included our dataset for Indian Sign Language and changed the number of training epochs as well as the stack size. It requires roughly 120 minutes to train a model for 250 epochs. Figure 2's graphs, which show several performance measures for both the training and validation sets, show how our model has improved.
Fig. 2 displays three different types of loss for the training and validation sets: classification loss, objectness loss, and box loss. The X-Axis displays the data point's epoch number, and the Y-Axis displays a percentage value in decimal form.
The box loss measures how well an object's center can be located by the algorithm and how well a predicted bounding box encloses an The mean average precision (mAP), which changes over the training epochs and achieves a value of 87.6% after the item, is shown in Figure 3.For the YOLOv5 model, we can see that the box loss value falls to less than 1% for training and less than 2% for validation after training for 250 epochs. The probability that an object exists in a suggested zone of interest is basically measured by objectness. For the YOLOv5 model, we can see that the objectness loss value drops to less than 0.6% for both training and validation after 250 epochs of training. If the objectivity is high, an item is probably present in the image window.

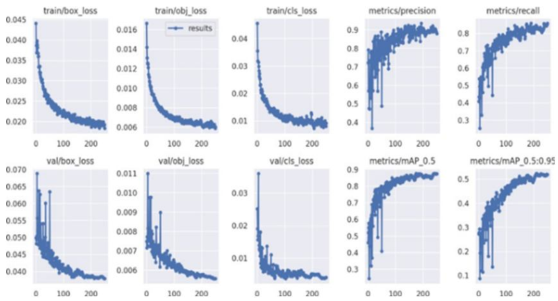


Fig. 2. Plots for the YOLOv5 model's training and validation set for box loss, objectness loss, classification loss, precision, recall, and mAP over the training epochs.

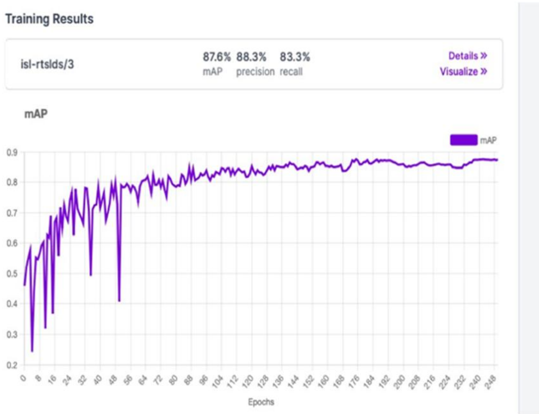


Fig.3. Graph showing mean average precision (mAP) for YOLOv5 model

How successfully the algorithm can determine the proper class of a given object is shown by the classification loss. For our YOLOv5 model, we can see that the value of classification loss reduces to less than 1% for both training and validation after training for 250 epochs.

We can also see the plots of recall and precision in Figure 2. A model's precision at the time of prediction is measured by its precision. All guessed positives are subtracted from the true positives. We can observe that 88% precision was attained for the YOLOv5 model. The recall serves as a gauge of how well our model detects True Positives. A 83% recall rate was attained. The mean Average Precision with an IoU (Intersection over Union) of 0.50, or 50%, is designated as mAP_0.5. The amount of a predicted bounding box that overlaps with the ground truth bounding box, divided by the combined area of both bounding boxes, is used to calculate intersection over Union (Iowa). The mean Average Precision (mAP_0.5:0.95) has an IoU interval of 0.50 to 0.95.

2. For YOLOv7 Model.

The depth of the model is scaled up in the architectural diagram, which raises the quantity of convolutions. It is necessary to scale the model's depth before scaling the transmission layer with the relevant width scaling factor. For the purpose of identifying objects of various shapes, anchor boxes are a collection of preconfigured boxes with various aspect ratios. With nine anchor boxes, YOLO v7 can detect a larger variety of item forms and sizes than earlier iterations, which helps to lessen the amount of false positives. The implementation of a new loss function termed "focal loss" in YOLO v7 is a significant improvement. Standard cross-entropy loss function, which is known to be less successful at identifying small objects, was utilized in earlier iterations of YOLO. By de-weighting the loss for well-classified samples and concentrating on the challenging examples—the difficult-to-detect objects—focal loss combats this problem. Additionally, YOLO v7 has a greater resolution than earlier iterations. Compared to YOLO v3, which processed photographs at a resolution of 416 by 416 pixels, it processes images at a level of 608 by 608 pixels. YOLO v7 can detect tiny objects with greater precision thanks to its better resolution.

The quickness of YOLO v7 is one of its key benefits. 155 frames per second is substantially faster than other cutting-edge object detection systems in processing images. Even the baseline YOLO model could process at a top speed of 45 frames per second. This qualifies it for delicate real-time applications like surveillance and autonomous vehicles, where faster processing speeds are essential.

The input was convolved with the 2 and 4 blocks of the 3x3 convolution using the same channel multiplier, and two more connections to the block were made. The input is fed directly into the bottom block using 1x1 convolution. At the base of the block, all of the features are concatenated, and 1x1 convolution When building a successful network, some properties, such as the number of calculations and computational density, are typically optimized. The YOLOv7 architecture is built on the ELAN (efficient layer aggregation network) technology. The shortest and longest gradient paths are managed by LAN to build an efficient network, which is necessary for deeper networks to converge and train effectively. ELAN's modules are shown in the diagram below. The input was convolved with 2 and 4 blocks of 3x3 convolution using the same channel multiplier to create two more connections to the block, but it is fed directly into the bottom block using 1x1 convolution. towards the block's base While building an efficient network, the amount of computations, computational density, and a few other variables are typically tuned. The YOLOv7 architecture is based on ELAN (efficient layer aggregation network). LAN considers building an efficient network by managing the shortest and longest gradient paths in order to let deeper networks converge and train effectively. The ELAN modules are shown in the diagram. The input was convolved with the 2 and 4 blocks of the 3x3 convolution using the same channel multiplier, and two more connections to the block were made. The input is fed directly into the bottom block using 1x1 convolution. At the base of the block, all of the features are concatenated, and 1x1 convolution is applied to extract rich information. Fig.4. displays three different types of loss for the training and validation sets: classification loss, objectness loss, and box loss. For the YOLOv7 model, we can see that the box loss value falls to less than 1% for both training and validation after 200 epochs of training. The value of classification loss drops to less than 0% for both training and validation after 200 training epochs, and the value of objectness loss decreases to less than 0.5%.

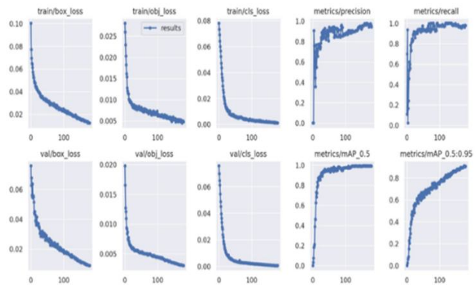


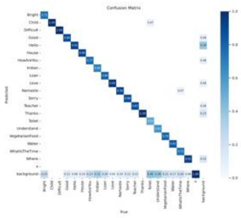
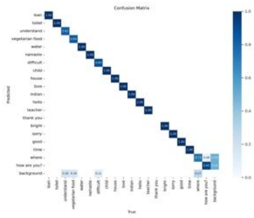
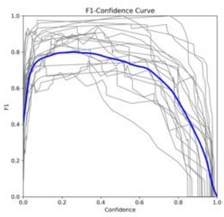
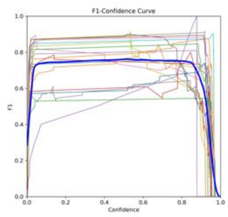
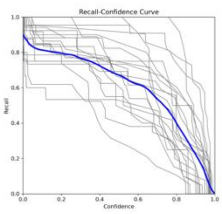
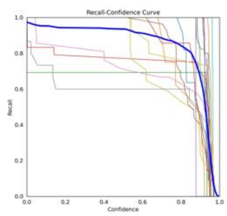
Fig. 4. Plots of box loss, objectless loss, classification loss, precision, recall and mean average precision (mAP) over the training epochs for the training and validation set for YOLOv7 model.

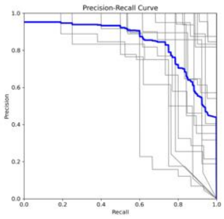
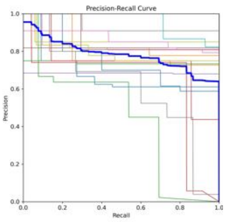
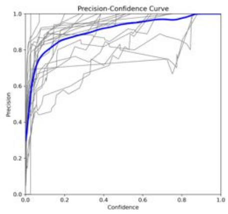
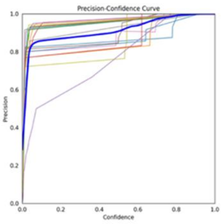
The developed models were able to detect real time sign language. The system was trained using the custom dataset created which consisted of 20 signs of Indian Sign Language which were: bright, child, difficult, good, hello, how are you, house, India, loan, love, Namaste, sorry, teacher, thanks, toilet, understand, vegetarian food, water, what is the time, where. The output video frames of the real time test environment of various phrases are shown in Fig. 5 with text showing the result of recognition.

Fig.5 Detection of 20 gestures of the ISL (Indian Sign Language) in real time

C. Result Analysis

TABLE I. A COMPARATIVE STUDY BETWEEN YOLOV5 AND YOLOV7.

Parameters	**YOLOv5**	**YOLOv7**
Accuracy	The YOLOv5 model has an accuracy of 87.6%	The accuracy we achieved is 96.5%
Precision	The precision of our model is 88.3%	The precision of our model is 87.5%
Recall	The recall of our model is 83.3%	The recall of our model is 96.6%.
Confusion Matrix	We have added a 21st class x in order to confuse the system and increase precision.	We didn't add an additional empty class; the performance difference was un-noticeable
Data Pre-processing	We have added various pre-processing and augmentation steps to our raw dataset and trained the model on a total of 8000 data points.	We have not carried out any data pre-processing.
FPS	The signs are getting detected at the minimum of 4fps	The signs are detected properly via video format and real-time at 3fps
Signs detected	Almost all 20 signs are detected, each having a relatively high accuracy.	Over 19 signs are getting perfectly detected, others are showing low confidence
Compatibility	YOLOv5 is compatible with both android and iOS applications.	YOLOv7 is only compatible with iOS however it causes overheating.
Confusion Matrix	 Fig.6. Figure showing Confusion Matrix of YOLOv5 model.	 Fig.7. Figure showing Confusion Matrix of YOLOv7 model
F1 confidence	 Fig.8. Figure showing average F1 confidence: all classes 0.8 at 0.258	 Fig.9. Figure showing average F1 confidence: all classes 0.76 at 0.513
Recall-Confidence curve	 Fig.10. Figure showing Recall-Confidence:all classes 0.90 at 0.0	 Fig.11. Figure showing Recall-Confidence:all classes 0.97 at 0.0

Precision recall curve	 Fig.12. Figure showing Precision-Recall curve: all classes 0.84 mAP@0.5	 Fig.13. Figure showing Precision-Recall curve: all classes 0.77 mAP@0.5
Precision confidence	 Fig.14. Figure showing Precision-Confidence curve: all classes 1 at 0.906	 Fig.15. Figure showing Precision-Confidence curve: all classes 1 at 0.994

VIII. CONCLUSIONS AND FUTURE WORK

Sign language detection is important as we are not able to communicate with deaf and mute people and real time sign conversion systems with good accuracy and performance for Indian Sign Language Detection were not available. In the systems developed, sign detection of gestures Indian Sign Language can be easily done in real time using YOLO. The systems have been trained to recognize simple signs of sign language such as Bright, Child, Difficult, Good, Hello, how are you, Loan, Love, Home, Where, Water, Understand, Indian, what is the time, Namaste, Toilet, Vegetarian Food, Teacher, Sorry and Thank you. As the systems detect these signs in real time, the communications barrier between the disabled and abled can be easily crossed.This study compared and contrasted the YOLOv5 and YOLOv7 object detection models on 20 gestures of Indian Sign Language dataset. As shown in Fig 17,the YOLOv5 and YOLOv7 models were compared in terms of Accuracy, Precision, Recall, F1-confidence,Recall-Confidence Values,Precision Confidence values,Precision-Recall values as well as other factors like signs detected, frames per second and compatibility. We conclude that the YOLOv7 performs better in all respects and is also time efficient for real time applications.

For future work, we plan on enlarging our dataset so as to improve accuracy as well as increase the number of signs the systems can recognize. We also plan to make the dataset more diverse and include the sign languages used in various regions of India and the world. The systems would then be able to recognize regional and local languages as well. We also plan to add the functionality of prediction of the next gesture using Natural Language Processing for faster and better interpretation. This system can also be used as an API with various virtual assistants like Apple Siri and Amazon Alexa in the future.

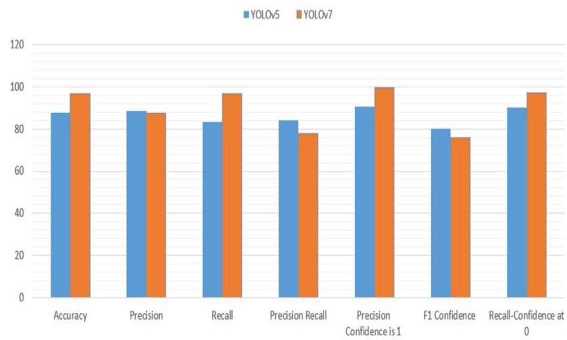


Fig.16. Figure showing comparison of various parameters for YOLOv5 and YOLOv7 models.

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Role of Various Techniques to Identify the Emotional Intelligence: A Review

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***Abstract*— Emotional intelligence has become a crucial factor in solving human's problems. Researchers in various fields have studied emotional intelligence and found that the construct is related to various intrapersonal and interpersonal factors, such as mental health, relationship satisfaction and job performance. This article provides an overview of current research on emotional intelligence and the many scientific techniques for capturing and analyzing emotion. In the psychological approach, various case studies based on psychometric tests are used to analyze emotional intelligence.**

***Index Terms*— EEG, Scientific Approach, Psychological Approach, Behavioral Problems, Linear Discriminant Analysis, cognitive activity**

I. Introduction

The primary objective of this paper is to understand Emotional Intelligence (EI) as it has different interpretations for different authors due to their individual findings that are based on different situations. These differences have led to the development of various models and techniques that are used to identify EI and measure EI. Accordingly the secondary objective of this paper is to study the scientific and psychological approaches in identifying emotional intelligence. With these objectives, our paper aims to develop a model that shows the EI Acquisition Techniques and present the important findings of previously published papers with respect to various human qualities and their association with EI under different parameters. The paper is an attempt to present some of the related best and most promising research in the EI field. A review of such research can help understand EI along with the approaches of identifying EI and accordingly present a model or a tabular review.
The concept of Emotional Intelligence (EI) was contrive by psychologists Peter Salovey and John Mayer (Mayer & Salovey, 1990), who defined it as “the ability to monitor one’s own and other's feelings and emotions, to discriminate among them and to use this information to guide one’s thinking and actions”. Later, the authors revised the definition of EI as the ability to perceive emotion, integrate emotion to facilitate thought, understand emotions and regulate emotions to promote personal growth (Mayer & Salovey, 1997). This conceptualization represents the ability model of EI. Mayer & Salovey (1990) are recognized for their great contribution in the emergence of EI.

A. Approaches to Emotional Intelligence

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The literature on Emotional Intelligence (EI) often identifies three main models: the ability model, the trait model, and the mixed model. Here's a brief overview of each of these models

- *Specific-Ability Approaches to EI:*

Specific-ability models focus on particular aspects or abilities related to emotional intelligence, such as perceiving emotions in faces or understanding subtle emotional meanings. These models assess EI in-depth in a specific area, allowing a better understanding of how individuals reason about that particular subject matter. They may involve assessments that measure specific aspects of EI, like recognizing emotions in facial expressions.

- *The Four-Branch Model of Emotional Intelligence:*

The Four-Branch Model of EI, proposed by Mayer and Salovey, presents emotional intelligence as an integrative approach.It categorizes emotional abilities into four branches:Perception and Appraisal of Emotion: Involves the ability to recognize and evaluate emotions, such as perceiving emotions in facial expressions.

Using Emotions to Promote Thinking: This branch includes using emotional experiences to enhance cognitive processes, like using a low-energy emotion to focus on a task. Understanding and Reasoning About Emotions: Involves the ability to comprehend and describe emotions using language and understanding rule-governed emotional experiences. Management and Regulation of Emotion: Focuses on controlling and regulating one's own emotions and helping others manage their emotions.

The model predicts various implications for an individual's life, such as their ability to cope with emotions effectively and develop expertise in specific emotional areas.

- *Mixed-Model Approaches to EI:*

Mixed-model approaches to EI have broad definitions and encompass a wide range of qualities, capabilities, and dispositions related to emotional and social intelligence. These models may include "non-cognitive capabilities" or "competencies," as well as traits from the personality domain.Measures in this category assess various EI attributes but may also incorporate other factors like happiness, stress tolerance, self-regard, adaptability, impulsiveness, social competence, creativity, flexibility, and intuition. These approaches interpret EI in a more inclusive and mixed manner than the specific-ability models.

In summary, specific-ability models focus on assessing particular aspects of emotional intelligence in depth, while mixed-model approaches take a broader perspective by including a wide range of emotional and social attributes, competencies, and traits in their assessments of EI. Both approaches offer valuable insights into understanding and measuring emotional intelligence.

II. Emotional Intelligence Through Scientific Approach

The term EI was first coined more than 25 years ago and, as the name suggests, it refers to a form of intelligence that is not about how we process information or think, but how well we deal with our emotions. It is a combination of two aspects ie. Emotions and intelligence. There are scientific methods available for identifying the emotions in a person. Our paper focuses on the details of the scientific approach as shown in figure 2 by way of classifying the various techniques through electronic equipment in order to identify the emotions. Emotions are known to have a prominent role in analyzing the state of mind of a person and in the interaction and communication among people. In recent times recognition and classification of human emotions from Electroencephalogram (EEG) has led to the development of brain computer interfaces which empowers computers in understanding human emotions [30].

Numerous studies on engineering approaches to automatic emotion recognition have been performed in the past few decades. They can be categorized into three main approaches. The first kind of approaches focuses on the analysis of facial expressions or speech. These audio-visual based techniques allow non contact detection of emotion, so they do not give the subject any discomfort. However, these techniques might be more prone to deception, and the parameters easily vary in different situations. The second kind of approaches focuses on peripheral physiological signals. Various studies show that peripheral physiological signals changing in different emotional states can be observed on changes of autonomic nervous system in the periphery, such as electrocardiogram (ECG), skin conductance (SC), respiration, and pulse.

In comparison with audio-visual based methods, the responses of peripheral physiological signals tend to provide more detailed and complex information as an indicator for estimating emotional states. The third kind of approaches focuses on brain signals captured from central nervous system such as electroencephalography (EEG), electrocorticography (ECoG), and functional magnetic resonance imaging (fMRI). Among these brain signals, EEG signals have been proven to provide informative characteristics in response to the emotional states. Since Davidson et al. suggested that frontal brain electrical activity was associated with the experience of positive and negative emotions, the studies of associations between EEG asymmetry and emotions have been received much attention.

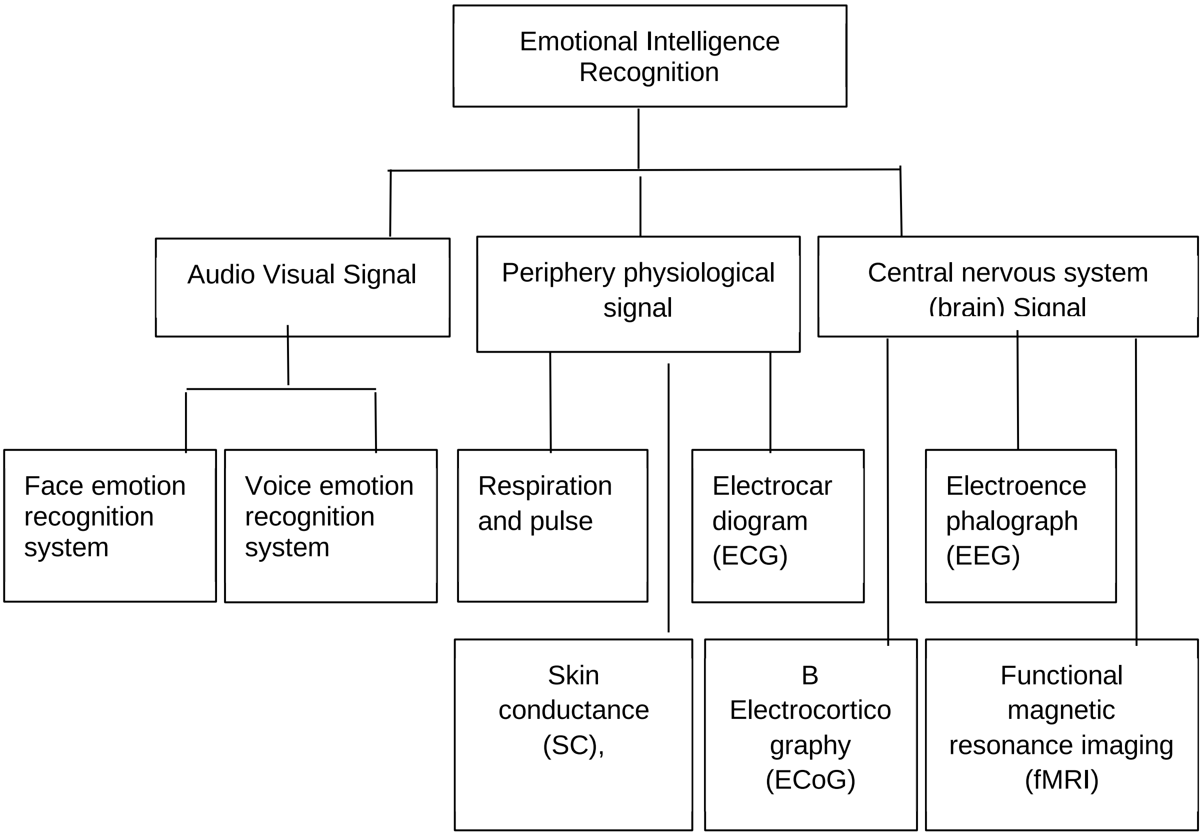

Fig 1.Different Scientific Techniques used in EI

III. LITERATURE REVIEW

The concept of emotional intelligence has become so popular in the management literature that it has become imperative to understand and leverage it for the sake of enhancing the capacity of human capital in organizations. As the pace of change is increasing and world of work is making ever greater demands on a person's cognitive, emotional and physical resources, this particular set of abilities are becoming increasingly important. Since majority of the concerns in organization involve people in different roles, emotional intelligence must become a determining factor for their effective management. It has also been found that ultimately it is the emotional and personal competencies that we need to identify and measure if we want to be able to predict performance at workplace resulting in its effectiveness, thereby enhancing the worth of the human capital.

In this scenario the competencies possessed by the people will have a bearing on the extent to which they can actualize their emotional intelligence. This paper discusses two approaches for EI, for which we propose two different types of reviews ie scientific approach review and psychological approach review; as follows.

A. Literature Review of Scientific Approach

The existence of challenges and problems faced by today's young generation has been corroborated through various papers. Also the fact that EI has been acknowledged as a scientific way of dealing with the situation, makes it a tool to identify, analyze and cognize the children's problems for further psychological suggestions and advice. For the cognizance of children's problems, the scientific approach as discussed above is instrumental in identifying six types of emotions such as happy, surprise, disgust, fear, anger and sad. Various scientific approaches, like Trait Emotional Intelligence Questionnaire-Child, audio visual signal like audio segmentation and speaker tracking front-end along with an emotion recognition back-end, periphery physiological signal and central nervous system signal with this EEG signals are used for the purpose.

In paper [7] the author is conducting a longitudinal study in primary school children to investigate how personality traits relate to resting state EEG patterns. This research aims to fill gaps in understanding the developmental aspects of this relationship and extend the investigation beyond fMRI to explore the electrophysiological underpinnings. By combining EEG data and parental assessments of personality, the study seeks to gain a more comprehensive understanding of the interplay between personality and brain activity in young individuals.

The authors [9] explored various methods to analyze the textual content of student-tutor dialogues to predict emotions such as boredom, engagement, confusion, and frustration. The findings indicated that certain linguistic, psychological, and cohesion-based features in the text were highly predictive of students' emotional states, demonstrating the potential for using natural language processing and machine learning techniques to understand and predict emotions in educational settings.

Numerous studies on engineering approaches to automatic emotion recognition have been performed in the past few decades. They can be categorized into three main approaches. The first kind of approaches focuses on the analysis of facial expressions or speech [11]; the second kind of approaches focuses on peripheral physiological signal and the third kind of approaches focuses on brain signals captured from central nervous system such as electroencephalography (EEG), electrocorticography (ECoG), and functional magnetic resonance imaging (fMRI).

In paper[14] the categories of recognition of emotions with three different modalities they are:

- Uni-modal
- Bi-modal
- Multimodal

The uni-modal emotion recognition includes only one modality as input to the system. The bimodal emotion recognition included two modality as input to the system, were as multimodal can include more than two modalities for recording the signals as input to the system [14]. Study of emotion is a part of behavioral science which comes under the umbrella of cognitive neuroscience. Brain being central processing unit of human body its study through various techniques helped researchers to understand cognition.

In the paper[17] authors have determined the systemic correlation between the indicators of cognitive activity and the parameters and development of emotional intelligence (EI) and the formation of typical behavior strategies in older preschool children of three functional types (FT-1, FT-2, and FT-3), including subjects with low (LHPA), medium (MHPA), and high (HHPA) levels of habitual physical activity. They revealed the EI features typical of each functional group of children and observed a strong negative correlation between the indicator of habitual physical activity HPA and the total EI score.

A variety of life functions and cognitive processes (CPs) have been identified in cognitive informatics, psychology, cognitive science, and neurophilosophy. This paper [18] attempts to develop a layered reference model of the brain (LRMB) that formally and rigorously explains the functional mechanisms and CPs of natural intelligence.

In the paper [19]authors found that children with higher reported externalizing behaviors exhibited significantly greater relative right frontal EEG activity at rest compared with children with little to no externalizing behavioral problems. There was, however, no relation between emotional intelligence and the pattern of resting frontal EEG activity. Thus, emotional intelligence and the pattern of frontal EEG activation at rest are independent predictors of externalizing behaviors in children. Findings also suggest that individual differences in emotional intelligence may not be based on differences in levels of emotional regulation or the generation of positive affect as reflected in frontal EEG asymmetries, but rather other social and cognitive competencies required for adaptive behavior. Externalizing behaviors such as aggression and delinquency are a pervasive form of childhood maladjustment which are costly to the individual, family, and society.[19]

In paper [25], they propose a system that detects second-level emotional states of children using hour-level audio recordings. The proposed system consists of an audio segmentation and speaker tracking front-end along with an emotion recognition back-end. Supervised support vector machine is used in the front-end to improve its robustness to short and inconsistent child speech pattern and end-to-end deep learning is used in the emotion recognition back-end to improve its robustness to noise and segmentation error. They observed that the overall correct segmentation and classification rate is 93.76%.

In this work [28] authors describe an interactive life-like facial display (FACE) and a supporting therapeutic protocol that will enable us to verify if the system can help children with autism to learn, identify, interpret, and use emotional information and extend these skills in a socially appropriate, flexible, and adaptive context. The therapeutic setup consists of a specially equipped room in which the subject, under the supervision of a therapist, can interact with FACE. The android display and associated control system has automatic facial tracking, expression recognition, and eye tracking. This survey [29] is the result of a research carried out among students in the first grade of primary school concurrently with a training program intended to develop emotional abilities in children. The following methods were applied during this study: observation, talk, questionnaire, pedagogical experiment.

In this paper[30] the author the preprocessed signals from the DEAP dataset are used for classifying human emotions. The classification accuracy using an SVM classifier with RBF kernel and a 10 fold cross validation for different electrode combinations. It is found that the classification accuracies vary upon choosing different combinations of electrodes. A maximum classification accuracy of 74.062 % was obtained using the 16 electrode combination.

In their paper[31] the author compared the performance of linear and nonlinear classifiers for emotion classification. The authors observed that the nonlinear classifiers produce better classification results. They obtained and an average classification accuracy of 66% using Linear Discriminant Analysis (LDA), 69.4% using Neural Networks (NN) and 72% using Support Vector Machine (SVM). Soleymani et al.

TABLE I: SUMMARY OF DATABASES FOR STUDYING EMOTIONAL INTELLIGENCE

Sr.No	Name of database	Total Samples
1	DEAP Dataset [11]	32
2	Enterface Dataset[12]	122
3	PhysioNet[13]	109
4	BCI Competition IV[14]	20

TABLE II: THE VARIOUS TECHNIQUES OR METHODS USED TO STUDY EMOTIONAL INTELLIGENCE.

Sr. No	Technique	Result
1	Linear Discriminant Analysis	69.4% %
2	Support Vector Machines	66.51%
3	Fuzzy Integral Fusion	87.59%
4	Filter Bank Common Spatial Pattern algorithm	71.30%

Table 1 and 2 summarizing techniques and databases related to the study of emotional intelligence

B. Literature Review of Psychological Approach

The review of previous research paper emphasizes on the relationship between ET and human qualities as is shown in Table 3. The study indicates that there are various human qualities as a result of adverse situation which make a person more emotional in nature.

TABLE III: LITERATURE REVIEW OF VARIOUS HUMAN QUALITIES AND THEIR ASSOCIATION WITH EI UNDER DIFFERENT PARAMETERS.

Sr. no	Title of paper	Aim	Result
1	The Relationship between depression and emotional intelligence among a sample of Jordanian children	To examine the relationship between depression and emotional intelligence among children.	Studies indicated that depressed male tend to have higher emotional intelligence than females.
2	Emotional intelligence, victimization, bullying behaviors and attitudes	To examine the relationship between Emotional intelligence, victimization,	Results revealed significant associations between bullying, victimisation, pro-victim attitudes and the EI dimensions Emotion

		bullying behaviors and attitudes	Recognition and Expression, Emotion Management and Control, Understanding the Emotions of Others and Emotions Direct Cognition
3	The effects of the growth environment on the adolescents' self-esteem, general intelligence and emotional intelligence	This paper aims to investigate the level of self-esteem, general intelligence and emotional intelligence of adolescents raised in foster care compared with a group of adolescents raised in normal family environments.	The results are showing differences between the two categories: adolescents raised in a normally family environment had higher marks at self-esteem, general and emotional evaluations.
4	Emotional intelligence mediates the relationship between insecure attachment and subjective health outcomes	This study investigated the mediating role of emotional intelligence in the relationship between adult insecure attachment and subjective ill health.	Results support a model in which insecure attachment is associated with deficits in emotional intelligence, which in turn is related to poorer health outcomes.
5	Behavior problems of children with autism spectrum disorder ASD and perceived stress in their caregivers: The moderating role of trait emotional intelligence?	This study is, we believe, first to examine whether Trait emotional intelligence might moderate the effect of child behaviour problems (CBP) on caregivers' psychological functioning.	Data yielded a direct relationship between child behaviour problems and Trait emotional intelligence, and caregivers' perceived stress scores ;however, no interaction effect was observed. These data reflect the fact that caregivers of children with more behaviour problems are at greater risk for psychological distress, as are caregivers with lower TEI
6	The Relationship Between Spiritual Intelligence and Emotional Intelligence with Life Satisfaction Among Birjand Gifted Female High School Students	This research determines the relationship between Spiritual Intelligence (SI) and Emotional Intelligence (EI) with Life Satisfaction (LS) among gifted female high school students in Birjand.	The results revealed that there is generally no meaningful relation between SI and LS, but a meaningful relation between EI and LS does exist.
7	Relationship between Emotional Intelligence and Educational Achievement	The research purpose is to look into the relationship between emotional intelligence and academic achievement.	Significant relation was found between emotional intelligence (self awareness, self management, social awareness and relationship management) and academic achievement.
8	Studying the relation between emotional intelligence and self esteem with academic achievement	It is a descriptive-correlative study and it is aimed to study the relation between emotional intelligence and self esteem with academic achievement.	Results showed that emotional intelligence and self esteem of students had no effect on their academic achievements.
9	Perfectionism and emotional intelligence: A test of the 2 × 2 model of perfectionism	The current study tested the interactive and main effects of two key aspects of perfectionism – personal standards and evaluative concerns – on emotional	Results from moderated regression analyses revealed similar patterns: both PS and CM were associated with emotional self-regulation (ERS), appraisal of others' emotions (AEO) and appraisal of self-emotions (AES), but only PS was associated with utilization of emotions for problem solving (UEPS).

10	Emotional intelligence, alexithymia, and interpersonal problems	The aim of this study was to examine the relations of emotional intelligence with alexithymia and interpersonal problems in a sample of students.	The results revealed that emotional intelligence was negatively associated with both alexithymia and different aspects of interpersonal problems including assertiveness, sociability, intimacy,and responsibility.
11	Relation between emotional intelligence and perceived stress among female students	The purpose of this study was to examine whether emotional intelligence is associated with perceived stress.	Regression analysis also revealed multiple correlations between TEI and perceived stress. Regression coefficient showed that emotional intelligence significantly predicted perceived stress.
12	Disruptive behaviour of students in primary education and emotional intelligence	This study analyses the relation between disruptive behaviours and the emotional abilities of children in primary education.	In conclusion, the lack of emotional abilities is a factor involved in disruptive behaviours, especially the capacity for emotional self regulation and self control.
13	Human Abilities: Emotional Intelligence	discuss the origins of the EI concept, define EI, and describe the scope of the field today.	Pivotal in this review are those studies that address the relation between EI measures and meaningful criteria including social outcomes, performance, and psychological and physical well-being.
14	Pivotal in this review are those studies that address the re- lation between EI measures and meaningful criteria including social outcomes, performance, and psychological and physical well-being.	The aim of the present study is to offer an exploration of the predictive validity of cognitive ability and emotional intelligence (EI) on scholastic achievement in a sample of Italian school-aged children (8–11 years).	results showed that trait EI had a unique power to predict math performance. Similarly, the analyses showed an interaction between emotion recognition ability and cognitive ability in predicting both language and math performance. Differences between the two emotional measures were discussed.
15	Classroom emotional intelligence and its relationship with school performance	The aim of this work was to develop a questionnaire for measuring group EI (G-TMMS) in educational contexts.	The G-TMMS showed a one-factor structure.It also demonstrated to have adequate internal consistency, temporal stability, and convergent validity. Moreover, group EI was associated with higher group school performance.
16	Connecting Emotional Intelligence and Academic Achievement in Adolescence: A Systematic Review	paper focuses on the connection between emotional intelligence (EI) and academic performance in compulsory education, by examining the existent research.	The results refer to the aims of research,models and measures of EI, measures used to assess academic achievement, dimensions of EI related with academic performance and potential influential factors on EI- academic achievement relationship. Studies generally aimed to take a more in-depth look at the relationship between different dimensions of EI and academic achievement in adolescents.
17	Ability emotional intelligence, trait emotional intelligence, and academic success in British secondary schools: A 5 year longitudinal study	This study examines the long-term effects of ability- and trait EI on academic performance for British adolescents.	Results show that the importance of ability EI resides in the fact that it moderates the effect of cognitive ability on performance in Year 11. Trait EI has a direct effect on Year 11 performance for boys only. This suggests that initiatives that help to develop ability EI and increase trait EI offer educators opportunities to improve educational achievement.

18	The relationship of trait emotional intelligence with academic performance: A meta-analytic review	aimed to assess the validity of trait emotional intelligence (trait EI) for predicting academic performance.	This meta-analysis has provided the first quantitative review of the association between trait EI and academic performance. The meta analysis yielded robust evidence of modest to moderate validity of trait EI for predicting academic performance.

Table 1 lists eighteen papers that have well defined aim and result. This listing has been crucial for our work and defining the future course of action. The cognition of emotions and intelligence with psychological approach along with its correlation to various factors, gives an insight into the areas of application and its benefits.

IV. Conclusion

The challenges and problems faced by today's young generation have been well-documented in various studies. Emotional Intelligence (EI) has emerged as a valuable scientific tool to address these challenges, providing a systematic approach to identifying, analyzing, and understanding children's emotional issues

The scientific approach discussed in this context focuses on recognizing six fundamental types of emotions: happiness, surprise, disgust, fear, anger, and sadness. To achieve this, researchers employ a range of scientific methodologies and tools, including the Trait Emotional Intelligence Questionnaire-Child, audio-visual signal analysis, physiological signal monitoring, and most notably, Electroencephalogram (EEG) data.

In essence, the integration of emotional intelligence assessment with EEG-based emotion recognition techniques represents a promising avenue for better understanding and addressing the emotional needs and challenges of today's youth, ultimately contributing to their overall psychological well-being.

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Multi Model Machine Learning Approach for Predicting Mental Health Outcomes

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***Abstract*— The proposed metric capacity unit methodology to classify patients' mental disorders based on their posts and relevant comments on Twitter is a unique and innovative approach to addressing the issue of leveraging machine learning algorithms for e-health. The aim was to investigate the effectiveness of different machine learning models for predicting mental health outcomes. Specifically, we compared the performance of a traditional single-model approach with a novel multimodal approach that combines multiple models to enhance predictive accuracy. Furthermore, the multimodal approach was particularly effective for predicting complex mental health outcomes that are difficult to capture with a single model. In addition, the study also used visualization techniques to provide explainability to the models used in the multimodal approach. This helped to understand how different models contribute to the overall prediction and identify which features were most important for predicting mental health outcomes.**
Overall, this unique approach has the potential to greatly impact the field of e-health and mental health, by leveraging the power of social media and machine learning algorithms to diagnose and address mental health issues in a more efficient and accessible manner.

***Index Terms*— Natural Language Processing (NLP), Mental Health, Multimodal Learning, BERTViz.**

I. INTRODUCTION

Social media has become an integral part of our daily lives, with users posting and communicating an incredible amount of information every day. This connectivity has also made stress more visible and prevalent than ever before. [2]With platforms like Twitter, Reddit, and Facebook, researchers have access to a wealth of data to study the worries and stresses of people worldwide.
Machine learning (ML) algorithms have proven to be effective in the diagnosis and treatment of internal diseases. The pattern recognition capabilities of ML, combined with big data analysis, can provide sophisticated and accurate results. The objective of this research paper is to investigate the application of several machine learning algorithms - including Decision Trees, Support Vector Machines, Naïve Bayes, Logistic Regression, and k-nearest Neighbor classifiers - for the analysis of the mental health condition of a specific group of individuals, by studying their social media posts.
Our research aims to provide a more accessible and efficient way to diagnose and address mental health issues globally[4][5]. By leveraging the power of big data and deep learning techniques, we hope to develop a sophisticated model for diagnosing mental health issues based on social media data. This research has the potential to revolutionize the field of e-health and improve the lives of people suffering from mental health issues.[6]

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II. Overview

A. Motivation

Social media platforms, such as Twitter, have become a major source of emotional expression for individuals around the world. By analyzing tweets, researchers can gain insights into the emotional states of people in different contexts, such as during a pandemic, natural disaster, or political event. Emotion prediction based on tweets can have practical applications in fields such as marketing, customer service, and public opinion analysis. For example, The ability to predict emotions can be advantageous for companies who wish to track customer attitudes towards their products, or for political campaigns who want to assess the public's perception of their candidate or proposed policies. Emotion prediction can be useful in mental health research and treatment. By analyzing the emotions expressed in tweets, researchers and clinicians can gain insights into the emotional states of individuals and potentially identify those who may be at risk for mental health problems. Predicting emotions based on tweets can also have broader implications for understanding human psychology and social behavior[7].

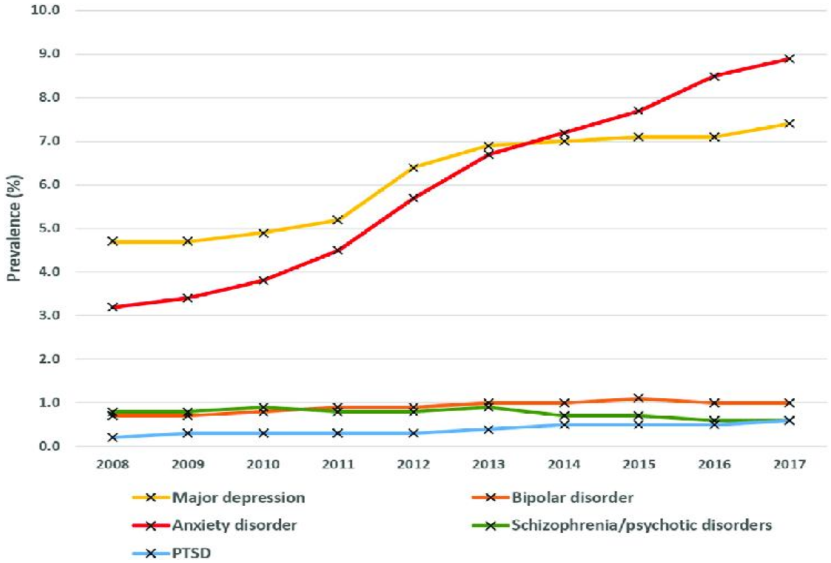

Fig 1. Cases Per Year

B. Problem Statement

Mental health conditions are a growing concern in today's society, affecting a significant portion of the population. Depression, [10] anxiety, and loneliness are among the most common mental health conditions that can have serious consequences if left untreated, including a negative impact on physical health, social relationships, and quality of life.[8] Social media has become an increasingly popular platform for communication and interaction, with billions of people using it every day. The vast amount of data generated by social media provides a unique opportunity to detect and predict mental health conditions in individuals, potentially enabling early intervention and prevention of these conditions. The goal is to develop a system that utilizes ML techniques to predict mental health conditions based on social media chats. Our system utilizes multimodal capabilities[13], incorporating data from multiple sources such as text, audio, and images, to enhance the accuracy and reliability of the predictions. This information is then used to provide audit prescriptions, including personalized recommendations for intervention and referral to mental health professionals if necessary.

C. Objectives

- To predict the emotion of a person based on social media and then predict if the person is suffering from any mental condition
- To check if proper dosage is given for a particular mental health condition
- Enhance the accuracy of the outcome by employing various techniques and strategies.
- An interface that is easy to use and navigate, which enhances the user experience.
- Improve the efficiency of prediction in this domain
- Visualizations in our system can help provide explainability to the models used in the multimodal approach

III. THEORY

Through an extensive review of IEEE papers cited in our references, we have come to the conclusion that detecting psychological stress in online posts is a highly sensitive application that requires the ability to interpret models accurately.[3]Through our use of emotion-based models, we have achieved results that are on par with the latest BERT model. [16]Additionally, we have developed an interactive visualization feature that improves the interpretability of our results. These unique features of our approach make it an innovative solution to the challenge of detecting psychological stress in online posts.

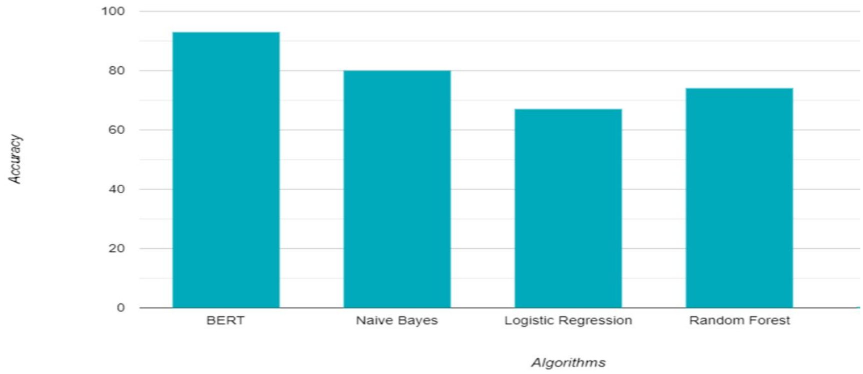

Fig 2. Accuracy Variation

A. Survey of Existing Systems

To create this system, we tested out BERT and DistillBert Models. This paradigm is one of the most well-known and frequently employed ones in the study of sentimental and mental disorders. To the best of our knowledge, no previous research project in this industry has attempted to undertake a comprehensive analysis of both sentiment and mental health disorders in a combined manner, according to our study of reference materials, and the majority of projects or businesses only use traditional sentiment analysis or only use social media data, including Twitter, to predict mental health disorders. After analyzing the existing literature, we found that [11] Naive Bayes, Logistic Regression, and Random Forest were the most popular models for sentiment and mental health disease prediction. However, it was noted that these models did not perform as well as the BERT model. ML models like Naive Bayes for sentiment analysis had an accuracy of 75-80\%. [1] The accuracy of the Logistic Regression and Random Forest algorithms for predicting mental health disorders was 75.17 percent and 76.31 percent, respectively. BERT, which uses fine-tuning and hyperparameter tuning, had a slightly higher accuracy here 81.9 percent. [12] The adaptability of the BERT model stems from its ability to recognize intricate patterns in textual inputs and its ability to focus on certain tasks, and the fact that it has already been taught, making it a good place to start for many natural language processing jobs.

B. Limitations and Research Gap

Since the majority of the currently utilized systems employed dated and common techniques for their models, they are not particularly effective. After being run, these models provide a relative accuracy that is lower. The current model does not yield significant findings, having an average precision of only 71\% [20]. Not only that, but other parameters, including the total loss, also show a significant decline. Our proposed system, in contrast to existing systems, utilizes new, faster transformer-based algorithms that are not commonly used in mental health prediction.[9] Additionally, our model includes multimodal capabilities, providing explainability and visualization that are lacking in many existing models [19]. Through our analysis of IEEE/Springer papers, we have identified flaws and drawbacks in existing research that our proposed system aims to address. By incorporating these advanced features, our system aims to provide more accurate and precise results, ultimately improving the overall effectiveness of mental health prediction and treatment.

C. Project Contribution

Team 1: Requirements and Planning

The problem statement was identified during the project's first phase, which also included careful requirement collection. One team member led the team in identifying the project goal of predicting mental health based on

social media data, while two other members conducted requirement gathering. The team worked together to prioritize and carefully collect the necessary requirements and made sure all fields were maintained during development. Good planning and record-keeping helped ensure that the software met the needs of the user and that accurate cost estimates could be made.
Team 2: Design and Implementation
The second phase of the project involved designing and implementing a machine learning-based system for predicting mental health based on social media data with prescription audit, using the BERT model for greater accuracy and a multimodal concept.Some team members conducted testing, while others assessed the system's effectiveness.

IV. BERT MODEL FOR PREDICTION AND VISUALISATION

A. Architecture

The Transformer serves as the foundation for BERT's architecture. The general structure of BERT is made up of a number of Transformer blocks, each of which is made up of an attention mechanism.
BERT was initially made available in base and big variations for both case-sensitive and case-insensitive input text. We utilized the 110M-parameter bert-base-uncased.

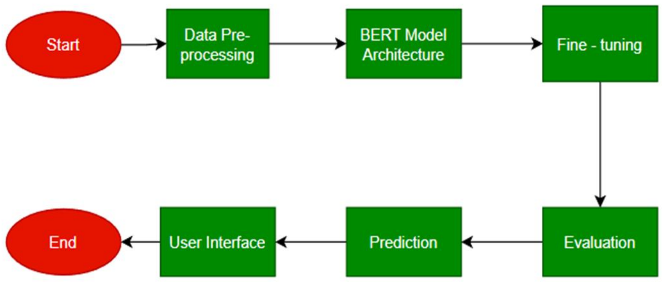

Fig 3. Modular Diagram

The process of building a mental health prediction system using social media data involves several key steps. Firstly, the preprocessed and cleaned data is given as input to a BERT model for predicting the emotional state of a person. To improve the accuracy of the model, attention layers and attention weights are used to focus on the most important parts of the text. The BERT model outputs the predicted emotional state along with the original tweet text. Secondly, the output from the emotional state prediction model, along with the original tweet text, is given as input to another BERT model for predicting the mental health status of the user. This model uses multi-class classification to predict the presence or absence of various mental health disorders based on the user's tweets. Similar to the emotional state prediction model, attention layers and attention weights are used to improve the accuracy of the mental health prediction model.To make the model more interpretable and gain insights into its inner workings. For visualization, we utilized the BertViz tool, which allows for a detailed analysis of the attention weights and important text passages that contribute to the model's predictions. This helped us gain a deeper understanding of how the model works and identify areas where further optimization may be necessary.

B. Algorithm and Process Design

To design an effective mental health prediction model, it is crucial to follow a well-defined algorithm and process. [15] Initially, a comprehensive dataset is collected from various social media platforms, which is then subjected to rigorous pre-processing techniques such as data cleaning and augmentation to extract relevant features and information while eliminating noisy data. [14] Subsequently, a suitable NLP algorithm such as BERT is chosen, and the pre-processed data is divided into separate training and testing datasets to evaluate the model's performance accurately. The processed data is then fed as input to the BERT model to predict the emotional state of a person with high precision and accuracy. Attention layers and attention weights are used to focus on the most important parts of the text, thus making the model more accurate. The output obtained from the emotional state prediction model along with the original tweet text is given as input to another BERT model for the prediction of the mental health of the user. Multi-class classification is used to classify the user's mental health status. The algorithm selection process involves training the algorithm on a designated training dataset, fine-tuning the hyperparameters to improve model performance, and evaluating the trained model on a separate testing dataset using performance metrics such as precision, recall, F1-score, and accuracy. Depending on the evaluation results, the model can be further refined by fine-tuning hyperparameters or selecting a different algorithm altogether. Once the model is trained, evaluated, and optimized, it can be utilized to predict outcomes on unseen data.

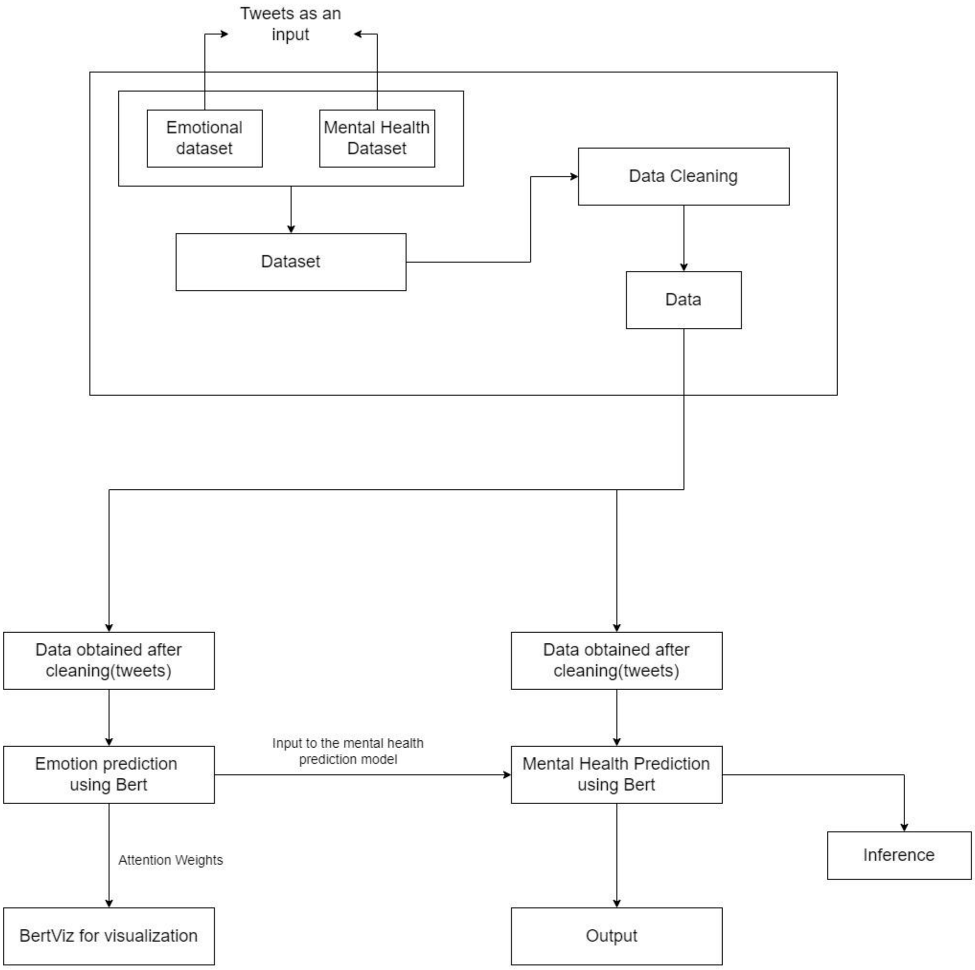

Fig 4. Flow Diagram

V. RESULTS AND EVALUATIONS

A. Verification and Validation

During the development of our model, we performed a thorough evaluation to ensure that it met all of the necessary requirements. To achieve this, we divided the dataset into separate training, validation, and testing sets. By doing so, we were able to evaluate the model's performance in a suitable environment and verify that it effectively accomplished its intended objectives. The results obtained from these sets were analyzed, and the conclusions derived are presented in the following figures.

The incorporation of the BERT model has demonstrated significant success in anticipating the emotional state and psychological health condition of users. This groundbreaking technology provides an improved, user-friendly, and low-cost solution for consultations with patients. Our ultimate solution comprises a sentiment and mental health predictor that is presented on a web application powered by the BERT model. Additionally, the use of optimized algorithms has helped to reduce loss. With further development of the model and expansion of the dataset, it may be possible to predict the appropriate dosage for various diseases, leading to even greater improvements in the model's functionality. Fig shows the sentiment detected, Fig shows the predicted mental health disease while Fig shows whether, for the particular disease, proper medication is given to the user or not.

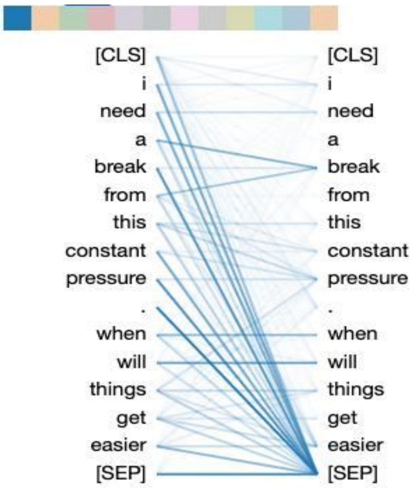

Fig 5. Visualization using BERTViz

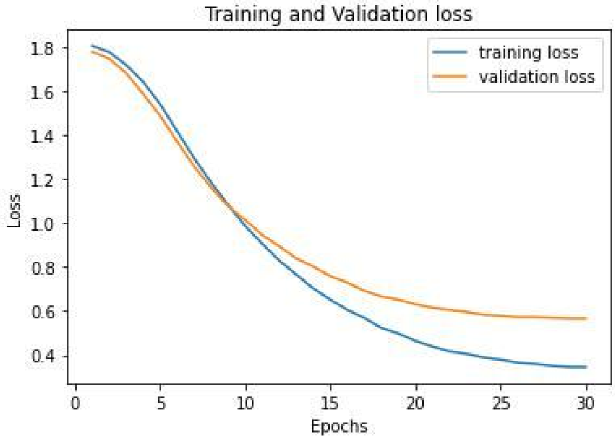

Fig 6. Training and Validation Loss

B. Analysis

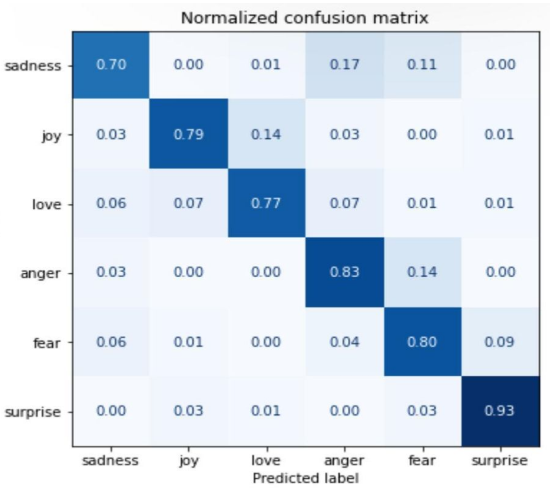

Fig 7. Confusion Matrix

classifiation report

	precision	recall	f1-score	support
0	0.70	0.80	0.75	61
1	0.79	0.87	0.83	63
2	0.77	0.82	0.79	66
3	0.83	0.72	0.77	80
4	0.80	0.73	0.76	77
5	0.93	0.89	0.91	73
accuracy			0.80	420
macro avg	0.80	0.81	0.80	420
weighted avg	0.81	0.80	0.80	420

Fig 8. Classification Report

VI. Conclusions

The field of mental health is constantly evolving with new algorithms and techniques being introduced to address the challenges posed by psychiatric disorders. However, there is still significant scope for improvement and further exploration of these disorders using various machine-learning techniques. The selection of appropriate features is a critical factor that can significantly impact the accuracy of mental health classification models.

Recent studies have demonstrated the usefulness of machine learning in diagnosing and comprehending psychiatric disorders. The incorporation of different sensor modalities from advanced devices has opened up new avenues for identifying patients' mood states and other crucial features that can enhance mental health treatment outcomes. As the field of mental health research continues to progress, machine learning will undoubtedly play an increasingly crucial role in developing new and effective treatment approaches.

Acknowledgment

Our team conducted a project on predicting mental health using social media data and prescription audits. This project provided us with a valuable learning experience, allowing us to apply our theoretical knowledge practically. We extend our sincere gratitude to our mentor, Prof. Dr. (Mrs.) Gresha Bhatia from the Computer Department, for

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Data Security Architecture in Cloud Computing based on Elliptic Curve Cryptography with Special Focus on Lowering the Cipher Space

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***Abstract*— Public key Cryptography which is associated with pair of public and private keys is an important requirement for electronic commence in the history of cryptography. Since public key is shared it should be digitally stored in the software in the form of public key Infrastructure (PKI) certificates Elliptic Curve Cryptography plays major role in cloud computing due to the exceptional property of smaller key size. ECC has wide range of applications in Secure Socket Layers (SSL) of cloud computing. The main disadvantage of ECC is the cipher space is two times the message. The present paper explains an innovative elliptic curve cryptosystem that reduces the cipher space, equal to the original message.**

***Index Terms*— Elliptic Curve Cryptography, Encryption, Decryption**

I. INTRODUCTION

A key exchange algorithm by Diffie – Hellman is an attractive protocol for communication between two unfamiliar users that uses power of large prime numbers. It greatly enhances the security of the internet and is proposed as internet standard. But the algorithm is suffered with security implication as man-in-middle attack. Later on, there were many modifications to D H Key Exchange algorithm. On the other hand, RSA is a public key cryptosystem which obtains its security from the difficulty of factorizing large integers into their prime. Though the public key operations are faster in RSA the strength of the algorithm will not be increased even if the key size is doubled. An alternative of RSA algorithm to achieve the same security certificate with considerably shorter key length is elliptic curve cryptography came to light in 1985 by Victor and Miller. Elliptic curve cryptography is based on a discrete logarithmic problem called (ECDLP). Since there are no exponential operations in ECDLP limited processing power, finite storage space with little band width is required for ECC. The hardness of ECDLP makes ECC less vulnerable compared with other classical cryptographic algorithms. So, ECC is especially viable for limited applications such as smart cards, cellular phones and wireless communication devices. Same elliptic curve may be used by many people with distinct key pairs. In spite of these advantages as ECC has similar structure with ELGamal, one message point maps to two cipher points on the curve. There is a small disadvantage that the encrypted message is twice than that of the unencrypted message. This leads to network congestion and communication risk. The present paper aims at reduction of the size of the cipher besides providing the security.

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II. Literature Survey

Several researchers in literature studied the benefits of ECC over conventional cryptosystems and deployed elliptic curves over finite fields for security applications. Many authors proposed text-based encryption algorithms using ECC. Benjamin Sebastina, Ugar Alpay Cenar (7) studied and compared significant advantages of ECC over RSA in SSL and TLS certificates. L. Dolendro and K Manglem (8) implemented text encryption using elliptic curve cryptography. In this chapter authors proposed a classical method of assigning characters to points on the elliptic curve, by pairing the ASCII values of the plain text characters. Renee Brady et.al. (9) proposed encryption scheme with elliptic curve cryptography. In that paper they discussed the limitations of communicating text messages through the sites like twitter and used Unicode to encode the text message as a number, Koblitz method to encode the text as a point on elliptic curve. A. Shamir (10) was the first to propose Identity-based cryptosystem to overcome the authenticity issues in a different way to traditional public key infrastructure. Aziz and Diffie [11] also suggested a secure and an authentic technique which requires prior communication. S. Thiraviya and S. Britto (12) proposed enhanced elliptic curve cryptography for online social network users. In that paper they implemented encryption, decryption time analysis, plain text, cipher text size analysis. KolhekarM, Jadhav A (13) proposed encryption technique based on elliptic curve. F. Amounas and E.H. EI Kinani [14] emphasized the advantage of a nonsingular matrix used to map similar characters to different points on the curve. T.N. Shankar and G. Sahoo (15) showed how an alphabetic table of two dimensions is used for conversion of two-dimensional plain text co-ordinate representation. These points are then added with elliptic curve points for encryption. K. Agrawal and A. Gera [16] designed message encryption with the help of Hill Cipher, where Cipher ASCII values are used to locate EC points. All these algorithms explain only the encryption methods, but they have not encountered the variation issue of the cipher size. The present text-based encryption algorithm protects the cipher from all types of attacks as well as considers the fixation of the cipher size to that of the original text.

III. Elliptic Curve Arithmetic

An affine equation E: $y^2 + b_1xy + b_3y = x^3 + b_2x^2 + b_4x + b_6$is called weierstrass equation on real field, for real b_1, b_2, $b_{3,}$ b_4, b_6 and x, y for encryption purpose, the curve is restricted to $y^2 = x^3 + ax + b$, $4a^3+27b^2 \neq 0$ on $\mathbb{F}q$.
Elliptic Curve group laws: - There are some special laws for adding two points on the elliptic curve unlike normal addition. Point addition on the curve uses chord -and – tangent rule to find out the resulting point [1, 2, 3]. All the points on the curve over finite field, with addition as binary composition will form a commutative group whose identity is point at ∞.
Addition Rules: - For two points P (x1, y1) and Q (x2, y2) of the curve, sum of P and Q is R (x3, y3). R (x3, y3) is obtained by considering the reflection point of the line passing through P, Q and the curve with respect to X- axis. Same geometric procedure applies for P and -P also. For P and -P the line is vertical. Where the addition of P and -P is ∞ [1, 2, 3].
Point Doubling on the Curve: - For P (x1, y1), the double point 2P is reflection of intersection point of tangent at P, with respect to X- axis [1, 2, 3]. Below given are examples for addition and doubling for the curve $y^2 = x^3-x$.

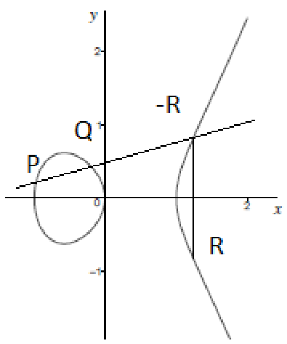


Figure 1. Geometric addition

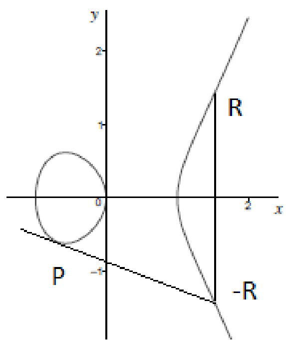


Figure 2. Geometric doubling

Identity: - Infinity point is identity.
Negatives: - A point with same X- co-ordinate and negative of Y- co-ordinate is called the negative of the point.
Point addition: - If $P\ (\dot{x}_1, \dot{y}_1)$, $Q\ (\dot{x}_2, \dot{y}_2)$ are two points where $P \neq Q$. Then $P + Q = (\dot{x}_3, \dot{y}_3)$ [1,2] $\dot{x}_3 = [(\dot{y}_2 - \dot{y}_1)/(\dot{x}_2 - \dot{x}_1)]^2 - \dot{x}_1 - \dot{x}_2$ and $\dot{y}_3 = [(\dot{y}_2 - \dot{y}_1)/(\dot{x}_2 - \dot{x}_1)]\ (\dot{x}_1 - \dot{x}_3) - \dot{y}_1$

Point Doubling: - Let P $(\dot{x}_1, \dot{y}_1) \in E(F_q)$ where $\mathrm{P} \neq -\mathrm{P}$ then

$$2\mathrm{P} = (x_3, y_3)\ [1,2]\text{where } x_3 = \left(\frac{3x_1^2 + a}{2y_1}\right)^2 - 2x_1 \text{ and } y_3 = \left(\frac{3x_1^2 + a}{2y_1}\right)(x_1 - x_3) - y_1$$

Point Multiplication: - Addition of points n times is called multiplication of point n times,
nP = P+P+……. n times.

ECDLP (Elliptic Curve Discrete Logarithmic Problem): - Elliptic Curve Cryptography mainly depends on hardness of Elliptic Curve Discrete Logarithmic Problem (ECDLP). It is a mathematical logic that finding a point Q on the curve for given n and P, Q = nP is simple whereas finding n = $\log_P Q$ is very difficult.

V. Proposed Method

In the present paper the authors designed a new technique to encrypt the message and to reduce the size of the cipher text to that of the plain text so that the computational strain, communication risk, storage space, processing power consumption can be considerably reduced. If two genuine users want to send messages to each other first they agree upon a curve Eq (a, b) over finite field with as many points as possible on it and publish. A secure elliptic curve is a curve that protects an elliptic curve protected by main physical attacks is secure. Some desired features in curve selection are

- The order of the curve should not have prime factors to face 1 attack by Pollig-Hellman attack
- It is not super singular
- It is non-anomalous curve order is not same as q.

A common look up table by assigning ASCII characters to points on the curve and a random function f (x, y) is shared between the users.
Alice selects a random point A, a large number at random α smaller than the order computes

A1= [A/α+α^2 A]modq

A2=[αA]modq

Keeping α as secret key she publishes A1, A2 as her general public keys.
In the same way Bob chooses big number β, a point B, calculates B1= [B/β+β^2 B]modq, B2=[βB]modq. He publishes B1, B2 as his general public keys and keeps β, B as his secret keys.
Again, Alice computes AB=[αB2]modq which is a specific to Bob. Bob computes BA=[βA2]modq which is specific to Alice to converse with her.

VI. Enciphering

Suppose Bob wants to send message M, with characters

M1, M2, ……Mn

1. First, characters are converted to points with the help of common look up table. P1, P2, P3…….Pn.
2. He selects a random point P0 with coordinates (x0, y0) on the curve and generates an integer r = [f (x0, y0)]modq using the published random function f(x,y).
3. He encrypts the point P0 as C0 = [P0+βA1]modq
4. Each point P1, P2…. Pn is encrypted as Ci= r^i [Pi+ β A1]modq i= 1,2,3……. n
5. He writes the corresponding text characters and sends the cipher text to achieve public medium.

VII. Decryption

Alice first decrypts Co as

P0={C0-[1/α^2 +α] BA}modq

Then Alice decrypts the cipher text as

Pi={Ci/r^i -[1/α^2 +α] BA}modq i=1,2…. n

Decryption works out properly:

$Pi= Ci/r^i - [1/\alpha^2 + \alpha]\ BA = Ci= r^i/r^i\ [Pi+ \beta A1] - [1/\alpha^2 + \alpha]\ BA$

$= [Pi+ \beta \{A/\alpha+\alpha^2 A\}] - [1/\alpha^2 + \alpha]\ \beta\alpha A$

$= Pi+ \beta/\alpha\ A+ \beta\alpha^2 A - \beta/\alpha\ A - \beta\alpha^2 A = Pi$

User 1	Public channel	User 2
A1= $\left[\frac{A}{\alpha} + \alpha^2 A\right] modq$ $A2 = [\alpha A] modq$ A, α are secret AB = αB2		$\{B1= \left[\frac{B}{\beta} + \beta^2 B\right] modq,$ $B2 = [\beta B] modq\}$, B, β are secret BA = βA2

Enciphering technique

Input: original message
Output: Cipher
Step1: Begin
Step2: i: Message M1, M2, Mn
ii: Assigned points P1, P2, Pn by table
Step3: Consider P0(x0, y0) at random and calculate r = [f (x0, y0)] $_{modq}$
Step4: encrypt P0 as $C0 = [P0 + \beta A1]$
Step5: Each point P1, P2… is encrypted as $Ci = \{r^i [Pi + \beta A1]\} modq$ i= 1,2,3…… n
Step6: convert the points to the characters from table
Step7: End

Decryption

Input: Cipher
Output: Original message
Step1: Begin
Step2: i: Cipher characters C1, C2, C3, …
ii: Characters to points P1, P2, P3… of the curve by using table
Step3: C0 is decrypted as $P0 = \left\{C0 - \left[\frac{1}{\alpha^2} + \alpha\right] BA\right\} modq$
Step4: Compute r = [f (x0, y0)] $_{modq}$ using the first point P0(x0,y0)
Step4: Each point P1, P2… is decrypted as $Pi = \left\{\frac{Ci}{r^i} - \left[\frac{1}{\alpha^2} + \alpha\right] BA\right\} modq$ i=1,2…. n
Step5: convert the points to the characters from table
Step6: End

VIII. Implementation of the Algorithm

Two users Alice and Bob select an elliptic curve $y^2 = x^3 + 3x + 27$ mod 331 with prime order is 317 possessing all the above-mentioned desired features. The curve, an EC coded ASCII table by mapping the 256 ASCII characters to first 256 affine points on the curve and a random function

$f(x,y) = [x^2y^2 + xy + x + y] mod\ 331$ are public.

Alice	Bob
$\alpha = 17$, A = (296,210) A1 = (8,296) A2 = (61,159) AB = (127,35)	$\beta = 19$, B = (231,3) B1 = (43,47) B2 = (88,123) BA = (9,320)

If Bob wants to send the message “SSSS” to Alice, the EC affine point corresponding to the character ‘S’ from the look up table is (39,144). He selects a random point

P0 = (36,38) and generates ‘r’ value as 68.

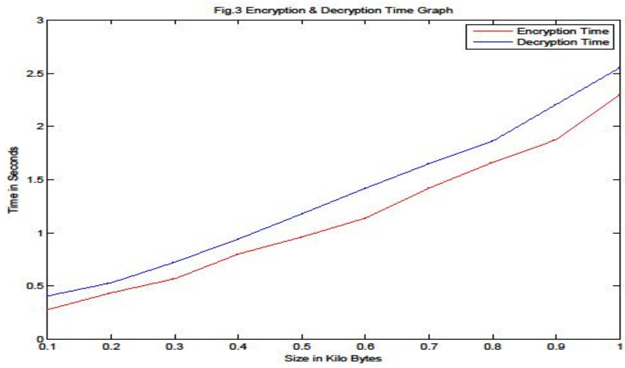
He encrypts the plain text as cipher points C1, C2, C3, C4

Message	Cipher
(39,144), (39,144), (39,144), (39,144)	(320,283)(248,60), (184,330)(257,52),(212,306)

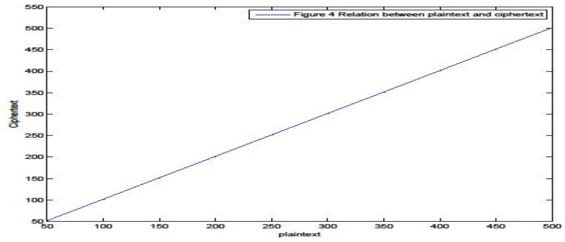
IX. Implementation Results and Performance Analysis

The encryption and decryption times for different size messages are recorded on a machine with 1GB RAM and 1.6 GHz processor speed on Win XP platform using MATLAB14. The following table gives encryption and decryption times in seconds for different size data. The time required for encryption and decryption for different size data are calculated and tabulated as follows
These values are plotted in the graph. The encryption and decryption time plots in figure 3 show that the execution time is very less when compared to other conventional cryptosystems. The time recorded for both encryption and decryption is below3 seconds. So, the computational and communication risk will be considerably reduced to the required levels.

Size of the message (in kilo bytes)	Encryption time (in seconds)	Decryption time (in seconds)
0.1	0.2774	0.4064
0.2	0.4372	0.5313
0.3	0.5695	0.7256
0.4	0.8023	0.9439
0.5	0.9617	1.1807
0.6	1.1400	1.4205
0.7	1.4218	1.6523
0.8	1.6627	1.8646
0.9	1.8768	2.2093
1.0	2.2986	2.555

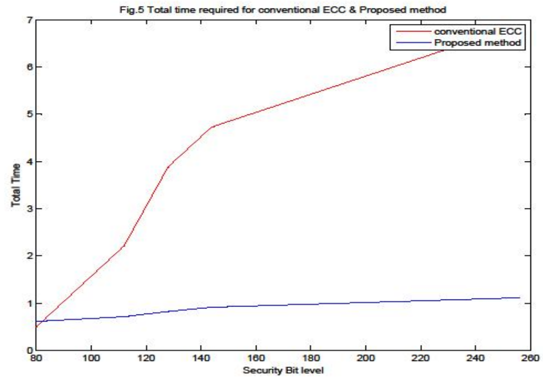


Since the cipher text size is fixed except one-point P0 or one-character C0 appended at the beginning of the cipher there is no network congestion in communication. The graph in figure 4 represents the relationship between plaintext and cipher text size. The graph is linear with negligible variation. So, the present technique is suitable for not only small, medium size messages but also for bigdata.



IX. COMPARATIVE ANALYSIS OF CONVENTIONAL ECC AND THE PROPOSED METHOD

A comparative study on total execution time is implemented between conventional ECC and the present method. The graph in fig. 5 shows that the present algorithm is faster than the conventional algorithm.



X. SECURITY ANALYSIS

General attacks are effective same message character maps to same cipher character. In the present algorithm each plain text character is encrypted using the value 'r' raised to the power of its position r^i , i = 1,2,3…. Since r^i , i = 1,2,3…. Different repetition will not occur. characters for small and medium size messages. In the example shown above all the same 'S' are encrypted to different EC points. To estimate the frequency of the characters a big message of size 1 kilobyte is encrypted using the present technique. Repetition of English alphabets is shown by the bar diagrams in figure 6. It is clear from the graph that the most frequently repeated English alphabets like A, E, S, T are negligible in number and all the other characters are numerals, special ASCII characters. So, the frequency analysis is impossible to execute here even for big data also.

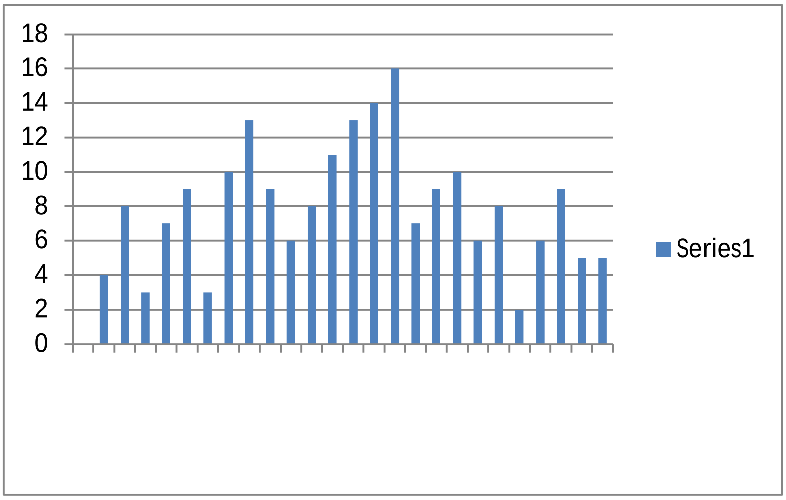


Fig.6 1

The hardness of ECC depends on the strength of ECDLP). A common attack on ECC is pollard Rho to solve ECDLP. The process of applying the Pollard Rho attack to solve ECDLP does not arise here since each character is encrypted different r^i.

XI. ADVANTAGE OF THE PRESENT SCHEME OVER THE EARLIER SCHEMES

In ECC a l bit key yields pair of points consisting of 4*l bits due to the two coordinates x and y. Each cipher character has bandwidth 4*l. Thus, the plain text coded to N points on the curve is encrypted as 2*N points with 4*l*N bit bandwidth which is significantly large. This results the transmission expensive and leads to network congestion. But in the present method the plain text with N characters is encrypted as (N+1) affine points with bandwidth 2*l*(N+1) almost equal to the size of the plain text. Each character is encrypted to a random character as long as q<n. If n = q+1 and if P0 = P(q+1) they are coded to the same cipher point, since r is a number in the finite field less than q which is the generator of the cyclic group. In ECC generally q is very large so that large volumes of data can be transmitted by communicating parties. The case of n>q occurs rarely. In such a case it is recommended to change either the secret key or the function f(x,y) to calculate r value after communicating q characters.

XII. CONCLUSIONS

The encryption technique proposed here offers same level of security as the conventional ECC protocol as it is highly difficult to calculate the secret keys of both the legitimate entities; α, A of Alice and β, B of Bob from the public keys A1, A2 and B1, B2, if the order of the elliptic curve is very large. Also, it reduces the size of the cipher text to that of the plain text. So, the ECC algorithm designed here is faster than previously proposed schemes. Another special feature of this algorithm is there is no pre sharing of the data before transmission. The curve, EC coded ASCII table and function are public. The keys A1, A2, AB; B1,B2,BA are communicated via public channel only. So, the present cipher is very useful for long messages because the cipher length is same as that of the plain text.

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Composition and Characteristics Analysis of Municipal Solid Waste using Proximate Method and Estimation of Greenhouse Gases from Landfill Sites in Punjab a State of India

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***Abstract*— given the rate of towns inhabitants growth the amount of leftover produced per person from different sources, in different ways and types in most of the Indian cities, managing this municipal solid waste is a major problem. Poor handling of municipal solid waste can harm the environment, can endanger public health and cause further socioeconomic issues. To gain a better understanding of the existing state of management of municipal solid waste, we conducted projections and analyses of the content, features, and greenhouse gas emissions from landfill sites in four different zones in Punjab. A combined methodology of quantitative and qualitative analysis was used for the investigation of primary and secondary data from the landfill site. We used uninformed samplings to determine the configuration of waste and performed a proximate analysis, which includes Lower Heat Value (LHV), Ash Content, Volatile Matter (VMC), Moisture Content (MC), and Fixed Carbon (FC). According to the study's proximate analysis findings, Zone II dumpsite has the highest VMC at 57.8% but the lowest MC (38.279%). In contrast to this, the Zone IV dumpsite solid waste has the highest MC of 48.046%. Ash content ranged between 39.2% and 46%, with the Zone III dumpsite solid waste having the highest and the Zone II dumpsite solid waste having the lowest levels. In addition, among the four dumpsites, solid waste from Zone III has the highest FC The LHV for the municipal solid waste varied from 2042.724kcal/kg (in zone iii) to 2493.798kcal/kg (in zone iv), demonstrating the viability of planning trash to energy production in cities. Subsequently, with the aid of IPCC methodology using the Default Method and First Order Model, we calculated the emission of greenhouse gases from the landfill sites, which are a major contributor to methane gas (CH4) emissions that are produced in favourable conditions by microorganisms, it was found out that the Default Method gave a better picture of the emission values of greenhouse gases.**

***Index Terms*— characterization, composition, proximate analysis, calorific value, and greenhouse gases of municipal solid waste.**

I. Introduction

India, which has nearly 1.47 billion inhabitants is currently the world's most populated country after China, with a population growth of 1.2% yearly this is the fastest growing nation-state (Census of India, 2023). The amount of solid trash created will only increase manifold with the economic success and the increasing percentage of people

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living in cities (Hoornweg and Bhada, 2012). The central board for pollution control (CPCB) of India reports that the amount of garbage produced per person has climbed steadily from 0.26 kg/day to 0.85 kg/day (CPCB India, 2018).
It has been discovered that the efficiency of the assortment parameters varies between 70 and 80 percent in the metro city whereas its efficiency is below 50 percent in the smaller cities and that this enormous growth in the generation of solid waste is due to changes in lifestyle, eating habits, and ideals of living in the urban population (CPHEEO, 2000). In nations with high incomes, trash creation per capita is predicted to increase by 19% by 2050, whereas it will increase by roughly 40% in low-income countries (Burke et al., 2018).
In most region of the countries, solid waste is gotten ridded of either in an open landfill site a salubrious landfill and with the help of the combustion. However, both the combustion and salubrious landfills are expensive and require proper operations and maintenance. The cost for developing countries is relatively low therefore developing countries typically use landfill sites for solid waste disposal (Nas and Bayram, 2008). Emerging nations like India are still making changes to improve their waste management for the most part, a solid waste dump is used without the required safeguards and proper operational controls in low-lying locations. Unsuitable solid waste management is causing environmental issues in major Indian cities (Sharholy et al., 2008).
The major issue is that in India only a few cities collect mixed forms of waste (Ahluwalia and Patel, 2018). Due to lack of awareness and accurate information, regarding the impact of trash on health, and the lack of adequate safety equipment for municipal workers, many gaps in waste management and employee safety have been discovered (Zhu et al., 2008).
Front-line workers and garbage pickers may suffer from several health problems and occasionally even pass away as a result of the improper management of waste at dump sites that frequently attracts animals, mice, mosquitoes and scavengers (Bercegol et al., 2017). The administration of solid waste, their characterization, their compositions along with their analysis in different weathers and emission of greenhouses gases like methane from landfill sites are discussed in this paper.

II. Literature Review

Any organic or inorganic waste produced by the households or commercial activities that has some potential to be reused in any scientific manner but has lost its value in its first owner's eye referred as waste, the proper involvements of municipal authorities', private agencies and the government sector are so essential for the achievement of long-term objectives of MSWM (Agarwal et al., 2015).
Garbage that is generated in kitchens, businesses, and construction sites, or that the municipality collects from the streets can either be solid or semisolid and can be either dangerous or not. This garbage is also referred to as urban waste or solid waste (Sridevi et al., 2012). Population, average annual income level, social behaviour, product demands, the amount and makeup of solid waste are influenced by a number of factors, including industrial production and the market for waste products., and they vary and depend on the source of origin (Yadav and Devi (2009); Late and Mule (2013)).
Numerous variables, including income, cultural traditions, dietary preferences, and climate, affect the makeup of solid waste (Srivastava et al., 2014). 48 million tons in 1997, 90 million tons in 2009, up from 6 million tons in 1947, and it is projected to rise to 300 million tons by 2047, the generation of solid trash has expanded significantly in recent years (Teddy, 2010; Sharholey et al., 2005). The disposal of rubbish in India is extremely improper and unorganise even the majority of metropolitical areas lack proper solid waste storage and collection facilities the trucks and bins used to collect solid waste are improperly designed, located, and maintained and the workers lack the necessary tools like masks, gloves, and disinfectant, which leads to inefficient collection. Only approximately or about 70% of municipal solid garbage gets collected on an average throughout the town and city (Saxena et al., 2010). The successful handling of solid waste is affected by a number of aspects that includes quality controls, improved training programs, teamwork, support management, and ratings of good performance (Sarok, 2013).
Fernando (2019), estimated and recognised a few key elements, such as pay and other benefits for employs, the commitment of society and business group, governmental backing, inspiration, etc. that can aid in the effective operation of the solid waste management agenda. Solid waste management entails innovating and sustainably implementing all of a waste management plan's component that can help control waste in that location. The existing waste management plan must be combined and implemented so that the local governing bodies are prepared to address any issues that may arise. Innovations should also be brought into the planning process (Shekdar, 2009).
Below "Fig. 1", shows the flowchart of existing municipal solid waste management system in Indian cities from that we can see the generation of waste from different sources likes commercial buildings, houses, street, hotels,

parks etc., later all of the wastes are collected by sweepers or by different tools and ragpickers then all the collected waste is then transferred to either junkyard or community bins depends upon the wastes type the recyclable waste sent towards recycling site for recovering it for next use and remaining waste sent to landfill sites through cart or automobiles.

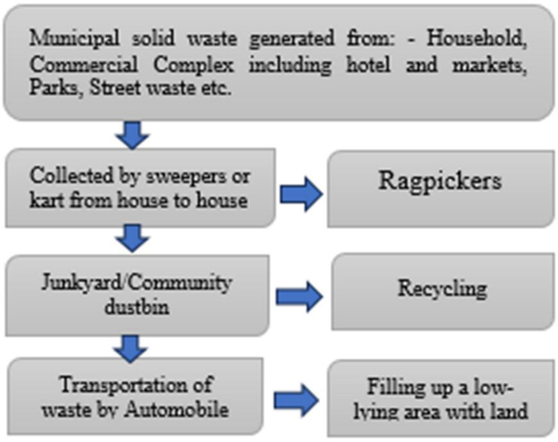

Figure 1. The flow diagram for India's current municipal solid waste management system (Singh et al., 2011).

III. Area Of Study

This research was done in a landfill site in the city of Kharar in the state of Punjab, India. Kharar is nearby Mohali city and comes in greater Mohali region having coordinates of 30.74*N 76.65*E with having elevation of about 309 metres or 1014 feet.

It is the first town in Punjab to convert wet waste into organic manure using latest tools and techniques. The present research is lugged in conformance to find out the practices and approach accomplished by Municipal Corporation of Kharar for the proper solid waste management, below "fig.2" shows the map of kharar region where landfill site is located and al the testing samplings and collection of waste were done.

Figure 2. Image showing map of Kharar, SAS Nagar, Greater Mohali, Punjab, India (Kaur and Kaur, 2022).

IV. Materials And Methods

A. Collection of primary data

The data of waste and samples of garbage were taken from the dumpsite of Kharar which is being managed by Municipal corporation of Kharar where collection of waste is being separated into four different zones namely Zone I, Zone II, Zone III and Zone IV. We collected the waste generation data from all the four zones. The average data of daily, monthly, and annual time periods are given below in the "Table I".

B. Composition and classification of waste

The classification of solid garbage from the landfill sites were done on the standard basis of American Society for Testing and Materials (ASTMR, 2022). Based on the suggestion by Wilson, the collection of wastes from all four zones were done in the month of November, February, and April with the help of a weighing machine having the sensitivity of 0.1kg. All the samples were weighed in pre-weighted tray. After this, all samples were spread on plane sheets and divided into four categories, namely waste of food, plastic squander, dry waste, and other waste. Further, their average weight % were calculated.

C. Proximate Analysis

In order to determine the amount of ash, moisture, volatile materials, and fixed carbon of the solid waste samples that were collected from the four zones of dumpsites, we used the ASTM 3175-3175 standard procedures for the proximate assessment of solid waste. In this procedure, 1000gm of sample was collected from each of the four dumpsite zones and taken to a lab for examination.

1.Moisture content

The level of moisture of solid waste samples was calculated according to ASTM 3173 method. In this, 1000gm of solid waste was taken and placed in pre-weighted tray and then samples were put into an oven for 24hrs at 105ºC to obtain a stable weight. With the help of below "(1)", the % of moisture content was calculated.

$$\% \text{ Moisture content}=\{(\text{Wet weight-Dry weight})/(\text{Wet weight })\} \times 100 \qquad (1)$$

2. Volatile Matter content

We used the ASTM 3175 method, in which 5gm of dry waste sample was obtained and placed inside a muffle furnace for 8 minutes at a temperature of 950oC in order to estimate the proportion of volatile matter present in the solid waste samples. Following full combustion to determine the dry weight of the ash, the samples were weighed, and the volatile matter was determined using "(2)", below and the percentage provided in "Table I".

$$\%\text{volatile matter}=\{(\text{Dry sample weight-Ash weight})/(\text{Dry sample weight})\}\times 100\% \qquad (2)$$

3. Ash and fixed Carbon content

By heating the waste samples in an oven at 750ºC, the ash content of the samples was determined under ASTM 3174 method. Ash content was the amount of residue left after combustion and the Fixed carbon content were determined using the following "(3)".

$$\%FC=100\text{-weight } (\%\text{moisture content}+\% \text{ Ash}+\% \text{ Volatile matter}) \qquad (3)$$

4. Lower Heat Value

The main advantage of using this model is that it gives results based on the size of samples (Liu et al., 1996) in order to calculate the calorific values correctly (Amin et al., 2011). To calculate the Calorific value or Lower Heat Value (LHV), we used the Proximate Analysis models. The ratio of fixed carbon to volatile carbon in weight served as the foundation for the Proximate Analysis model's creation. The following "(4)", can be used in order to determine calorific value of solid waste samples using Proximate Analysis (Rajesh et al., 2013).

$$LHV=44.75VM-5.85W+21.2 \qquad (4)$$

Where LHV = lower heating Value (kcal/kg)

VM = Volatile matter (%)

D. Emission of Methane

As it is common knowledge that all landfill sites involve the disposal of solid waste under ideal conditions for anaerobic decomposition of organic materials, which releases methane gas the IPCC (Intergovernmental Panel on Climate Change) recommends two techniques to estimate the quantity of methane gas emissions the IPCC default method and the second is the first order decay model the main distinction between the two approaches is that the, IPCC-default method undertakes that all potential methane will be released in the year in which solid waste was disposed whereas the FOD method considers the precise timing of the emissions (Froiland et el., 2006).

1. IPCC Default Method

With this approach it is considered that all potential methane emissions are discharged the same year as garbage disposal with the use of this model it is possible to compute methane emissions with a minimal amount of input for a set of parameters whereas IPCC allow default values in the absence of precise data the "(5)", below forms the basis of the default method.

$$\textbf{Methane emissions}\left(\frac{Gg}{yr}\right) = \left(MSWT \times MSWF \times MCF \times DOC \times DOCF \times F \times \frac{16}{12} - R\right) \times (1 - OX)$$

Where:
MSWT= total MSW generated (Gg/yr).
MSWF= fraction of MSW disposed at disposal site.
MCF= methane correction factor.
DOC= Fraction of degradable organic carbon in the waste.
DOCF= Fraction of DOC dissimilated.
F= Fraction of methane in the landfill gas.
R= Recovered methane (Gg/yr).
OX= Oxidation factor.

2. Method of First Order Decay

Quantity of methane produced at the dumpsite is calculated by using this method. According to this method, the amount of methane produced at the dumpsite is based on time. The FOD model has been used to estimate the annual emissions of methane from sites where waste has been placed, with the use of the following "(6)".

$$Q_{T,x}=k\times MSWT(X)\times MSWF(X)\times MCF(X)\times LO(X)\times e^{-k(T-X)}\times F \quad (6)$$

Where: QT, x= The amount of methane generated in the current year from waste disposed in the year X.
X= the methane gas generated in the current year from waste disposed in the year X.
K= Ln (2)/t½. (1/yr) and t½ is half-life period for degradation process.
MSWT (X)= total MSW generated (Gg/yr) in year X.
MSWF (X)= Fraction of MSW disposed to solid waste disposal sites in year X.
MCF (X)= Methane correction factor (fraction) for year X.
LO (X)= DOC x DOCF for the year X (Gg CH_4/Gg waste.
Where: DOC= fraction of degradable organic carbon in the waste.
DOCF= fraction of DOC dissimilated.
T= the current year (year of the emission estimate) Gg/yr.

V. Results And Discussion

The primary data of solid wastes that was collected daily, monthly and annually average generation from the landfill sites of the four zones are shown in the "Table I".

TABLE I. AVERAGE SOLID WASTE GENERATION IN TONNES AT KHARAR LANDFILL SITE VIA MUNICIPAL CORPORATION OF KHARAR, MOHALI, PUNJAB.

Sources	Average Waste Generation in Tonnes		
	Daily	Monthly	Yearly
Zone I	13.12	393.6	4723.2
Zone II	12.8	384	4608
Zone III	14.87	446.1	5353.2
Zone IV	11.47	344.1	4129.2
Average	13.065	391.95	4703.4

In this landfill site the solid waste is collected from all sources with the help of trucks and hand carts. From the above table, we found out that among all four zones, the highest amount of waste generation is in Zone III i.e., 14.87 tonnes/day while Zone IV has the lowest generation of solid waste at 11.47 tonnes/day.

1. Physical composition

The results of the data of four zones at landfill sites that were conducted in the month of November, January, and May (2022-2023) are shown in the "Table II".
On the bases of physical classification of solid waste at four zones, the results show that food waste has the highest % composition ranging between 22-27.5%. The next is the composition of dry waste which varies from 15.5-

19.5%. Other types of waste have the lowest % composition which lies between 0.4-1.25% and the plastic waste composition is limited to 7-9.5%.

TABLE II. AVERAGE % PHYSICAL COMPOSITION WEIGHT OF WASTE.

		WASTE IN TONNES			
Category	Zone I	Zone II	Zone III	Zone IV	Average
Food waste	27.5	24	29.5	22	25.75
Dry waste	16.5	17	19.5	15.5	17.125
Plastic waste	8	6.5	9.5	7	7.75
Other	0.5	1.25	1	0.4	0.7875

Below "fig.3" shows the average % division of Solid waste in the landfill sites of Kharar, Punjab at four zones.

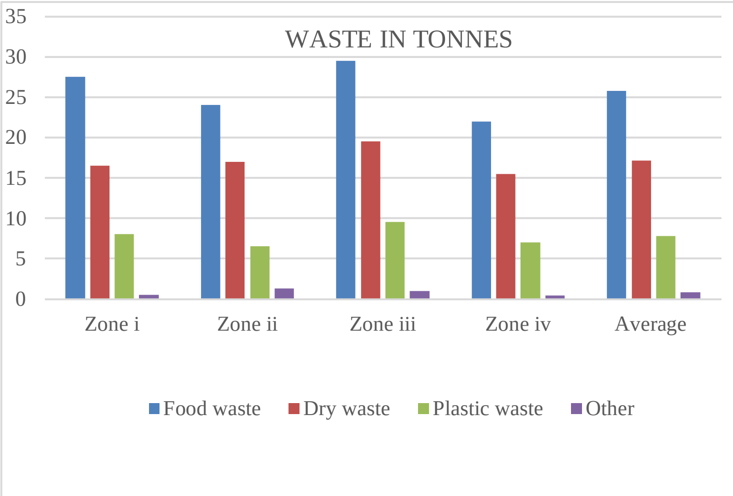

Fig.3 - Average solid waste weight% composition in four zones of dump sites

2. Proximate Analysis

On the basis of Proximate Analysis, we determined the content of volatile substances, moisture, ash, and fixed carbon from all the four zones of landfill sites which was collected in different months of the year. "Table III" demonstrates the median outcome of the Proximal Analysis over all four waste site zones.

TABLE IV. AVERAGE % OF MC, VMC, ASH AND FC FROM LANDFILL

Sources	Zone I	Zone II	Zone III	Zone IV
MC %	6.149	8.279	8.046	16.867
VMC %	33.8	37.8	31.8	20.6
Ash %	24.4	31.2	26.2	22.2
FC %	35.651	22.721	33.954	40.333

From the result of the above equation "(1)", "(2)", "(3)" and "(4)", it is found out that the MC of solid waste samples from Zone IV have the highest content i.e., 16.867% but it contains low VMC i.e., 20.6. Whereas, in Zone I the MC is the lowest i.e., 6.149%. The VMC in Zone II is higher i.e., 37.8% than other zones. The content of ash

% varies from 22.2-31.2 %. The content of Fixed Carbon in Zone IV is higher at 4.033% and lower in zone II at 22.721%. Figure 2 represent the graphical data of the proximate analysis of all four zones.

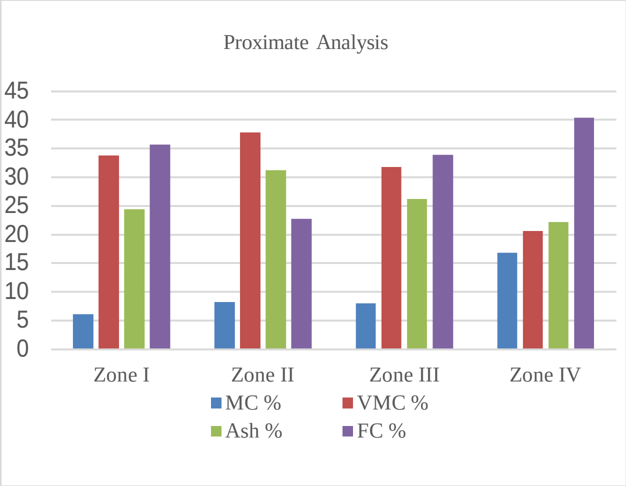

Fig.4 - Average % of MC, VMC, Ash and FC from landfill sites

3. Calorific Value

Equation 5 has been used to compute the solid waste's lower heat value based on the Proximate Analysis. "Table IV" depicts the lower heat value from all four zones.

TABLE.IV – CALORIFIC VALUES OF FOUR ZONES AT LANDFILL SITE

	Calorific Value		
Zone I	Zone II	Zone III	Zone IV
1484.106	1651.326	1382.724	825.798

From the above table we can find out that in all four sites or zones the LHV varies between 825.798- 1651.326 kcal/kg, whereas Zone II has the most calorific content of 1651.326 kcal/kg and Zone IV has the lowest calorie content of 825.798 kcal/kg.

4. Methane Emission

The Landfill site of Kharar, Punjab was started around year 2008 with an area of around 4 acre and a depth of around 15 feet. This site is managed by Municipal Corporation of Kharar, Punjab. The daily waste receives here is 13.12 tonnes/day from four different zones. With the help of IPCC methods, we have found out that the emission of methane slowly decreased in past few years by the Default method, but the FOD method showed that it gradually increased in past few years by at Gg/yr.

From both the methods we observed that DM produces greater value of methane gas emission than FOD method since any alteration in the amount of solid waste projected faster on the result of IPCC-DM, whereas the FOD method is slow to adapt the changes.

The implementation of DM is easier as well because it gives eloquent result whereas implementation of FOD methods is a little complicated since it requires vast knowledge of decaying process and many more data related to disposal at sites. Further, in the Kharar landfill sites, the emissions of methane were found to be at a standard deviation of 33.165 in DM and in FOD it is nearly 7.467.

VI. CONCLUSION

It is evidently known, the solid waste management practices have got better in recent years however, looking at the pressing environmental concern and increased in urgency of concrete and cooperative action, we need to utilize the resources efficiently and accelerate the process in this era of technology, we must focus on better waste management, and technology-based entrepreneurship.

An increased involvement of NGOs, Municipal bodies, governing bodies, and authorities towards enhancing public awareness should be ensured because participation of public in an efficient management of solid waste is one of the most crucial steps, along with that, proper measurements and mitigation policies should be implemented as per the guidelines of SWM.

This paper reached on conclusion that composition and classification of Solid waste from the landfill sites of the city of Kharar, Punjab as MSW is a potential source of energy, our analysis has also demonstrated the heat values ranges which clearly shows the viability of waste-to-energy plans like power production through incineration. Further, our paper concluded that the generation of solid waste or organic waste has increased because of a This paper reached on conclusion that composition and classification of Solid waste from the landfill sites of the city of Kharar, Punjab as MSW is a potential source of energy, our analysis has also demonstrated the heat values ranges which clearly shows the viability of waste-to-energy plans like power production through incineration. Further, our paper concluded that the generation of solid waste or organic waste has increased because of a multifold increase in population, as there is an unprecedented increasing in methane gas from landfill sites. Hence, there is a pressing necessity of initiation of mitigation for controlling the greenhouse gases emissions which could become a great source of energy, and solve the issue of power shortage in many places.

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A Fine Tuned Pre-trained Model for Classification of Brain Tumor using Magnetic Resonance Imaging

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***Abstract*— Any growth inside of the brain's restricted areas can harm humans. It is a challenging task for radiologists to classify tumor types because cancers are heterogeneous. The manifold collection of cells fosters prominent molecular squiggle with discriminative levels of sensitivity to treatment. Medical diagnosis has changed and diversified due to deep learning trends, particularly in magnetic resonance imaging (MRI). This study suggests a binary class classification and detection method for the early diagnosis of brain tumors as a solution to this issue. The pre-trained ResNet50, VGG19 and InceptionV3 deep learning models of the transfer learning approach make this possible. The different scenarios were assessed with the help of two classes of publicly available MR brain tumor datasets and with data gathered from hospitals. The accuracy rates for the pre-trained method InceptionV3, ResNet50, and VGG19 produced 99.72%, 98.84% and 94.65%, respectively. The three pre-trained models are ensembled. The highest performance accuracy in the detection of brain tumors was achieved using Inceptionv3, and VGG19 on testing samples. The results of the proposed method evaluation outperform those of existing methods.**

***Index Terms*— transfer learning, classification, tumor, ResNet, Pre-trained model, VGG19, and InceptionV3.**

I. INTRODUCTION

In the modern era, Johns Hopkins Medicine reported more than 120 distinct kinds of brain cancers, according to the brain tissue they affect. The microscopic structure of the brain is extremely multifaceted with multiple structures controlling different nervous system functions. About 25-30 adults per 100,000 have brain or cerebellum tumors [1]. Cutting-edge invasive and radiation therapies combined with improved diagnostic procedures have improved the lifespan by up to years and boosted the quality of life for patients after diagnosis. [2]. Advanced imaging and artificial intelligence (AI) image analysis demonstrated interesting differences in biological MR imaging statistics among molecularly defined tumor subgroups on newly diagnosed adult cancer patients with deep cellular characterization [3]. Due to brain tumor postoperative entirety and symptomatic hemorrhage affected 21.6% and 9.6% of patients, respectively. In univariate analysis, a needle biopsy was found to be significantly riskier for all symptomatic hemorrhages than methods that allow for adequate hemostatic manipulation (such as open and endoscopic biopsies) [4]. The management and treatment of brain tumors, one of the most challenging medical conditions to treat, depend on an early and accurate diagnosis. The most popular and effective diagnostic techniques for locating suspected primary brain tumors are computed tomography (CT) and magnetic resonance imaging (MRI), which can also assess the presence of edema, hemorrhage, and hydrocephalus [5].

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Recent developments in transfer learning (TL) have enabled the recognition and classification of patterns found in medical imaging. The ability to retrieve and extract information from data without the help of radiologists and other medical professionals is a prime instance of this field's advancements. TL is proving to be a useful tool for enhancing performance in a variety of applications, such as disease prognosis and diagnosis, tumor tissue identification, and tumor grade classification [6-8]. In MR images, the most advanced technique recently used is a convolutional neural network (CNN), as the input images pass from the number of several layers to improve the accuracy if the MR images are high [9, 10].

In TL, data trained for a specific task can be reused for another related task, and it is carried out to reduce the problem of overfitting and to train fewer data with augmentation. Also, more reliable as compared to the traditional machine learning approach. Additionally, performance assessments have demonstrated that they possess excellent diagnostic precision [11-13].

Using a variety of techniques and models, numerous studies have been done on the classification of MR brain tumors [14-20]. However, some of these studies have limitations, such as a lack of performance comparison between the proposed model and machine learning methods [21]. The aim of relevant studies is to provide models for classifying two types of brain tumors without including no-tumor brains images [22-25]. Diagnosis of brain tumor is not always a straightforward mechanism to predict, not accurate and highly rely on the experiences of radiologists. There are crucial diagnostic challenges when there aren't the typical tumbling lesions [26] and limitations arise to medical experts and pathologists can benefit from computer-oriented interventions. Tremendous attempts have proposed automatic or semiautomatic techniques for brain tumor classification [27-30]. In the present study, we have tried to propose models, with constraints, and recommendations, and provide suitable solutions, which categorized brain tumors into two classes. The modeling methods have been compared to recognize significant variations that occur in terms of performance. The mentioned key points comprise our contribution:

(1) Extensive dataset of 1926 T1C+, T2, and T1 MRI images used on our network, which are desirable for training and testing phases.
(2) To demonstrate the concept of transfer learning by three pre-trained CNN architectures are used.
(3) For the purpose of classifying the brain MRI images into meningioma and schwannoma classes, a standalone, layer-based CNN architecture is created from scratch.
(4) The proposed scheme classifies brain tumor into two classes, and compared to the existing classification models.

The following subsections constitute the remainder of the paper. Information on the related work of research on brain MRI classification is detailed in Section 2. The suggested methodology and specifics of the TL algorithms are described in Section 3. In Section 4, it is further discussed how the experimental work compares to current cutting-edge TL approaches and ensemble deep learning (DL) approaches. Section 5 encompasses the research paper and discusses possibilities for the future.

II. Related Work

In the recent years many methodologies related to transfer learning for classifying using MRI brain images are developed and summarized in Table I.

The study conducted by Hao et al. [31] in 2021, presented tumor diagnostic framework employed on transfer learning and reduce labelling cost to enhance the model performance. In the paper 2D slice used to train and fine tune model, consist of 203 patients for training and 66 patients for validation dataset; classification into LGG and HGG categories. The proposed model achieved AUC of 82.89% for 66 patient test datasets. Tenghongsakul et al. [32] also employed transfer learning approach with InceptionResNet-V2, ResNet50, MobileNet-V2, and VGG16 in addition CLAHE image enhancement model used to improve the contrast. The proposed models applied using 253 MR images with split of 155 images of brain tumor and 98 of healthy brain images. The data augmentation applied and the dataset contained 1085 images of brain tumor and 980 healthy images. Data split into 70% (1445) of training, 15% (311) of test and validation of 15% (309) images. It has been analyzed from the literature that InceptioResnetV2 acquire 98.08% accuracy, MobileNet-V2 of 98.90%, ResNet50 of 99.73%, and VGG16 of 100%. Mehrotra et al. [33], presented tumor identification by employing deep transfer learning approach, the pretrained models comprises of AlexNet, GoogleNet, ResNet50, ResNet101 and SqueezeNet. Total image consists of 696 MR images of T1-weighted, categorized into two classes benign (224) and malignant (472); the performance accuracy obtained ResNet101 of 94.74%, ResNet50 of 95.69%, GoogleNet of 98.09%, AlexNet of 99.04%, ad SqueezeNet of 98.56%. The paper is limited to used small datasets and classification done using binary categories. Ullah et al. [34], also presented deep learning approach to tumor diagnostic and classification framework. The dataset is categorized into glioma, meningioma, and pituitary brain tumors. The author used to evaluate the performance on InceptionresnetV2, InceptionV3, Xception, Resnet18, Resnet50, Resnet101, ShuffleNet, DenseNet201, and MobileV2. The high accuracy achieved with 98.91%. Noreen et al. [35] presented a tumor diagnostic framework by employing pretrained Inception-V3 and DenseNet201 deep learning models; consist of 3064 T1-weighted contrast MR images; achieved highest accuracy in comparison to past research works. Ullah et al. [36] five CNN pre-trained models among which InceptionV3 and ResNet101 achieved 97% accuracy. The model is trained using Kaggle dataset with four tumor categories: no tumor, meningioma tumor, pituitary tumor and glioma tumor. Gomez et al. [37], proposed seven pre-trained models for classification of brain tumor and among these models InceptionV3 scored 97.12% accuracy on the datasets of Figshare, SARTAJ, and Br35H. Rajput et al. [38], employed ResNet50, VGG19 and InceptionV3 models for classification into four categories of consists of three types of brain tumor and healthy brain images using Kaggle datasets. The suggested models of Inception V3 achieved highest accuracy of 99%. Krishnapriya and Karuna [39], proposed VGG16, VGG19, ResNet50, and Inception V3 models using data augmentation on Chakrabarty 2019 datasets. It had been analyzed that VGG-19 acquired 99.48% accuracy with compare to other models. The summarized related work is shown in Table I.

TABLE I. RELATED WORK

Author	Aim	Tumor class	Dataset	Model
Hao et al. [31]	To reduce labeling cost	LGG, HGG	BRATS 2019	AlexNet
Tenghongsakul et al [32]	To enhance contrast of MR images by using CLAHE method	Tumor, Healthy brain	Kaggle	InceptionResNet-V2, ResNet50, MobileNet-V2, and VGG16
Mehrotra et al. [33]	To develop strong deep learning model of TL and investigate five models	Benign, Malignant	TCIA	AlexNet, GoogleNet, ResNet50, ResNet101 and SqueezeNet
Ullah et al. [34]	To compare the performance of hybrid approach (DL and SVM)	Glioma, meningioma, pituitary	Kaggle	InceptionresnetV2, InceptionV3, Xception, Resnet18, Resnet50, Resnet101, ShuffleNet, DenseNet201, and MobileV2
Noreen et al. [35]	To extract multi-level features from different bottom layers of the pre-trained models	Meningioma, glioma, pituitary	-	Inception-V3 and DenseNet201
Ullah et al. [36]	To automate categorization of brain tumors	Pituitary, glioma, meningioma, no tumor	Kaggle	CNN, VGG16, VGG19, InceptionV3, and ResNet101
Gomez et al. [37]	To employ optimized classifier using multi class	Glioma, pituitary, meningioma, healthy	Figshare, SARTAJ, Br35H	InceptionV3, ResNet50, InceptionResNetV2, Xception, MobileNetV2, EfficientNetB0, Generic CNN
Rajput et al. [38]	To detect and classify brain tumor	Glioma, pituitary, meningioma, normal brain	Figshare, SARTAJ, Br35H	VGG19, Inception-V3, ResNet50
Krishnapriya and Karuna [39]	To automate classification into tumor and non-tumor categories	Tumor, non-tumor	Chakrabarty 2019	VGG19, VGG16, ResNet50, InceptionV3

III. PROPOSED MODEL

In the CNN pre-trained approach, there are several models approached for brain tumor categorization, in this research we employed only three pre-trained deep neural network models, including InceptionV3, VGG19, and ResNet50, to determine how well they performed when identifying and classifying brain tumors.

The proposed model is depicted in Fig. 1., which demonstrates a concise view of TL based approach for brain tumor categorization using brain MR images. The proposed TL model for brain tumor classification comprises the following steps.

Phase 1, we collected freely available Kaggle MR image dataset for training and validation sets, including meningioma, and schwannoma MR images, and we split the dataset into the training, validation, and test directory. For testing collected data sets are utilized that is gathered from well-known Hospitals of India.

In Phase 2, we employed train_datagen. flow_from_directory to read the MR images of the dataset from the training directory.

Phase 3, the preprocessing phase is an essential task before performing data enhancing operations. It includes the following scenarios: Normalization process is carried out to perform resize operation. The input image for InceptionV3, VGG19, and ResNet50 is normalized to 229 x 229 x 3.
Phase 4, a large number of datasets need to be used to train the deep learning model in order to improve accuracy. In every scenario, this method does not produce satisfactory results, especially when there are only small datasets available. The data augmentation process uses transformational techniques like rotation, scaling, and translation to increase the number of images to the database. The images in the training set are arbitrarily translated up to ten pixels vertically and horizontally, zoomed to a resolution of twenty pixels, and rotated at an angle between 90 degrees to increase the number of images. On the other hand, featurewise_center = True and feature wise_std_normalization = True, and rescaled to 1.0/255 for the validation set of images. For this ImageDataGenerator function was utilized to dynamically create sets of augmented images during the training, and validation process. Furthermore, the augmented images were only used to train the proposed framework, and also for the validation phase, hence, only real images which were collected from hospitals were utilized to test the learned framework.

TABLE II. DATA AUGMENTATION

Class	Total Slices	Augmented Images	Format	Type
Meningioma	1326	3345	JPG	Grayscale
Schwannoma	465	889		

Phase 5, for evaluating the performance of the proposed model, the dataset is split into 3-fold cross-validation train-validation-test set.
Phase 6, involves unfreezing some of the top layers in order to train the final base model layers as well as the newly added classifier layers. The method enables the base model's higher order feature representations to be fine-tuned so that they are more pertinent to the given task.
Phase 7, which divides brain tumors into binary classes. In the study, a softmax layer in the transfer learning models categorized images into two classes, meningioma, and schwannoma, by using the terms.
In this study we use pre-trained CNN models to classify brain tumors in two classes of meningioma and schwannoma.
The Fig. 2. depicts the general architecture of pre-trained TL classification for identifying and classifying brain tumors. Additionally, we assessed and validated each model to determine how well various pre-trained TL algorithms performed at classifying the various types of brain tumors.

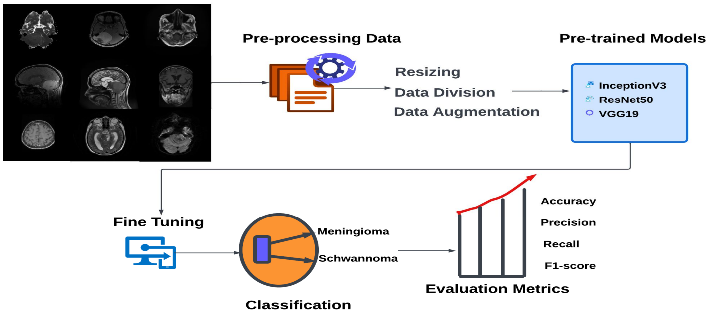


Figure 1. Proposed architecture

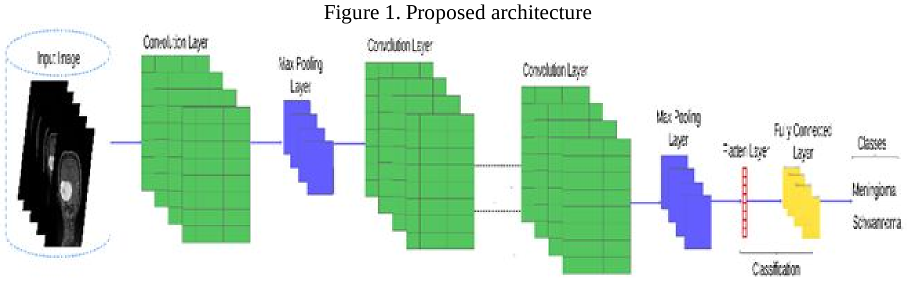


Figure 2. Architecture of pre-trained model

A. MR Dataset

In this work, the dataset exploited was downloaded from Kaggle 2020 [40] and combined with the collected dataset from Safdarjung Hospital New Delhi, PGI Hospital, and Medanta Hospital, India. Images are 512 x 512 pixels in size. For the collected dataset of every patient, radiologists examined independently the MRI image to define the pathological type. The dataset has different physiological structures, shapes, colors, and positions, etc. The sample of MRI images are given in Fig. 3. First row represents the meningioma type of brain tumor and second column shows schwannoma brain tumor, where they exhibit different appearances.

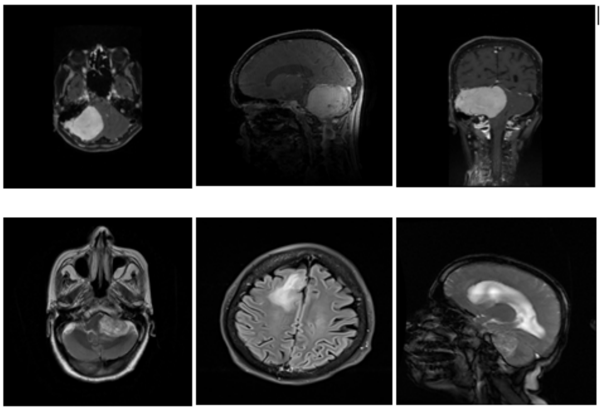
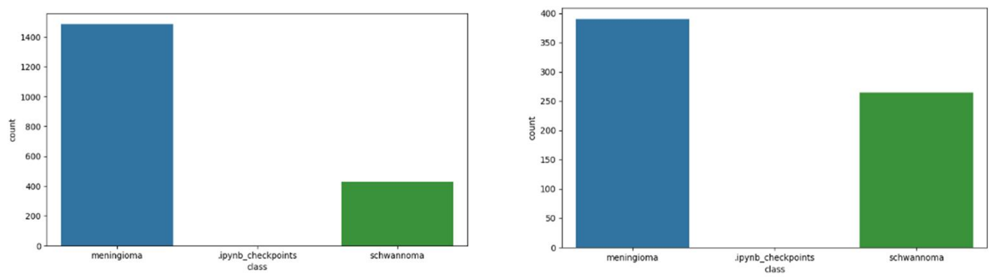


Figure 3. Sample MR images of two patients with meningioma and schwannoma brain tumor row wise

The dataset comprises of 1926 slices, including 1354 images belongs to training set and 572 images contains for validation set directory. In the Fig. 4. (a, b) shows the number of images contained in the training set for classification into meningioma and schwannoma brain tumor and validation set considered for tumor detection respectively. Further, Table III represents the dataset summary exploited in our study.



(a) (b)

Figure 4. Total number of images (a) Training set (b) Validation set

TABLE III DATA SPECIFICATION

Data	Source	MR Sequence	Total Image	Format
Kaggle (train + Validation)	Online	T1, T2, T1C+	1926	JPG
Collected (test)	SGPGI, Safdarjung, Medanta Hospitals	T1+C, T2, Flair	26	

IV. EVALUATION

In this section, thorough information is adopted of fine-grained brain tumor classification experimentation. i.e., the TL settings and it provides an in-depth discussion of the findings to assess the performance of our model. For this, the proposed framework uses three CNN architectures, such as InceptionV3, VGG19, and ResNet50.

A. Machine Settings

The pre-trained TL networks are employed for this research, i.e., InceptionV3, VGG19, and ResNet50, which can categorize images into numerous different type classes and are trained on 1.28 million images of the ImageNet database. The aim of this study is a two-class classification of brain tumors using the brain tumor dataset. Experiments were carried out by assigning different values to the parameters to determine the optimum values for each parameter. We utilized a 0.001 learning rate and a 32-image batch size. In addition, each deep learning model was trained up to 60 epochs to conduct the TL experiments for detecting and categorizing brain tumor types, accounting for the possibility of overfitting. We performed all experimentations on a machine equipped with T4-GPU. For implementation, we used the Google Colab version of PYTHON. The refined parameters used for the classification experiments. All the TL models were trained and validated on the same TL settings indicated in Table IV for the classification of brain tumors.

TABLE IV. PARAMETERS OF TRANFER LEARNING ARCHTECTURES

Parameter	Value
Classifier	SoftMax
Total Epochs	60
Optimizer	Adam
Verbose	1
Loss Function	Cross-Entropy
Activation Function	ReLU
Patience	10
Batch Size	32

B. Evaluation Metrics

We proposed the accuracy, precision, recall, and F1-score [6] in the study to evaluate the effectiveness of all deep transfer learning networks. These performance metrics are determined:

$$\text{Accuracy} = \frac{TP+TN}{TS} \quad (1)$$

$$\text{Precision} = \frac{TP}{TP+FP} \quad (2)$$

$$\text{Recall} = \frac{TP}{TP+FN} \quad (3)$$

$$\text{F1-score} = 2 * \frac{Precision*Recall}{Precision+Recall} \quad (4)$$

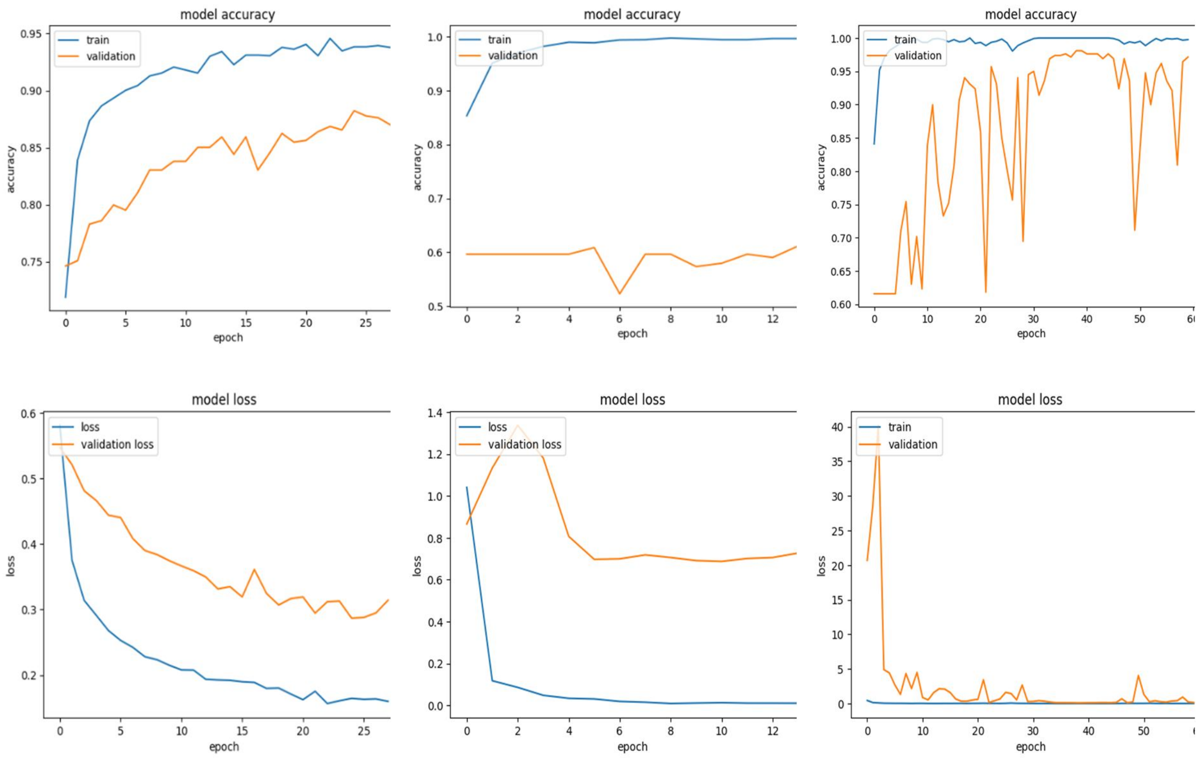
Where, TP stands for true positive, TN for true negative, FP for false positive, and FN for false negative and TS denotes the total number of images.

C. Results

This section analyses the functioning of different pre-trained TL models used to categorize the brain tumors dataset into meningioma and schwannoma. The major benefit of TL classifiers is to reduce overfitting problem and fine-tuning, which rapidly occur in deep learning algorithms when training with a smaller amount of images.

The training and testing accuracy of our best operated pre-trained models, i.e., VGG19, ResNet50, and Inceptionv3, is represented in Fig. 5. For this the data augmentation technique are used, which notably increased the size of dataset, all models took substantial time for classification. The experiment is carried out by setting number of epochs equal to 60. In each epoch, accuracy, training, and validation error is calculated. The proposed model achieves highest classification accuracy and lowest training and validation loss compared with other architectures. The accuracy and loss of each proposed model are shown in Fig. 5 column wise.

Table V represents the detailed results of various TL algorithms in classifying brain tumor images and shows that each TL classifier achieved satisfactory results. Using evaluation metrics for accuracy, precision, recall, and f1-score, we examined and assessed the TL algorithms. The results show that the InceptionV3 DL model achieved the best average accuracy of **99.72%**. Whereas, VGG16, and ResNet50 achieved the lowest average accuracy of 94.65%, 98.84% respectively. We also concatenate these three models by employing best saved model. As shown in Table V the ensemble model does not gives satisfactory results as compared to InceptionV3 model. The ensemble system, however, displays the lowest correctness metrics standard deviation, demonstrating that its



(a) VGG19 (b) ResNet50 (c) InceptionV3

performance is more consistent when tested with threefold cross-validation. It is essential to mention that data augmentation and hyper parameter tuning of the InceptionV3 framework achieved different results.

It is evaluated that the ensemble model does not gives satisfactory results as compared to InceptionV3, ResNet50, and VGG19 model. InceptionV3 model achieved effective results because of several reasons. This model can extract more robust, detailed, and discriminative, deep features. The proposed model InceptionV3 produced excellent performance in brain tumor classification which are shown in bold style in Table V. The comparison findings of Table V pre-trained models are represented in Fig. 6.

TABLE V. AVERAGE CLASSIFICATION ACCURACIES

Model	Evaluation Metrics				Total Time
	Accuracy	*Precision*	*Recall*	*F1-score*	
InceptionV3	**99.72%**	89.48%	**88.55%**	87.66%	25m14s
ResNet50	98.84%	**95.98%**	76.84%	**91.50%**	10m 56s
VGG19	94.65%	87.89%	84.66%	85.87%	35m20s
Ensemble Model(VGG19 + ResNet50 + InceptionV3)	85.68%	86.06%	86.76%	86.54%	10m 23s

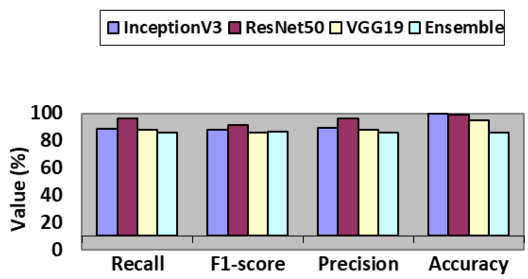


Figure 6. Comparison between pre-trained models

D. Comparison with state of art work

Table VI shows the comparison study among existing approaches and proposed work. For performance evaluation only accuracy metric more significantly evaluated in the approached research work. In the Table VI first column represents the related work, second column shows the models employed in each work. Whereas the third column shows the accuracies of the computed models. According to the Table VI, the InceptionV3 model of proposed work indicates 99.72% accuracy. Which is highest compared to existing state-of-art-work. Due to fine-tuned hyperparameter values and for testing meningioma and schwannoma brain tumor categorization includes real MRI images from Hospitals, which gives better results for tumor classification.

It is also demonstrated from Table VI that Zobeda and Nazrov [45], utilized same InceptionV3 model acquired least accuracy with 96.6% on binary classification. Whereas Srigiri & Yepuganti [39] also utilized InceptionV3 model and achieved 81.25% accuracy using 305 MR images.

TABLE VI. COMPARISON WITH PREVIOUS WORK

Work	Model	Accuracy
Srigiri & Yepuganti [39]	VGG19, VGG16, ResNet50, InceptionV3	99.48%, 99%, 97.92%, 81.25%
Mohsen et al. [41]	VGG19, ResNet101	99.98%
Fatima et al. [42]	EfficientNetB2	98.86%
Muezzinoglu et al. [43]	PatchResNet	98.10%
Anul et al. [44]	DCNNBT	99.18%
Zobeda and Nazarov [45]	InceptionV3	96.6%
Demir et al. [46]	MobileNetV2+KNN	99%
Proposed model	InceptionV3 + Augmentation + Fine tuning	99.72%

Also analysed that results acquired from other studies to classify brain tumor using CNN models ranged from 96 to 99% accuracy.

V. CONCLUSION

This paper represents a comparative analysis of InceptionV3, VGG19, ResNet50, and ensemble models for the classification of brain tumors. The goal of this effort was to automate the prediction of brain tumors by finding a better classifier for brain tumor classification. The deep learning models applied and classified brain tumors into meningioma and schwannoma using a classification MRI dataset. An accuracy of 99.72% signifies the effectiveness of InceptionV3 for reliable brain tumor classification. Despite the limited data we have achieved good results. For this, we have applied a data augmentation technique to increase the size of training and validation set. In the future, results can be further improved by training models with larger datasets.

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Privacy Preserving Support Vector Machines using Ring Learning with Errors

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***Abstract*— The growing concern of protecting privacy through machine learning has led to an emphasis on data sharing and analysis. Support Vector Machines (SVMs) are frequently used for classifying and predicting tasks and are renowned for their efficiency in numerous applications and their capacity to handle both linear and non-linear data. This paper presents a privacy-preserving SVM training scheme, maintained through using Ring Learning with Errors (Ring-LWE). The Ring-LWE function, which is composed of lattice-based cryptography, offers a secure framework for realizing privacy-preserving machine learning. Encrypted data sets of various sizes are trained, and the difference in accuracy between encrypted and normal datasets is negligible.For that reason, during the training of models that use confidential information, BFV(Brakerski/Fan-Vercauteren) encryption method can be applied to maintain the confidentiality of the data.**

***Index Terms*— Support Vector Machine, Privacy preserving, Homomorphic encryption, Ring-learning with errors**

I. INTRODUCTION

Privacy-preserving support vector machines (SVMs) are a promising approach to protect private data while carrying out machine learning tasks. The need for data security and privacy has become increasingly important as the world is digitized. Homomorphic encryption has gained a lot of attention in the field of machine learning for privacy-preserving SVMs. Support vector machines are commonly used for data mining and machine learning applications, such as image recognition, credit scoring, and medical diagnosis. Nevertheless, sharing the entire dataset can sometimes be a challenge due to privacy and security considerations. To overcome this obstacle, privacy-preserving support vector machines using homomorphic encryption have been developed. These methods allow the data to be studied and classified without posing any risks of unauthorized access to the original data.
Our research employed the BFV (Brakerski-Fan-Vercauteren) scheme, a reliable post-quantum cryptography method, to secure the whole dataset. This encryption has exceptional resistance to quantum attacks, making it an ideal choice for guaranteeing durable data security. Additionally, our approach uses a special technique called homomorphic encryption, which enables us to execute math operations on the encrypted data without requiring its decryption. This is a pivotal benefit for privacy-preserving machine learning, allowing us to obtain useful findings through computation while keeping the confidential information private.
This study aimed to show the effectiveness and practicality of using encryption for machine learning tasks. A Support Vector Machine (SVM) model was trained using the entire dataset in its encrypted form, which represents

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a significant improvement compared to traditional methods that require data to be decrypted before training, thus potentially compromising privacy. To evaluate the impact of the encryption and computation strategy, experiments were conducted on several different datasets, spanning various domains and sizes. These datasets were then encrypted and SVM models were trained on them. The performance of these models was then compared to those trained on their original, unencrypted datasets.

Our research contributes to the field of privacy-preserving machine learning by providing valuable insights into the trade-offs between data privacy and model accuracy. We conducted a comparison to assess the extent to which data encryption affects the predictive capabilities of an SVM model, showing the practicality and limitations of applying privacy-preserving techniques in a real-world context. Moreover, our findings also demonstrate the feasibility of training SVM models on fully encrypted datasets using the BFV scheme. It highlights the potential benefits and challenges associated with this approach, as well as the importance of post-quantum cryptography methods in maintaining the security of sensitive data used in machine learning applications. We provide valuable guidance for machine learning practitioners in their future endeavors with secure and confidential data analysis.

II. Literature Review

Due to developments in technology related to data analysis, there have been ethical concerns relating to privacy. The usage of Computation on Encrypted Data (COED) has been seen as a way to keep people's details private while simultaneously allowing data operations to be done. Kyung Hyun Han et al. [1] gave their suggestion for a fresh approach to efficiently employing a Gaussian sampler as well as a GPU-accelerated NTT algorithm to hasten encryption. This has applications in protecting the privacy of convolutional neural network calculations and privacy-preserving SVM classification. They evaluated the RLWE-IPFE encryption algorithm and determined the best optimizations for GPU processors. They suggested ways to assist in optimization, namely performing computations in parallel, removing the need for synchronization among threads, and implementing a more efficient indexing pattern.

In 2022, Yange Chen et al.[2] evaluated past research concerning privacy-protective SVM approaches, comprising of those that apply secure two-party computations, secure multi-party computations, and homomorphic encryption, and acknowledged that while these strategies have the potential to be good, they regularly confront substantial computational demands and restricted scalability. To tackle these shortcomings, they introduced a new process which utilizes a distributed two trap doors typical key cryptosystem (DT-PKC) during the SVM classification procedure to preserve the privacy of patients, and examined the semantic security of the DT-PKC and BGN cryptosystems using the ideal-reality game and security examination technique.

Pu Duan et al. [3] proposed a novel and proficient classification model utilizing a safe calculation system for nonlinear SVMs depending on the Gaussian kernel capacity. This protocol can be developed to different kernel capacities and lessen the measure of encoded information, make the figuring procedure more straightforward, and upgrade calculation productivity. They presented a system that incorporates a disseminated two trapdoors public-key cryptosystem that guarantees the secrecy of private information and support vectors.

III. Motivation

Today, in our increasingly data-driven world, privacy worries have hit unprecedented levels. With AI and artificial intelligence continuing to develop fast, there is a strong necessity to protect delicate facts, especially when it comes to businesses such as healthcare, finance, and individual analysis. In our attempts to fight against these protection difficulties, we wanted to step in.

Moreover, The Support Vector Machine (SVM) has become a beneficial tool in the machine learning field, renowned for its proficiency in categorizing and regression jobs. Unfortunately, classic SVM initiatives normally demand direct access to unprotected facts; which can be a severe danger to the safety of private information.

R-LWE is a robust cryptographic technique known for providing secure data protection and encryption in the post-quantum era. We were thus intrigued by the prospect of using sophisticated cryptographic techniques to ensure that sensitive data are protected, as well as enabling computations on them. It was a compelling incentive to look at what could be achieved by bridging the gap in machine learning and cryptography.

IV. Problem Domain

The field of Privacy-Preserving Support Vector Machines (SVMs) with Ring Learning With Errors (Ring-LWE) is multifaceted, encompassing subjects from machine learning and data analysis utilizing SVMs, encryption and secure computation through Ring-LWE, and knowledge of privacy hazards and their potential risks, in addition to recognizing the significance of data privacy and various categorization jobs.

Homomorphic encryption is a form of cryptography that involves transforming data into a form of encryption that can be used and studied in the same way as the original. This type of encryption allows for complex mathematical operations to be performed on encrypted data without sacrificing the integrity of the encryption. Ring Learning with Errors is a type of cryptography that relies on lattice problems. The fundamental mathematical problem in Ring Learning with Errors is to identify the coefficients of a hidden secret polynomial hidden in a set of chaotic polynomial evaluations. These evaluations are composed of a small amount of random noise that is multiplied by a random polynomial. The challenge lies in separating the hidden polynomial from the noisy evaluations, a task that is thought to be computationally difficult.

V. Problem Definition

This research is focused on finding a way to reconcile data protection and accuracy in machine learning. To do so, BFV, a scheme that defends against quantum attacks, and homomorphic encryption are utilized. A Support Vector Machine (SVM) can be trained on encrypted data, eliminating the need to decrypt it, which is the goal of this research. Experiments have been conducted to evaluate the effects of encryption on model performance and to explore the feasibility and limitations of the approach.

The challenge here is to establish a secure and confidential data analysis system for machine learning using sophisticated encrypted data techniques. Examples of such encryption systems include the BFV scheme and homomorphic encryption to train models on the data without compromising private or sensitive information[10]. This requires further investigation into how encryption impacts model accuracy and to devise effective strategies for safeguarding privacy while still obtaining meaningful results from the machine learning process.

VI. Statement

This research aims to understand the potential impact of data encryption on Support Vector Machine (SVM) models while preserving data privacy in machine learning. It tests the effectiveness of BFV scheme and holomorphic encryption on fully encrypted datasets in order to provide guidance on data security for real-world machine learning applications.

VII. Innovative Content

The paper "Privacy-Preserving Multi-Class Support Vector Machine Model on Medical Diagnosis" [2] explores a novel combination of homomorphic encryption and privacy-preserving multiclass support vector machine that will allow secure and private clinical diagnosis using cloud computing. It provides a viable option for medical professionals to obtain diagnosis support without surrendering individual data and confidentiality of the service providers.

With an improved performance on graphics processing units, the authors of the paper "cuFE: High Performance Privacy Preserving Support Vector Machine with Inner-Product Functional Encryption" [1] proposed a new implementation of IPFE. Optimization of the most laborious stage inside the IPFE plan led them to propose fresh tactics that could parallelize the Gaussian sampling. Compared to other approaches, the implemented method showed considerable speedups.

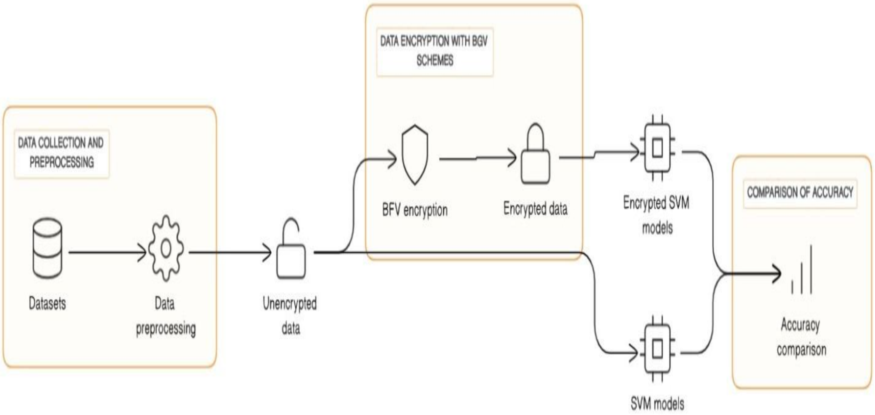
VIII. Problem Formulation

A. Data Collection and Preprocessing

Initially, we had carefully chosen datasets which covered a wide range of sizes, complexity and domains. This has enabled our analysis to be comprehensive and reflect the realities of today's world. Data sets were made up of data from a variety of areas, such as the health sector, finance and Social Sciences. Prior to model training, we conducted thorough data preprocessing to cleanse, standardize, and prepare the datasets for analysis. In order to assure the quality and coherence of data collected in our studies, this step was crucial.

B. SVM Model Training

Unencrypted Data: We took the unencrypted data and trained SVM models with it. This was used for evaluation purposes. The accuracy of these models, which represent their actual performance in the most common and standard form, has been recorded.



C. Data Encryption with BFV Schemes

Encryption of the same datasets using BFV has been a key stage in this process. It is known that this cryptographic technology can be used to secure data, while allowing for the computation of encrypted data. The use of BFV has ensured that the information is confidential and protected over an extended period of analysis [11]. In order to protect sensitive information, this encryption step introduces a new level of protection with regard to the privacy issues that arise when dealing with Personal or Confidential Information.

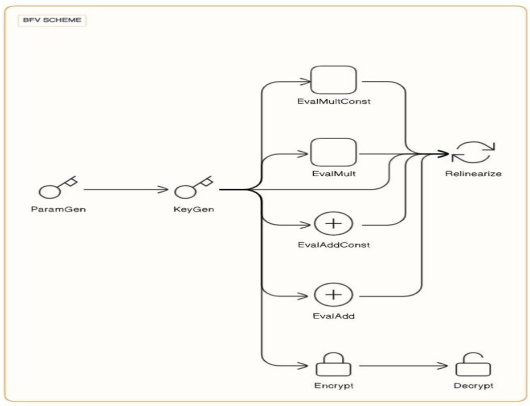
D. SVM Model Training

Encrypted Data: After encrypting our datasets, we trained SVM models with them[9]. A change from typical practices, this innovative method aimed to determine if machines could learn from encrypted data with better outcomes. Our recording of their accuracy gave us a foundation for assessing how they compared to baseline SVM models taught on uncovered information.

E. Comparison of Accuracy

The accuracy of SVM models trained on both the encrypted and unencrypted datasets was meticulously compared in the analysis's final stage. We were able to determine how data encryption affected model performance. It provided useful insights into the practicalities of using encryption algorithms like BFV in machine learning scenarios, shedding light on the trade-offs between privacy and utility.

IX. Solution Methodologies



BFV is a type of fully homomorphic encryption, which allows calculations to be carried out on encrypted data without having access to the decryption key[7]. This is achieved by forming two distinct rings: a plaintext ring and a cipher text ring. The plaintext ring is used to store unencrypted messages while the cipher text ring holds encrypted messages. As the homomorphism property of BFV establishes a link between these two rings [8], it is possible to apply functions between the two rings without having to decrypt data. This means that computations can be done on encrypted data without need for decryption.

In order to use the BFV scheme, one must first generate public and private keys. The process begins by selecting two prime numbers p and q such that q divides p-1. Subsequently, two polynomials f(x) and g(x), with coefficients in the integers modulo q, are chosen. The product of f(x) and g(x) is computed, modulo p, to produce h(x). A secret key is also chosen in the form of a polynomial of degree n-1, with coefficients in the integers modulo q. These two values as well as the parameters p, q, and n are used to create the public key (pk) and secret key (sk).
The encryption process is composed of the following steps:

1. Plaintext message m is changed into a polynomial m(x) which holds n-1 coefficients in the form of integers modulo q.
2. A random polynomial e(x) with n-1 coefficients expressed as integers modulo q is created.
3. Ciphertext c is generated by the addition of m(x) and 2e(x) modulo p, where the coefficients are each added individually.
4. The ciphertext c is encrypted using the public key pk.

The process of deciphering involves these steps:

1. Utilize the top-secret key sk to decrypt the ciphertext c, which yields the polynomial c'(x).
2. Employ the polynomial q to derive the message polynomial m'(x) by computing c'(x) modulo q.
3. Extract the plain text message m via deciphering the message polynomial m'(x).

The security of the BFV system is based upon how challenging it is to find the key s if one only has access to the public key pk and a collection of noisy ciphertexts.

TABLE I: HEART_FAILURE_CLINICAL_RECORDS DATASET

age	anaemia	creatinine_phosphokinase	diabetes	ejection_fraction	high_bp	platelets	serum_creatinine	serum_sodium	sex	smoking	time	DEATH_EVENT
75	0	582	0	20	1	265000	1.9	130	1	0	4	1
55	0	7861	0	38	0	263358	1.1	136	1	0	6	1
65	0	146	0	20	0	162000	1.3	129	1	1	7	1
50	1	111	0	20	0	210000	1.9	137	1	0	7	1
65	1	160	1	20	0	327000	2.7	116	0	0	8	1
90	1	47	0	40	1	204000	2.1	132	1	1	8	1
75	1	246	0	15	0	127000	1.2	137	1	0	10	1
60	1	315	1	60	0	454000	1.1	131	1	1	10	1
65	0	157	0	65	0	263358	1.5	138	0	0	10	1
80	1	123	0	35	1	388000	9.4	133	1	1	10	1

X. RESULTS AND SENSITIVITY ANALYSIS

In summary, the analysis of multiple datasets reveals a consistent trend: Compared to unencrypted data, model performance suffers when trained on encrypted information. Due to data encryption, this decrease is expected because it introduces additional noise and complexity that complicate pattern recognition in models.
With varying drops across datasets, accuracy degenerates; 3%, 2%, and 5% being the respective decrements felt by Datasets 1 through 3. Data characteristics and encryption approaches differ in these cases. Encryption offers significant advantages over non-encrypted data despite slight reductions in model precision.

XI. DATA MODEL

Davide Chicco and Giuseppe Jurman [4] propose the possibility of predicting the likelihood of survival in heart failure cases using just two health metrics: serum creatinine and ejection fraction. This approach of machine learning relies on a single data point for each individual, where each row stands for a person and every column additionally designates a unique health metric. Besides, the study implies that these two key factors might be incredibly useful in deducing the fate of people convalescing from heart failure.
Table II consists of more than 4,240 records and 16 attributes[5], enabling prediction of a 10-year risk of coronary heart disease (CHD). Its value to researchers and healthcare professionals is immeasurable as it assists them in assessing and understanding the risks related to CHD. With the support of this dataset, predictive models can be developed to highlight those at greater risk of this potentially deadly heart condition and allow for timely interventions and proactive healthcare strategies.
Table III, entitled "Gender Recognition by Voice and Speech Analysis," was built with the goal of distinguishing between male and female voices. It consists of 3,168 sound recordings with both male and female speakers. This dataset is a valuable asset to those exploring the development of models which can identify gender through analyzing voice and speech.

TABLE II: FRAMINGHAM DATASET

male	age	education	current smoker	CigsPerDay	BPMeds	PrevalentStroke	PrevalentHyp	diabetes	TotChol	sysBP	diaBP	BMI	heartRate	glucose	TenYearCHD
1	39	4	0	0	0	0	0	0	195	106	70	26.97	80	77	0
0	46	2	0	0	0	0	0	0	250	121	81	28.73	95	76	0
1	48	1	1	20	0	0	0	0	245	127.5	80	25.34	75	70	0
0	61	3	1	30	0	0	1	0	225	150	95	28.58	65	103	1
0	46	3	1	23	0	0	0	0	285	130	84	23.1	85	85	0
0	43	2	0	0	0	0	1	0	228	180	110	30.3	77	99	0
0	63	1	0	0	0	0	0	0	205	138	71	33.11	60	85	1
0	45	2	1	20	0	0	0	0	313	100	71	21.68	79	78	0
1	52	1	0	0	0	0	1	0	260	141.5	89	26.36	76	79	0
1	43	1	1	30	0	0	1	0	225	162	107	23.61	93	88	0

TABLE III. VOICE DATASET

meanfreq	sd	median	Q25	Q75	IQR	skew	kurt	sp.ent	sfm	mode	centroid	meanfun	minfun	maxfun	meandom	mindom	maxdom	dfrange	modindx	label
0.05978	0.06424	0.03203	0.01507	0.09019	0.07512	12.8635	274.403	0.89337	0.49192	0	0.05978	0.08428	0.0157	0.27586	0.00781	0.00781	0.00781	0	0	1
0.06601	0.06731	0.04023	0.01941	0.09267	0.07325	22.4233	634.614	0.89219	0.51372	0	0.06601	0.10794	0.01583	0.25	0.00901	0.00781	0.05469	0.04688	0.05263	1
0.07732	0.08383	0.03672	0.0087	0.13191	0.12321	30.7572	1024.93	0.84639	0.4789	0	0.07732	0.09871	0.01566	0.27119	0.00799	0.00781	0.01563	0.00781	0.04651	1
0.15123	0.07211	0.15801	0.09658	0.20796	0.11137	1.23283	4.1773	0.96332	0.72723	0.08388	0.15123	0.08896	0.0178	0.25	0.2015	0.00781	0.5625	0.55469	0.24712	1
0.13512	0.07915	0.12466	0.07872	0.20604	0.12732	1.10117	4.33371	0.97196	0.78357	0.10426	0.13512	0.1064	0.01693	0.26667	0.71281	0.00781	5.48438	5.47656	0.20827	1
0.13279	0.07956	0.11909	0.06796	0.20959	0.14163	1.93256	8.3089	0.96318	0.73831	0.11256	0.13279	0.11013	0.01711	0.25397	0.29822	0.00781	2.72656	2.71875	0.12516	1
0.15076	0.07446	0.16011	0.0929	0.20572	0.11282	1.53064	5.9875	0.96757	0.76264	0.0862	0.15076	0.10594	0.02623	0.26667	0.47962	0.00781	5.3125	5.30469	0.12399	1
0.16051	0.07677	0.14434	0.11053	0.23196	0.12143	1.39716	4.76661	0.95925	0.71986	0.12832	0.16051	0.09305	0.01776	0.14414	0.30134	0.00781	0.53906	0.53125	0.28394	1
0.14224	0.07802	0.13859	0.08821	0.20859	0.12038	1.09975	4.07028	0.97072	0.77099	0.2191	0.14224	0.09673	0.01796	0.25	0.33648	0.00781	2.16406	2.15625	0.14827	1
0.13433	0.08035	0.12145	0.07558	0.20196	0.12638	1.19037	4.78731	0.97525	0.80451	0.0117	0.13433	0.10588	0.0193	0.2623	0.34036	0.01563	4.69531	4.67969	0.08992	1

XII. COMPARISON OF RESULTS

Datasets	Accuracy of training model of unencrypted data	Accuracy of training model of encrypted data
Dataset 1	71	68
Dataset 2	63	61
Dataset 3	67	62

Across all datasets, accuracy declines when the model is trained using encrypted data as opposed to unencrypted data. This is expected since transforming the data can introduce extra noise and complexity, hindering the model's ability to recognize the patterns. The dip in accuracy is steady for all datasets, indicating that the effects of encryption on model efficiency remain relatively constant. This consistency can help in scenarios where privacy and protection are essential for decision-making and resource distribution. Yet, the degree of accuracy decrease varies from dataset to dataset. Dataset 1 experienced a decrease of 3 percentage points, in Dataset 2 it was 2 percentage points, and for Dataset 3 it was 5 percentage points. These variations could be due to the specific traits of the data as well as the encryption methods used. The difference in accuracy between the encrypted and normal datasets was negligible.

XIII. JUSTIFICATION OF THE RESULTS

The paper called "cuFE: High Performance Privacy Preserving Support Vector Machine with Inner-Product Functional Encryption" examines various techniques for implementing privacy-preserving Support Vector Machines (SVMs). The authors make use of homomorphic encryption algorithms as a way to secure the SVMs.

A different paper, "Privacy-Preserving Multi-Class Support Vector Machine Model on Medical Diagnosis," looks at the implementation of two encryption schemes based on Deterministic Trapdoor Public Key Cryptography (DT-PKC) and the BGN cryptosystem to achieve privacy preservation when using an SVM model.

Our study focuses on utilizing the BFV encryption scheme for homomorphic encryption in regards to the implementation of privacy-preserving Support Vector Machines. This method allows us to make sure that sensitive data is kept secure while allowing us to do operations on the encrypted data within the context of SVM, which proves the efficiency of advanced cryptographical techniques in preserving privacy with a maintained utility of machine learning models. This aligns with the strategies discussed in prior papers that also looked into DT-PKC, BGN cryptosystem, and homomorphic encryption.

XIV. Conclusion

Through our experiments, we trained Support Vector Machine (SVM) models using both normal and encrypted datasets of various sizes. The remarkable finding was that the difference in accuracy between the encrypted and normal datasets was negligible.. This outcome underscores the effectiveness of our approach in preserving data privacy within SVM. It serves as strong evidence that the use of Ring Learning With Error encryption allows us to secure and process data while still achieving the desired SVM results, affirming the practicality of privacy-preserving machine learning.

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Skin Disorder Diagnosis through Soft Computing: A Comprehensive Overview

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***Abstract*— In the modern world, skin conditions and lesions have risen to the top of the list of illnesses that affect individuals of all ages. Bacterial skin infections, fungal skin infections, eczema, and scabies are common skin diseases that individuals over the world experience, but especially so in underdeveloped nations. The traditional approach for diagnosing skin cancer is through biopsies. The skin is removed or scraped off, and the subject then goes through a series of laboratory tests. A type of category of illnesses known as skin disorders divides the various states of the skin's cells into hierarchical levels of development. Death may occur if the sickness is not contained as it spreads. Skin diseases are brought on by a variety of internal and environmental variables, including dietary differences, different organisms' cells, hormonal imbalances, and immune system disorders. In this paper we are comprehensive overview of skin disorder diagnosis through soft computing using ANN, SVM and Image Processing-Based Technique Also brief work about our research methodology and related work of skin disorders.**

***Index Terms*— ANN, SVM, Skin Diseases, Image Processing-Based Technique.**

I. INTRODUCTION

Skin cancer is a fatal disease that affects the skin. The form of skin cancer might be benign or aggressive. Moles on the skin simply seem as benign melanoma. The symptoms of malignant melanoma include bleeding sores. Malignant the most deadly type of skin cancer is melanoma. It develops from a pigmented skin lesion that has malignant development. It is a disorder that starts in skin's melanocytes and spreads gradually [1]. Other than second skin disease, acne is a less prevalent sort of skin condition. However, if it is not discovered in the early stages of the disease, it is extremely dangerous and fatal. It raises the percentage of mortality from skin cancer up to (75%) of all deaths. According to American Cancer Society forecasts, there will be an increase of more than 76000 new instances of skin illness in 2014. Less than 7% of occurrences of skin cancer are caused by this less frequent kind of skin illness. However, because it has a higher propensity to metastasis than other skin tumors, it is by far the most dangerous.2. Types of Question Answering System: Due to this trait, psoriasis and acne are the most deadly types of skin cancer (melanoma is predicted to be the cause of more than 75% of skin cancer-related fatalities in 2012) [2]. However, this particular skin condition has been regarded as among the most dangerous because it is dangerous and its prevalence has been gradually rising over time. Another disorder that affects the skin cells is acne. To quantitatively represent this state in photographs taken with a regular camera, a structure of High Level Intuitive Features (HLIFs) is provided. Whiteheads, blackheads, red, inflamed areas, and other acne-

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related skin conditions commonly affect the face and shoulders. With rising rates and subjectivity in various types of current clinical skin detection methods, psoriasis is the dangerous and harmful form of skin disease. As a result, Skin disease detection decision support systems are required, of which feature extraction is a crucial and valuable step. Standard camera images have lower and higher limits on their capacity to detect diseases since they are low-level characteristics that exist in high-dimensional image feature spaces, if we analyse the existing features of the set of photos for analysis. In [3] Images using several applications of the ABCD-rule for skin diseases a novel practical method for the early identification and detection of skin diseases is dermatoscopy. Dermatologists frequently employ matrices like the ABCD [4] or the seven-point checklist [5] (Skin asymmetry, border irregularity, colour patterns, and region's diameter). It provides an introduction to the 7-point checklist algorithm, which is an algorithm for detecting skin diseases like acne and psoriasis [6]. The symmetry is used, but it's highly objective and subjective, which causes a lot of variation in the observations [7]. Acne prevalence is on the rise, and systematic objective decision support systems can help meet the need while lowering subjectivity. A few of the current clinically employed detection dermoscopy, multispectral imaging, thermal imaging, and hyper spectral imaging are examples of approaches, to mention a few. Currently used electromagnetic, acoustic, and mechanical waves are used in skin imaging techniques [8].

II. Literature Survey

Numerous authors are producing intriguing results using a variety of methods and classifiers:
Kumar et al.'s computer-based detection method, described in their study [9], utilizes image processing techniques and artificial intelligence. The process involves several stages, including collecting dermoscopic images, filtering them to eliminate hair and noise, segmenting the images using a Maximum Entropy Threshold value, extracting features using GLCM (Gray-Level Co-occurrence Matrix), and finally, classifying the images using the KNN (K-Nearest Neighbours) algorithm.
C. Barata and colleagues introduced a comprehensive approach in their work [10], which revolves around leveraging a Computer-Aided Design (CAD) tool equipped with a multifaceted set of functionalities. This tool not only facilitates picture acquisition but also encompasses image processing, feature extraction, and diagnostic capabilities. Their proposed methodology lays the foundation for a robust framework designed to enhance various aspects of the research.
In this research paper, K. K. Singh et al. [11] present a comprehensive methodology for evaluating the efficacy of picture histogram equalization. This approach involves the utilization of an image's Gray Level Co-occurrence Matrix (GLCM) as a pivotal component in the process of obtaining a wavelet decomposition specifically tailored for the analysis of human skin tissue. This method is designed to contribute valuable insights and advancements in the field of image processing and medical imaging.
In their research study, Bromiley et. al. [12] Introduced a novel approach aimed at enhancing the precision of skin disease detection. Their innovative methodology involves the integration of rapid skin disease detection techniques with the fusion of two distinct image segmentation processes to precisely identify skin lesions. A pivotal aspect of their work is the proposal of a novel function designed for capturing colour variation images and facilitating border recognition. These functions are particularly valuable in the context of images acquired using smartphones, offering a promising avenue for improved skin lesion diagnosis.
In the realm of comparative analysis employed within the context of colour and textural features, K. Wang [13] implemented a specific methodology. His research revealed a nuanced understanding of how colour features interact with other factors in producing outcomes. Notably, Wang observed that colour features in isolation tended to yield suboptimal results. However, when integrated with complementary factors, their performance improved significantly. Wang also undertook meticulous adjustments to the results within the global and local methodologies. In the global approach, he achieved a commendable sensitivity of 96% alongside a specificity of 80%. Meanwhile, within the local methodology, his efforts yielded a remarkable sensitivity of 100% and a specificity of 75%. These findings underscore the intricate interplay of colour and other features in the analytical domain, shedding light on the potential for synergistic enhancements in outcome quality.
In their research paper, Ahmad and colleagues [14] present a novel approach to diagnosing Erythemato-Squamous illnesses. They propose a Feature Selection technique that utilizes a Linguistic Hedges Neural-Fuzzy classifier. Their method, employing three clusters and incorporating 18 fuzzy rules, was subjected to rigorous performance evaluation across four training-testing partitions. The results revealed outstanding classification accuracy, achieving a Root Mean Square Error of 6.5139e-013 for the 80–20% training–test partition.
In their research work [15], Sunday and Hossain introduced an innovative approach for the diagnosis of erythemato-squamous diseases, wherein they advocated the adoption of an extreme learning machine (ELM).

Their research involved a comprehensive comparative analysis, juxtaposing the outcomes of ELM against those derived from a conventional artificial neural network. The investigation yielded substantive insights, unequivocally demonstrating that the ELM exhibited superior attributes, including exceptional learning speed, commendable generalization performance, and an inherent simplicity of implementation. These findings contribute significantly to the body of knowledge surrounding the application of ELM in medical diagnostics, shedding light on its potential as a powerful tool for efficient and effective disease identification.

In their study [16], F. Bapko and L. Kabri harnessed the power of artificial neural networks to meticulously ascertain the presence of a diverse array of skin conditions, achieving an impressive diagnostic success rate of 90%. Furthermore, their investigation delved into the identification of distinct characteristics unique to areas afflicted by skin cancer, shedding light on critical insights within this domain of medical research.

In their comprehensive examination of a decision-support system predicated on the semantic analysis of melanoma images, Karol et. al., [17] harnessed the capabilities of Artificial Neural Networks (ANNs) and Support Vector Machines (SVMs) for the purpose of classification. After a thorough exploration of various kernel functions in SVMs, their study culminated in the discernment that the linear kernel, when employed within a support vector machine framework, yielded the most superior results in terms of classification accuracy and performance. Their meticulous investigation lends valuable insights into the efficacy of linear kernel SVMs within the context of melanoma image analysis, demonstrating the significance of this finding for the broader field of medical image classification.

In their study, Rouhollah and Mohammad [18] utilized an intelligent system for the diagnosis and prediction of oral disorders, including conditions such as Lichen Planus, Leukoplakia, and Squamous cell carcinoma. The results of their research revealed a remarkably low training error of 0.0199. Similarly, Stephen et al. [19] harnessed the power of Support Vector Machine to enhance the diagnosis of melanoma. Their findings demonstrated that this approach achieved a noteworthy average sensitivity of 0.86 and specificity of 0.72, which plays a pivotal role in supporting clinical decision-making processes. These research outcomes underscore the effectiveness of these intelligent systems in the realm of medical diagnosis and signify their potential to significantly impact the field.

To elucidate the feature extraction process employed in this research paper, J. Abdul et al. [20] leveraged the 2D Wavelet Transform technique. Subsequently, for the crucial task of classification, the researchers employed a Back-Propagation Neural (BPN) Network. This network effectively partitioned the available dataset into two distinct categories: malignancy and non-cancerous cases. It is noteworthy to mention that within the field of dermatology, a widely accepted and practiced guideline is the ABCD rule, which serves as a fundamental reference point for evaluating skin lesions.

III. Methodology

The approach that will be employed in this study to categorize and comprehend different skin illnesses as the following is the process:

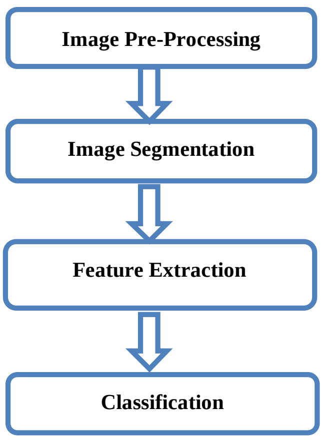

Fig. 1 Block Diagram of Skin Diseases Detection System

A. Image Pre-Processing

In most cases, the picture that is utilized for image pre-processing is an index image, so RGB skin photos must first be converted to index images before further processing. Here, we apply image conversion methods to the acquired image, such as converting an image of diseased skin illness into a binary image. In order to use the most recent image obtained for additional processing. We prepare an obtained image for further use by making it acceptable for additional image pre-processing operations. The primary goal of picture pre-processing is to improve the quality of the photos. Images have undergone several adjustments as part of the quality improvement process, including noise removal from a selected image, edge detection, edge shaping, brightness, contrast, hair removal, cropping, and resizing. Our primary goal in this stage is to improve the image, so we first remove any unnecessary components from the processed image. Next, we adjust the image matrix and remove any noise from the image.

B. Image Segmentation

A digital image is actually divided into a number of pieces throughout this procedure. To make analysis and generating a useful and relevant image easier, the real work of image segmentation and histogram plotting is done using equations (1) and (2). This image is then utilized to extract features. The thresholding approach is one of the earliest and most basic strategies used in this procedure.

C. Feature Extraction

In fact, by taking this action, we are reducing the resources required to interpret a substantial amount of processed data. In the segmented image, we abstract the texture, colour, and geometry of the image. Regularity, smoothness, medium rate, aspect ratio, parameter, compactness, boundary and edge detection, among other things, are some of the texture's main attributes. Simply said, a texture is a highly complex visual pattern made up of major entities and subordinate entities with traits like brightness, colour, slopes, size, etc.

D. Classification

To distinguish malignant melanoma from other skin conditions, a classifier is used. Artificial Neural Network (ANN)-based classifiers are employed based on the computational simplicity. In the realm of decision analysis, decision trees [21] serve as graphical representations that delineate choices and their associated potential ramifications. These decision trees exhibit a tree-like hierarchical structure, commencing with a root node that subsequently branches into child nodes. Within a decision tree, three distinct types of nodes are discernible: chance nodes, decision nodes, and end nodes. Chance nodes, denoted by circular shapes, encode the probabilities of various outcomes. End nodes signify the ultimate results of particular decision paths, whereas decision nodes, characterized by square shapes, signify pivotal decision points that necessitate choices. A system for detecting the presence of a disease and classifying it, if it is, is known as a skin disease detection and classification system. Decisions made based on features gathered utilizing feature extraction methods form the basis of categorization [22].

IV. SOFT COMPUTING TECHNIQUES

A. Artificial Neural Networks (ANN)

The structure and operation of biological neural networks in the brain serve as the basis for the mathematical model known as an artificial neural network (ANN), also known simply as a neural network. A number of artificial neurons, or nonlinear processing units, are connected to one another by weights in an ANN, which can be trained and predicted. By changing weights, ANN can "learn" a task. ANNs have been effectively employed to solve classification problems in a variety of domains, including biology, medicine, industry, control engineering, software engineering, environmental analysis, and economic and social applications [23]. A feed forward ANN model known as a multilayer perception is widely utilized to address a variety of issues. The most general-purpose and widely used neural-network paradigm at the moment is the back propagation network, also known as a multilayer network, which trains the network using the gradient descent method.

B. Support Vector Machine (SVM):

For classification and regression analysis, supervised learning models called support vector machines are used. It is a classifier that is frequently used in bioinformatics. In higher dimension future space, a support vector machine creates an ideal hyper plane with the equation wT x + b = 0. This uses the largest available margin to distinguish data from different classes. The margin is the separation between an ideal hyperplane and a vector (for example) that lays a close second. The decision function f(x) = sign (wT x + b) is used for classification, where x stands for the test data variables and w and b are plane coefficients. SVM performs best when creating hyper planes in the so-called feature space Z, a high-dimensional space, as opposed to the input space. In a higher dimensional space, an ideal separation hyper plane can be created by substituting the dot product of data points with a kernel function [23].

C. Image Processing-Based Technique:

Arnal Barbedo [24] studied various classification techniques for both human and plant skin disease detection. By using innovative approaches that make use of image processing, the signs of illness are discovered on stems or leaves. The main objective of the plan is to increase the rate of detection while identifying, measuring, and categorizing the infection. But despite using a greater number of illnesses, the approach failed to detect sickness. Skin conditions that could be bacterial, fungal, allergic, enzyme, or other were exceedingly damaging to the skin and could spread if not precisely identified as soon as feasible. It is now essential to precisely identify the type of sickness at an early stage and control it by taking the necessary safeguards. Therefore, the core of image processing and a genuinely effective method was automatic image analysis. It becomes important for delivering the quantitative information connected to skin diseases, especially in the medical industry. Therefore, during therapy, demonstrated to be a useful early warning system for potential issues. Today, it was necessary to accurately detect disease without penetrating the body; as a result, digital images of the diseased skin region were simply acquired by the camera and could be processed using image processing tools. Numerous image processing tool sub-techniques were in use and had a significant impact on research. Megha Tijare [25] has created an effective algorithm for classifying disorders using image processing software.

V. Conclusion

Therefore, the integration of advanced image processing techniques for feature extraction and machine learning algorithms holds immense promise in revolutionizing skin disease diagnosis, making it more accessible, cost-effective, and efficient, ultimately contributing significantly to reducing mortality rates, curbing disease spread, and mitigating skin disease progression. This study has refined various parameter values from infected skin conditions including psoriasis and acne that were obtained using the active contour method. This paper encompasses an analytical approach involving surveys and interviews with skin treatment and disease specialists. The system comprises two primary components: 1) Image Segmentation and 2) Feature Extraction.

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Precision Agriculture using Machine Learning and IoT for Optimal Crop Growth and Yield

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***Abstract*— This paper presents an innovative approach to improving agricultural practices using modern technologies such as machine learning, IoT, and image processing. The proposed system includes two main modules: fertilizer prediction and crop recommendation and crop disease detection. The first module utilizes machine learning algorithms to analyze data from various sources such as soil sensors, weather stations, and historical crop yield data to predict optimal fertilizer requirements and recommend suitable crops for the specific soil type and climate. The second module employs image processing and Convolutional Neural Network (CNN) algorithms to detect crop diseases by analyzing images captured by IoT devices such as drones and cameras. The proposed system aims to increase crop yield, reduce the cost of crop maintenance, and promote sustainable farming practices. The results of this research demonstrate the potential of smart agriculture technologies in improving food security and agricultural sustainability.**

***Index Terms*— Smart irrigation system, data analytics in agriculture, precision agriculture.**

I. INTRODUCTION

Agriculture plays a significant role in ensuring food security and is the backbone of many economies. However, traditional agricultural practices are often inefficient and labor-intensive, resulting in lower crop yields and higher maintenance costs. With the rapid advancements in technology, there is an opportunity to modernize agriculture and make it more efficient and sustainable. This project proposes a smart agriculture system that integrates machine learning, IoT, and image processing technologies for fertilizer prediction, crop recommendation, and crop disease detection.

The proposed system utilizes various sensors, including DHT11 for measuring temperature and humidity, and soil moisture sensors for collecting data on soil moisture levels. The collected data is uploaded to the cloud using the Blink platform, where it is analyzed using machine learning algorithms. The system then uses this data to predict optimal fertilizer requirements and recommend suitable crops for the specific soil type and climate.

In addition to fertilizer prediction and crop recommendation, the proposed system also includes a crop disease detection module. The system captures images of crops using IoT devices such as drones and cameras and analyzes them using image processing and Convolutional Neural Network (CNN) algorithms. This helps to detect crop diseases at an early stage, allowing farmers to take timely action to prevent their spread and minimize crop losses. The integration of IoT technologies and machine learning algorithms in agriculture has the potential to revolutionize the sector by increasing crop yields and reducing maintenance costs. Furthermore, the use of sustainable agricultural practices will also help to conserve natural resources and promote a more environmentally

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friendly approach to farming. The following sections provide a detailed description of the system architecture, data collection, and analysis methodology

II. HELPFUL HINTS

There have been several research papers published on the topic. Here are summaries of some of the notable research papers:

1. "Integration of IoT and Machine Learning for Precision Agriculture" This paper proposes an integrated framework that combines IoT devices and ML algorithms to optimize resource management in precision agriculture, improving crop yield and minimizing environmental impact.
2. "Crop Yield Prediction using Machine Learning Techniques in Precision Agriculture" The study focuses on using ML techniques to predict crop yield based on historical data, weather conditions, soil quality, and other relevant factors. The results demonstrate the potential for precise yield estimation in agriculture.
3. "Smart Irrigation System for Precision Agriculture using IoT and ML" This paper presents a smart irrigation system that utilizes IoT sensors to collect data on soil moisture, temperature, and humidity. ML algorithms analyze the data to optimize irrigation scheduling, leading to efficient water usage and improved crop health.
4. "Weed Detection and Classification in Precision Agriculture using Machine Learning" The research focuses on developing ML-based algorithms for weed detection and classification in crop fields. The proposed approach enables precise and timely weed control, reducing the use of herbicides and minimizing yield loss.
5. "Disease Diagnosis in Crops using IoT and Machine Learning in Precision Agriculture" This study proposes a system that combines IoT sensors and ML techniques to diagnose diseases in crops. By monitoring environmental conditions and analyzing plant health data, the system enables early detection and targeted treatment of crop diseases.
6. "Optimal Fertilizer Recommendation using Machine Learning and IoT in Precision Agriculture" The paper presents a method for optimizing fertilizer application in precision agriculture by integrating ML algorithms with IoT data on soil nutrients and crop requirements. This approach ensures efficient nutrient management and minimizes environmental impact.
7. "Crop Monitoring and Yield Estimation using IoT and Machine Learning"This research focuses on developing a comprehensive crop monitoring system that utilizes IoT devices for data collection and ML algorithms for yield estimation. Accurate monitoring and prediction contribute to improved decision-making in precision agriculture.
8. "Real-time Pest Detection and Control using IoT and Machine Learning in Precision Agriculture"The study proposes an integrated system that combines IoT sensors and ML algorithms for real-time pest detection and control. By analyzing sensor data, the system provides early warnings and enables targeted pest management strategies.
9. "Energy-Efficient Sensing and Communication in IoT-based Precision Agriculture" This paper addresses energy efficiency challenges in IoT-based precision agriculture systems. It explores ML-based techniques to optimize energy consumption in sensor networks, prolonging battery life and reducing maintenance efforts.
10. "Predictive Maintenance in Precision Agriculture using Machine Learning and IoT" The research focuses on developing ML-based models to predict and prevent equipment failures in precision agriculture. By analyzing sensor data from agricultural machinery, proactive maintenance strategies can be implemented to minimize downtime.
11. "Automated Irrigation Control using ML and IoT in Precision Agriculture" This study presents an automated irrigation control system that utilizes ML algorithms and IoT sensors. By considering factors such as soil moisture, weather conditions, and plant water requirements, the system optimizes irrigation scheduling for improved water management.
12. "Drought Monitoring and Prediction using IoT and Machine Learning in Precision Agriculture" The paper proposes a system for drought monitoring and prediction in precision agriculture. By analyzing IoT data on soil moisture, weather patterns, and crop stress indicators, ML algorithms provide early warnings and inform water conservation strategies.
13. "Smart Pest Management in Precision Agriculture using IoT and ML" This research focuses on developing a smart pest
14. "Optimal Harvesting Time Prediction using Machine Learning in Precision Agriculture" This study proposes an ML-based approach to predict the optimal harvesting time for crops. By analyzing data on plant growth, weather conditions, and crop maturity indicators collected through IoT devices, farmers can make informed decisions to maximize yield and quality.

15. "Sensor Fusion Techniques for Data Integration in Precision Agriculture using IoT and ML" The paper investigates sensor fusion techniques for integrating data from multiple IoT devices in precision agriculture. ML algorithms are employed to process and combine data from different sensors, enhancing the accuracy and reliability of agricultural monitoring systems.
16. "Water Quality Monitoring in Precision Agriculture using IoT and Machine Learning" This research focuses on monitoring water quality in agricultural systems using IoT devices and ML techniques. By analyzing data on pH levels, nutrient concentrations, and contaminants, the system helps farmers maintain optimal water conditions for crop growth.
17. "Automated Crop Disease Identification using ML and IoT in Precision Agriculture" The study proposes an automated system for crop disease identification in precision agriculture. ML algorithms analyze data from IoT sensors, including images and plant health indicators, enabling early disease detection and targeted treatment.
18. "Smart Nutrient Management in Precision Agriculture using IoT and Machine Learning" This paper presents a smart nutrient management system that integrates IoT sensors and ML algorithms. By continuously monitoring soil nutrient levels and crop requirements, the system optimizes fertilizer application, ensuring balanced nutrient supply for improved crop health and productivity.
19. "Real-time Weather Monitoring and Prediction for Precision Agriculture using IoT and ML" The research focuses on real-time weather monitoring and prediction in precision agriculture. By collecting data from IoT weather stations and employing ML models, the system provides accurate and timely weather forecasts, enabling farmers to make informed decisions for crop management.
20. "Crop Growth Modeling and Yield Prediction using Machine Learning in Precision Agriculture" This study proposes a crop growth modeling framework that utilizes ML techniques to predict crop yield based on various factors such as historical data, weather conditions, and crop management practices. The model provides valuable insights for optimizing crop production and resource allocation.

Overall, these research papers demonstrate the potential of smart agriculture systems that leverage IoT and machine learning to improve crop production and promote sustainable agriculture. The papers highlight the importance of data analysis, sensor technology, and real-time recommendations for optimizing crop growth and minimizing waste.

III. METHODOLOGY

A. Hardware

The Project consists of following equipments :

1. Nodemcu

The NodeMCU comes with a firmware preloaded, which includes a Lua interpreter and a set of libraries for Wi-Fi, GPIO, and other functions. It can be programmed using Lua scripts, but it is also compatible with the Arduino IDE and can be programmed using the Arduino language. In addition to its built-in Wi-Fi capabilities, the NodeMCU can also be used with various sensors and actuators, making it a popular choice for IoT projects. It also supports the MQTT protocol for IoT messaging and has a built-in web server for creating web based user interfaces.

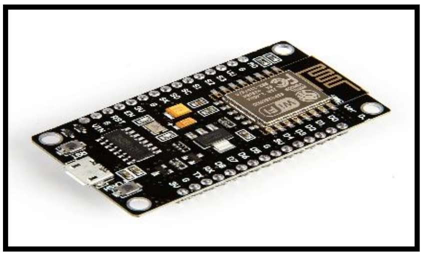

Fig 1: Node MCU

2. DHT

DHT stands for Digital Humidity and Temperature sensor. It is a type of sensor that can measure both humidity and temperature levels in the surrounding environment. There are various types of DHT sensors available, but the most common ones are the DHT11 and DHT22 sensors. The DHT sensors use a capacitive humidity sensor and a thermistor to measure humidity and temperature, respectively. The sensor outputs a digital signal that can be read by a microcontroller or other electronic device.

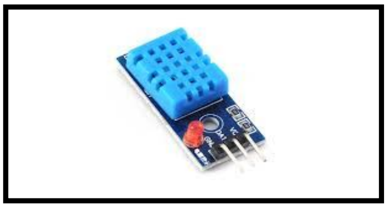

Fig 2: DHT sensor

The DHT11 is a low-cost sensor that can measure humidity levels between 20% and 90% with an accuracy of ±5%. It can also measure temperature between 0°C and 50°C with an accuracy of ±2°C.
The DHT22 is a higher-end sensor that can measure humidity levels between 0% and 100% with an accuracy of ±2-5%, depending on the temperature and humidity range. It can also measure temperature between -40°C and 80°C with an accuracy of ±0.5°C. The DHT11 is a low-cost sensor that can measure humidity levels between 20% and 90% with an accuracy of ±5%. It can also measure temperature between 0°C and 50°C with an accuracy of ±2°C. The DHT22 is a higher-end sensor that can measure humidity levels between 0% and 100% with an accuracy of ±2-5%, depending on the temperature and humidity range. It can also measure temperature between -40°C and 80°C with an accuracy of ±0.5°C.
Both the DHT11 and DHT22 sensors are commonly used in various IoT projects, such as weather monitoring systems, indoor climate control, and smart home automation. They can be interfaced with microcontrollers like Arduino or NodeMCU to collect and analyze data, and can be programmed to trigger certain actions based on the measured values. Both the DHT11 and DHT22 sensors are commonly used in various IoT projects, such as weather monitoring systems, indoor climate control, and smart home automation. They can be interfaced with microcontrollers like Arduino or NodeMCU to collect and analyze data, and can be programmed to trigger certain actions based on the measured values.

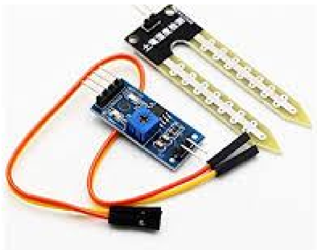

Fig 3: NodeMcu : Esp8266

3. Moisture Sensor

A moisture sensor is a type of sensor that is used to detect the moisture content of soil or other substances. There are several types of moisture sensors available, but the most common ones are resistive, capacitive, and Time Domain Reflectometry (TDR) sensors.
Here are some technical details about moisture sensors:

a. Resistance Range

The resistance range of the sensor determines the accuracy of moisture detection. A typical resistive moisture sensor has a resistance range between 100 kΩ to 100 MΩ.

b. Sensitivity

The sensitivity of the sensor determines how much the resistance or capacitance changes for a given amount of moisture. Sensitivity is usually expressed as a percentage change per unit of moisture.

c. Operating Voltage

The operating voltage of a moisture sensor varies depending on the type of sensor. For resistive moisture sensors, the operating voltage is typically between 3 to 5 volts DC. For capacitive sensors, the operating voltage is usually between 3.3 to 5 volts DC.

d. Measurement Range

The measurement range of the sensor determines the minimum and maximum moisture levels that can be detected. This range can vary depending on the type of sensor and the environment in which it is used.

e. Output Signal

The output signal of a moisture sensor can be analog or digital. Analog sensors output a voltage or current that changes with the moisture level, while digital sensors output a binary signal indicating whether the moisture level is above or below a certain threshold.

f. Calibration

Moisture sensors need to be calibrated for accurate readings. Calibration involves determining the relationship between moisture content and sensor output, and can be done using a known moisture source or by comparing readings to a reference sensor.

B. Software

The Software part of project consists of an application that is integrated with 3 Machine Learning models that are helping to for prediction of different parameters and the app act as the interface between
User and the models. The application is made using Flutter and uses dart as its programming language. We have divided the whole structure of application into 4 parts namely:

1. Crop Recommendation.
2. Fertilizer Prediction.
3. Disease Prediction
4. Farm status

Fig. Application Interface

1. Crop Recommendation

The model used for Fertilizers prediction is developed using Deep Neural Networks (DNN). Dataset which is used for training and testing purposes is obtained from Kaggle.

Working of the model

1. DNN model processes the input data through the network.
2. Then each hidden layer extracts and transforms features to generate meaningful representations.
3. The model is trained using the ReLu Function.

4. Trained model is scaled using the MinMaxscaler function.
5. And a scaled array of values is used for prediction.

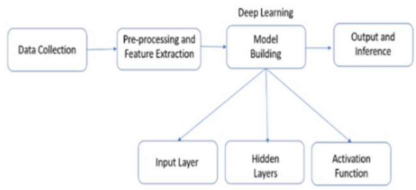

Fig. Workflow of the model

Crop is recommend for a particular field by taking various input parameters such as

- Nitrogen
- Phosphorus
- Potassium
- Rainfall
- Temperature
- Humidity
- PH

The values are given to model and the prediction is obtained after which user is given respective information about the crop and can also choose to get more information through the buttons available. The dataset used for the model is taken from Kaggle website and is divided as 80% of data for training and 20% for testing.

2. Fertilizer Detection

The model used for Fertilizers prediction is developed using Deep Neural Networks (DNN). Dataset which is used for training and testing purposes is obtained from Kaggle. The dataset used comprises various features such as soil temperature, soil moisture, Nitrogen, Phosphorous, Potassium Values, Humidity, Crop Type, Soil Type.
Working of the model:

1. DNN model processes the input data through the network.
2. Then each hidden layer extracts and transforms features to generate meaningful representations.
3. The model is trained using the ReLu Function.
4. Trained model is scaled using the MinMaxscaler function.
5. And a scaled array of values is used for prediction.

So by utilizing a DNN architecture, which consists of multiple hidden layers, the model is capable of learning complex patterns and relationships within the dataset and more accurate results are delivered to farmers.

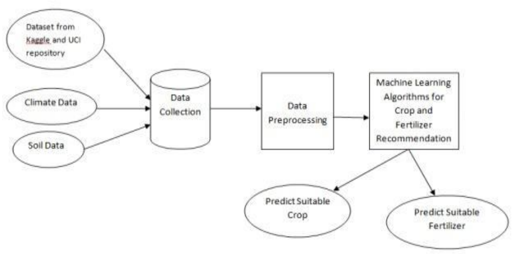

Fig. Workflow of the model

3. Disease Detection

Convolutional Neural Network (CNN) model is employed for leaf disease detection. The model is trained and tested using the Plant Village dataset, a widely used dataset specifically designed for plant disease classification.

The dataset provides a diverse range of leaf images, including both healthy leaves and leaves affected by different diseases.
Below flowchart explains the working of CNN:

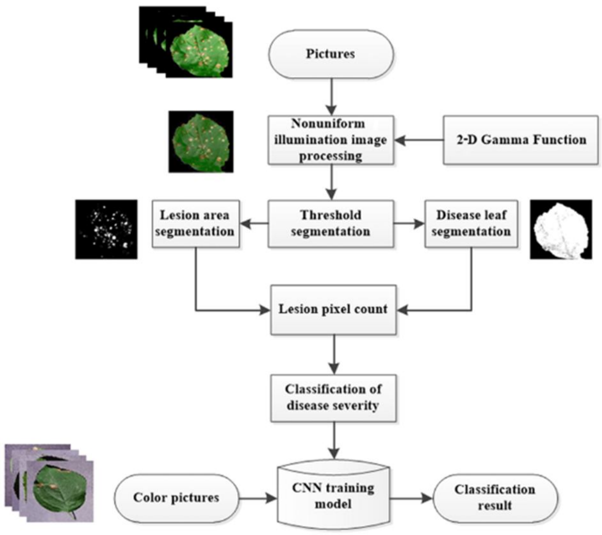

Fig. Working of CNN

Steps to be followed before deployment of the model
1. Train CNN model to learn and distinguish patterns and features indicative of specific plant diseases.
2. Trained model is then evaluated on a separate testing set from the same dataset
3. Assess its performance and accuracy in detecting and classifying leaf diseases.

Working of the model
1. Input the leaf image
2. Pre-process the image
3. Feature Extraction
4. NN classification
5. Result

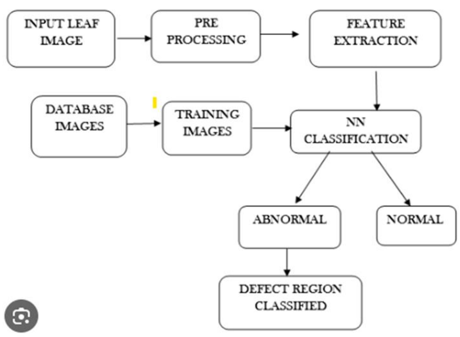

Fig. Working of the model

4. Min-Max scaling

The Min-Max scaling technique, also known as Min-Max normalization, scales numerical features to a specific range, typically between 0 and 1. The mathematical formula for Min-Max scaling is as follows:
For each feature, the scaled value (S) is calculated for each data point (x) as:
S = (x - min(X))/(max(X) - min(X)
Where:
1. s the scaled value of the feature.
2. s the original value of the feature for a specific data point.
3. min(X) is the minimum value of the feature across all data points.

4. max(X) is the maximum value of the feature across all data points.

Here's a step-by-step explanation of the process:

Find the minimum (min(X)) and maximum (max(X)) values of the feature across all data points in the dataset.

For each data point, subtract the minimum value (min(X)) from the original feature value x). This operation ensures that the minimum value of the scaled feature is 0.

Divide the result from step 2 by the range of the feature, which is the difference between the maximum value (max(X)) and the minimum value (min(X)). This step scales the feature to fit within the range [0, 1].

The result of Min-Max scaling is that all values of the feature are transformed to a range between 0 and 1, with 0 corresponding to the minimum value in the original data and 1 corresponding to the maximum value. Values between 0 and 1 represent the relative position of a data point within the range of the feature.

This scaling technique is useful when working with algorithms or models that are sensitive to the scale of the input features, as it ensures that all features have a consistent and comparable impact on the model regardless of their original scales.

IV. Results And Conclusion

1. Crop Prediction

Crop prediction model developed using Deep Neural Networks (DNN) has yielded remarkable results, achieving an impressive accuracy of 94.6%.

This accuracy of 94.6% showcases its potential as a reliable tool for crop prediction, enhancing agricultural productivity, and aiding in sustainable agricultural practices.

2. Fertilizer Prediction

Fertilizer prediction model developed using Deep Neural Networks (DNN) has also demonstrated outstanding performance, achieving an impressive accuracy rate of 94.6%.

With an accuracy of 94.6%, the developed fertilizer prediction model holds significant potential in assisting farmers, agronomists, and fertilizer manufacturers. By providing precise and tailored fertilizer recommendations, the model can help optimize plant nutrition, minimize environmental impact, and improve crop yields.

3. Leaf Disease Detection

Convolutional Neural Network (CNN) model developed for leaf disease detection has demonstrated outstanding performance, achieving an impressive accuracy rate of 95%. This high level of accuracy indicates the model's capability to effectively classify and identify various leaf diseases.

Overall, we have developed a robust application which can

- detect soil moisture.
- detect humidity and soil moisture
- recommend suitable crop
- recommend fertilizers
- detect plant disease and recommend pesticide

thus helping the farmer to increase his income and efficiency in agricultural practices.

V. Future Scope And Acknowledgement

Here are several potential future scopes for the smart agriculture IoT-based project:

1. Expansion of the system

The current project can be expanded to cover more crops and regions, providing farmers with a comprehensive solution for optimizing crop growth and minimizing waste.

2. Integration with drones and robotics

The integration of drones and robotics with the smart agriculture system can automate certain farming tasks such as planting, irrigation, and pest control, reducing labor costs and increasing efficiency.

3. Sustainability and Environmental Impact

The project can further emphasize sustainability by incorporating environmental impact assessments and promoting eco-friendly farming practices.

Overall, the future scope for the smart agriculture IoT-based project is vast, and there are numerous opportunities for innovation and growth.

We would like to extend our heartfelt acknowledgement to our project guide Prof. Mukund Kulkarni for his guidance and support towards the project.

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Data Modeling Practices for E-Commerce

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***Abstract*--In modern times, large amounts of data with diverse characteristics, such as volume, variety, etc., are generated daily. For enterprises such as E-commerce, which is escalating nowadays, massive amounts of unstructured data have increased significantly, making it essential to manage high data availability and consistency in conventional databases. To establish extreme data availability and consistency, opting for the most effective data model is necessary to ensure that data accuracy and consistency are achieved and can be easily accessed and manipulated by the intended users. The development of data modelling approaches has made it possible to use massive quantities of data without degrading performance or loosening the conventional ACID properties. This paper emphasizes the importance of efficient data modelling. It provides practical guidelines for structuring RDBMS data models and for NoSQL data models, considering the types of data access patterns and highlighting their advantages and limitations in terms of e-commerce enterprises.**

***Index Terms*— Data modeling, guidelines, Nosql, RDBMS, access pattern**

I. INTRODUCTION

The outbreak of interest from e-commerce enterprises in big data is increasing daily. Big data is classified into four categories: volume, variety, velocity, and veracity. E-commerce systems eventually generate big data, including massive volumes of customer data, products, categories, carts, orders, etc. E-commerce data is generated in real-time, meaning it must handle the velocity of the generated data. Also, it generates data of considerable variety, such as click stream data (b), image data (c), and video data (d), and such data can be incomplete, noisy, or inaccurate, and that's when veracity comes into the picture [1]. E-commerce sites and platforms face the challenge of maintaining consistent availability, performance, and throughput across all channels.
For an e-commerce application that generates and handles highly unstructured data with volume, variety, velocity, and variability, a superior database design becomes a must to maintain high data availability and consistency. For this reason, standard data modelling guidelines have become a must-have. Using relational databases proves to need improvement for such applications. In this context, NoSQL databases offer new storage solutions in large-scale environments, replacing many traditional database management systems. However, there are no clear boundaries between SQL and NoSQL, as it is becoming a trend that NoSQL databases can achieve strong consistency. At the same time, SQL has started to embrace some NoSQL characteristics.
This exploration highlights the importance of data modelling and its types. It shows a survey on the adaption of RDBMS/NoSQL data models in research precisely chosen for an e-commerce application. The content discusses data modelling guidelines used in RDBMS and NoSQL databases.
The rest of this paper is structured as follows: Section 2 shows the paper selection that was carried out through the survey for this paper. Section 3 briefs E-commerce life cycle and. Section 4 summarises data modelling

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Practices for E-commerce. Section 5 presents the concept of data modelling. Section 6 lists data modelling guidelines for relational databases. Section 7 lists data modelling guidelines for the NoSQL database. Section 8 lists challenges and scope for both RDBMS and NoSQL.

II. Research Paper Selecton

The method for choosing current research that was used for this survey is shown in Fig. 1. We began reading articles on data modelling for e-commerce and quickly saw that the data models varied greatly. Some people only use relational data models, while others use both relational and non-relational data models. Document store is a common NoSQL database for e-commerce. In relational databases and document-store databases, we have seen variances in database design. In order to compare with suggested E-commerce data models, we investigated relational and document store data modelling principles.

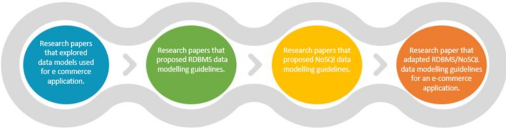

Fig. 1. Paper Selection Process

III. Background

A. Growth of the e-commerce industry in Big Data

According to [7], the mass of data in the digital universe will increase by 61 percent by 2025, reaching 175 zettabytes. Fig 2 shows the revenue growth of the E-commerce industries in India by 2026 [8].

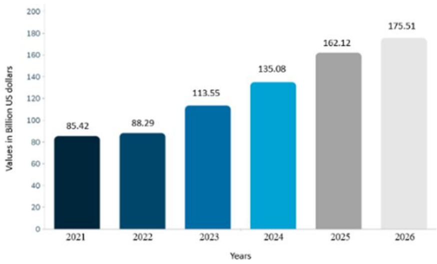

Fig. 2. Growth of e-commerce in India by 2026

B. E-commerce Life Cycle

Figure 3 shows life cycle of E-commerce. It mainly includes user signin, order placement, payment, order delivery to their stored shipping address by the vendors.

Fig. 3. E-commerce Life Cycle

E-commerce application generates and handles highly unstructured data with volume, variety, velocity, and variability. A superior database design becomes a must to maintain high data availability and consistency. For this reason, standard data modeling guidelines have become a must-have.

ER diagram shown in Fig 5 describe how various entities of E-commerce are related to each other.

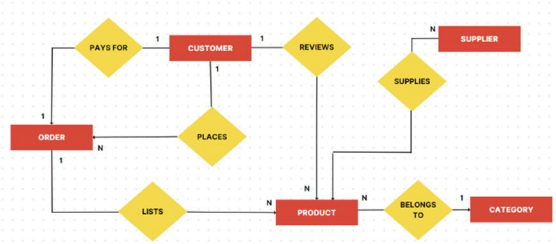

Fig. 5. ER diagram for E-commerce

Table 1 in this section enumerates few important functionalities of e-commerce application identified from relationships presented in ER diagram.

TABLE. I. DATA RELATIONSHIPS IN E-COMMERCE

Relation	Cardinality	Description
F1	1:M / 1:S	Customer Places Order
F2	M:1	Orders referring to product
F3	M:1	Products Belongs to Category
F4	M:N/ S:S	Supplier Supplies Products
F5	1:1	Customer makes payment

IV. DATA MODELING

Data modelling use data models to describe how data will be entered, captured, and modified in a database operation system [9]. Data modelling is a process of designing a data organization in the database and schema describes this database design. A well-designed data model helps ensure that the data is accurate, consistent, and complete and can be easily accessed and manipulated by the intended users. Some key benefits include increased efficiency, flexibility, and scalability.   Fig. 4 describes the phases of data modelling at various abstraction level.

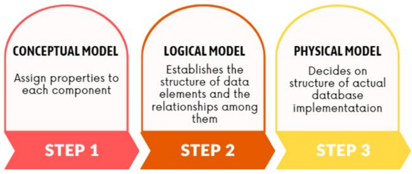

Fig. 4. Phases of data modeling

A database design comprises three main phases: a conceptual data model, a logical data model, and a physical data model.

- *Conceptual level data modeling*: The conceptual level seeks to demonstrate ideas about the system's domain to the end user by defining entities and interrelations within the model's bounds.
- *Logical level data modeling*: Unlike the previous level, the logical level focuses on creating designs with more specific ideas about the applications domain. This level is also known as the schema.
- *Physical level data modeling*: The physical level of a database management system describes implementation of logical schema using suitable data structures, file organization along with indexes to speed data access

V. RELATED WORK

Table 1 summarizes data models proposed by various researchers for E-commerce at conceptual, logical, and physical level of database design. It shows high popularity of NoSQL for E-commerce. It may because of increasing unstructured and semi-structured big-data usage in E-commerce. But, E-commerce application has critical need of consistency for order placement and payment, which suggest use of relational databases. Some developers prefer relational for complex data processing also. A very limited article like [22] discuss E-commerce design with relational databases. On other side, [5],[9],[13],[14],[15],and [21] uses document store; [16],[20] uses graph databases.

NoSQL databases are known for its flexible schema feature and the document store is most flexible NoSQL. But, the empirical results given at [2-4] shows that database design matters even in document oriented NoSQL for performance, energy, and storage requirement.

TABLE. II. DATA MODELS FOR E-COMMERCE

Ref	Year	Data Source	Conceptual	Logical	Physical
[12]	2022	Real data	ER	RDBMS, Document	PostgreSQL, MongoDB
[13]	2022	Real data	ER	Document	MongoDB
[14]	2022	Real data	UML	Key-Value, Column, Document	Oracle NoSQL, Cassandra, MongoDB
[15]	2021	Sample data	-	RDBMS, Column	SQL, Cassandra
[16]	2019	Sample data	Graph	Graph	Neo4j
[17]	2018	Real data	Generic	Column, Document	Cassandra, MongoDB
[18]	2017	Sample data	UML	Document	-
[19]	2017	Sample data	ER	Column	Cassandra
[20]	2016	Real data	UML, graph	Graph	Neo4j
[21]	2016	Sample data	ER	Document	MongoDB
[22]	2016	Sample data	UML, ER	-	MySQL
[23]	2016	Sample data	-	Document	MongoDB
[24]	2015	Real data	-	RDBMS, Document	MS SQL, MongoDB
[25]	2015	Real data	ER	Document	MongoDB
[26]	2013	Sample data	ER	Document	Oracle, MongoDB

VI. RELATIONAL DATA MODEL

A. Cardinalities

Cardinalities of relationships play a crucial role in the development of relational databases. One-to-one (1:1), many-to-many (1:M), and many-to-many (M:N) relationships are the only cardinalities considered by relational data models.

B. Relational data modeling guidelines

Entity participation also plays important role in relational data models. This section briefs various entity participation and suggest data modeling accordingly.

i. Total participation from E1

Total participation from E1 implies that every entity of E1 is associated in the relationship set. Here, Order entity is totally participated in Deliver_At relationship.

Fig. 6. Total participation of Order entity in Deliver_At

Table 3 shows the relational data modeling guidelines in case of total participation from E1, for each cardinality. E1 and E2 are the entities and PK is primary key.

TABLE. III. DATA MODELING GUIDELINES (TOTAL PARTICIPATION FROM E1)

cardinality	Total participation from E1
1:1	1. Combine table for E1 and E2 2. PK of E1 3. Table at-least in 3NF
1:M	1. Create separate table E1 and E2 2. PK of E1 in E1, PK of E2 in E2 3. PK of E2 use as FK in E1
M:N	1. Create 3 tables: E1, E2, R 2. Store PK's of E1 and E2 in R along with relationship attributes. 3. Normalize table in 3NF

ii. Total participation from E2

Total participation from E2 implies that every entity occurrence in E1 is compulsory and must be connected with a corresponding entity occurrence in E2.

Fig. 7. Pattern for total participation from E2

Table 4 shows the relational data modeling guidelines in case of total participation from E2, for each cardinality.

TABLE. IV. DATA MODELING GUIDELINES (TOTAL PARTICIPATION FROM E2)

cardinality	Total participation from E2
1:1	1. Create combine table for E1 and E2 2. PK of E2 3. Table in 3NF
1:M	1. Create separate tables E1 and E2 2. PK of E1 in E1, PK of E2 in E2 3. PK of E1 used as FK in E2
M:N	1. Create 3 tables: E1, E2, R 2. PK of E1 in E1 and PK of E2 in E2 3. Store PK's of E1 and E2 in E3 with relation of E2

iii. Partial Participation of E1 and E2

Partial participation of E1 and E2" refers to a situation where there are some instances in either E1 or E2 that are unrelated to any instances in the other entity set.

An e-commerce database can exhibit partial participation from E1 and E2 through the connection between the "Customer" and "Product" entities. It is not necessary for each customer in the "Customer" entity set to have made a purchase from the "Product" entity set, and similarly, each product may not necessarily be linked to a customer.

Fig. 8. Pattern for partial participation from E1 and E2

Table 5 shows the relational data modeling guidelines in case of partial participation from E1 and E2, for each cardinality.

TABLE. V. DATA MODELING GUIDELINES(PARTIAL PARTICIPATION OF E1/E2)

rdinality	Partial participation from E1 and E2
1:1	1. Create separate tables for E1 and E2 2. Create another table with FK of E1 and E2 3. Normalize table in 3NF

1:M	1. Create separate tables for E1 and E2 2. PK of E1 in E1, PK of E2 in E2 3. Use both PK of E1 and E2 as FK in another
M:N	1. Create separate tables for E1 and E2 2. Create another table with FK of E1 and E2 3. Storing relations of both E1 and E2 in E3

VII. NON-RELATIONAL DATA MODEL

Fig. 9 shows the growth in the CAGR of NoSQL in the global market. According to research published in [11], while the market size of RDBMS is more significant than that of NoSQL, the CAGR of NoSQL's growth rate is much higher in the coming years than that of SQL. The CAGR of SQL is only 12 percent from 2021–2029, and for NoSQL, it is around 30 percent.

Fig. 9. Growth of NoSQL in global market

A. Categorization of NoSQL data models

NoSQL, also called "Not Only SQL", facilitates the storage and retrieval of data in a non-relational database format. The widespread adoption of these databases increased after the 2000s due to the decreased storage cost and the increasing data processing requirements.
Fig 10 shows the categorization of the NoSQL database, which is categorized into four types: Document store, Key-Value store, Column-oriented, and Graph-oriented. Article [28] shows which of these NoSQL data models is maximumly used.

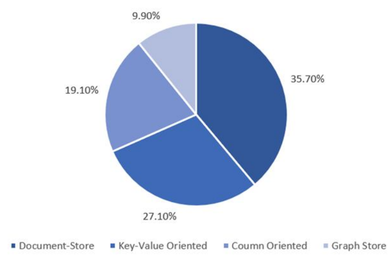

Fig. 10. Categorization of NoSQL data models

From the above graph, it is clear that the frequently adapted non-relational data model for big data is a document-oriented database.

A. Cardinalities

Unlike relational database, document oriented NoSQL uses following seven type of cardinalities for a relationship.

1. One-to-One (1:1)

A one-to-one relationship implies that a single document is exclusively linked to another document. For instance, in a document-oriented database, a customer document could have an embedded address document with a one-to-one correspondence.

2. One-to-Few (1:F)

As an instance, a document for a blog post can include comments embedded inside it, although there could be a maximum count constraint on the number of comments permitted.

3. One-to-Many (1:M)

An instance of a customer document can be associated with several order documents, for instance.

4. One-to-Squillion (1:S)

To describe a one-to-many relationship in NoSQL databases where the "many" side is extremely large, the term 1:Squillion cardinality is used. This relationship pertains to a situation where one document is linked to a large number of other documents. An example of this type of relationship would be a user document in a web application that has millions of log documents associated with it.

5. Few-to-Few (F:F)

Few:Few cardinality in NoSQL databases refers to a relationship where both entities involved have a small number of connections with each other. To illustrate, on a social media platform, users may have only a few friends, and those friends may also have only a few friends in common.

6. Many-to-Many (M:N)

In NoSQL databases, the Many:Many cardinality refers to a situation where two entities have a many-to-many relationship with each other. As an illustration, in a document-oriented database, a blog post document could be associated with multiple tag documents, and each tag document could also be associated with multiple blog posts.

7. Squillion-to-Squillion (S:S)

Squillion:Squillion cardinality in NoSQL databases refers to a relationship between two entities where both entities have an enormous number of relationships with each other. An example of this could be an e-commerce platform where a product document is related to millions of orders, and an order document is related to millions of product items.

B. NoSQL data modeling guidelines

As seen in section VII(B), the most adapted NoSQL data model in the case of Big Data is Document oriented databases. Hence, here the focus is on the data modeling guidelines of a document-oriented data model according to the data access pattern used.
In this section, Table 6 shows the different approach adapted in reviewed articles for an e-commerce based entities, here R refers to reference and E referes to embedding, given F1, F2, F3, F4, and F5 are the functionalities from Table 2 , with E1 and E2 referring to entities of the functionality, <E> referring to Embedding and <R> referring to Referencing.

TABLE. VI. DATA MODELING APPROACHES IN E-COMMERCE

Ref	F1	F2	F3	F4	F5
[12]	E1 <R> E2	E2 <R> E1	-	E1 <R> E2	-
[17]	E2 <E> E1	E2 <R> E1	E2 <E> E1	E1 <E> E2	E2 <E> E1
[18]	E1 <R> E2	E2 <R> E1	E2 <E> E1	-	E1 <R> E2
[24]	E1 <R> E2	E2 <R> E1	E2 <R> E1	E1 <R> E2	-
[25]	E2 <E> E1	E2 <R> E1	E2 <R> E1	E1 <R> E2	E2 <R> E1
[26]	E1 <R> E2	E2 <R> E1	E2 <E> E1	-	-

Below is the enlisted standard data modeling guidelines based on observations observed from carious researches for access patterns such as single access query, predicate on e1, and predicate on e2.

1. Single access query

A query for a single access retrieves only one document by using a unique identifier. For instance, in an e-commerce platform, the order ID can serve as the primary key for the order collection, and a single access query can retrieve the document for a specific order using that ID.

Table 7 shows the data modeling guidelines in case of a single access query data access pattern.

TABLE. VII DATA MODELING GUIDELINES FOR SINGLE QUERY ACCESS

1:1	Embed sub-doc in parent document or Reference parent document in related child document
1:f	Prefer embedding the few side within the one side of the document or Use indexing on both documents
1:m	Store the “many” relatd entities as an array of nested objects withi the one side or “Many” side have a separate collection with unique identifier of primary document.
1:s	Use referencing with data being partitioned or sharded or Reference with data cached in memory
f:f	Embed related child document in parent document or Index both documents or Reference primary document in related child document
m:m	Store array of embedded sub documents or Store documents in separate collection with each document having array of referenced ID of primary document
s:s	Prefer referencing with sharding or Reference with Indexing

2. Predicate on E1

To retrieve all documents that meet a specific condition on a particular field within the document, a predicate on E1 is used. For instance, in an e-commerce system, a predicate on E1 for the order collection could be used to retrieve all orders placed by a specific customer.
Table 8 shows the data modeling guidelines in case of predicate on entity 1.

TABLE. VIII DATA MODELING GUIDELINES FOR PREDICATE ON E1

1:1	Store both entities E1 and E2 within single document or E1 and E2 will have separate collection with E1 having reference of E2
1:f	Store E2 documents as an array within E1 document or E1 will have references of E2 and each E2 have reference to corresponding E1
1:m	Store references of E2 in primary document E1 or Store array of embedded document E2 in E1
1:s	Store references of multiple E2 documents within E1 or Reference with denormalized E2 data or E2 documents are stored as a large array within E1
f:f	Each E1 document contains array of embedded E2 documents or Each E1 document contains references to its associated E2 documents
m:m	Use referencing with array of references of E2 in E1 or Create a separate collection to store relationships between E1 and E2
s:s	Prefer indexing on both documents or Use hybrid method of using both embedding and referencing

3. Predicate on E2

To retrieve all documents that meet a condition on a specific field in a related document, a predicate on E2 is used. For instance, in an e-commerce system, a predicate on E2 for the order and product collections could be used to obtain all orders that contain a particular product.
Table 9 shows the data modeling guidelines in case of predicate on entity 2.

TABLE. IX DATA MODELING GUIDELINES FOR PREDICATE ON E2

1:1	Prefer embedding E1 within E2 document or Separate collection of E1 and E2 with E1 referenced in E2
1:f	Reference E1 from E2 document or Embed array of E1 instances within the E2 document
1:m	Prefer referencing E1 document in E2 document or Embed array of E1 within E2
1:s	Store references E1 within E2 or Embed E1 in E2
f:f	Use indexing Embed E1 in E2 or
m:m	E3 will have E1 and E2 ref or Store array of references of E1 in E2
s:s	E2 will have an array of sub-doc for each E1 or Prefer referencing E1 in E2

VIII. CHALLENGES AND SCOPE OF RELATIONAL AND NOSQL DATABASE

A. Challenges faced by Relational database

- *Scalability:* As the volume of data in an e-commerce application increases, it can be challenging to maintain consistent performance and response times. Scaling a relational database can be complicated and costly.
- *Security*: E-commerce apps store sensitive customer information, including credit card information, and therefore vital to ensure that the database is secure. Security breaches can significantly affect customer confidence and loyalty.
- *Complexity*: E-commerce applications can be complex, with multiple data sources and complex inter-entity relations. Dealing with these relationships in a relational database can be difficult.

B. Scope of Relational databases

- *Data Integrity:* Relational databases are intended to maintain data integrity and ensure consistency and accuracy. This is especially important for e-commerce applications, where errors in data may result in loss of sales and revenue.
- *Transaction Support:* Relational databases are built to process transactions, ensuring the modifications made to the database are consistent and reliable. It is vital in e-commerce applications, where transactions must be recorded accurately and securely.
- *Data Consistency*: Relational databases provide a coherent way to organize data, facilitating data consistency maintenance across the e-commerce application. It ensures that errors and inconsistencies in the user experience are avoided.

C. Challenges faced by NoSQL database

- *Lack of ACID compliance*: NoSQL databases prioritize scalability and availability over consistency, leading to consistent data with strong consistency guarantees.
- *Limited query capabilities*: NoSQL databases generally have limited query capabilities relative to relational databases, making data extraction for analysis more difficult.
- *Data Modeling complexity*: NoSQL databases often require a different data modeling approach from relational databases, which may require further expertise.

D. Scope of NoSQL databases

- *Scalability*: NoSQL databases are designed to process large amounts of data and are highly scalable, making them an ideal choice for e-commerce applications that require high uptime and performance.
- *Flexibility*: NoSQL databases can handle unstructured or semistructured data, allowing greater flexibility in the data types that can be stored.
- *High availability*: NoSQL databases are created to have a high level of availability, with built-in replication and aggregation features that guarantee data accessibility even in the event of a system failure.
- *Performance*: NoSQL databases can deliver high performance, particularly for heavy read workloads, due to their ability to move horizontally across multiple nodes.

IX. CONCLUSION

The exponential growth of data sources, data volume, and data variety from digital data all necessitates selecting the most efficient data model to guarantee data accuracy and consistency. Which strategies should be used and whether or not an RDBMS or NoSQL should be used is still up in the air. This study seeks to show the benefits and drawbacks of both relational and document-oriented NoSQL databases in an effort to convince the reader of the necessity of efficient data modelling. Data retrieval via complicated queries is commonplace in large enterprises; as a result, data modelling principles are presented taking into account the sort of data access pattern required.

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Integrating Machine Learning for Real-Time Intelligent Collision Avoidance

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***Abstract*— During foggy seasons, accidents are a major problem and can result in serious injury or even death. To solve this problem, we are developing an intelligent vehicle system that predicts accidents in foggy conditions using machine learning. This system warns drivers in time and helps to avoid potential dangers. By analyzing factors such as vehicle speed, reaction time, line of sight, traffic flow and communication, we train the system to accurately detect and respond to threats. Our goal is to reduce accidents in foggy conditions and improve overall road safety. Traditional methods of detecting accidents on foggy roads are ineffective and increase the risks for drivers and passengers. To address this challenge, we propose a hybrid model that combines vehicle cameras and advanced machine learning techniques. By analyzing camera images and taking into account historical data about weather, traffic and other factors, our model accurately predicts future road conditions. Real experiments have proven the effectiveness of our approach. By adopting this hybrid model, we can significantly reduce accidents caused by poor visibility in foggy conditions, making our roads safer for smart cities.**

***Index Terms*— machine learning, vehicular system, foggy season, convolution neural networks, random forests, support vector machines.**

I. INTRODUCTION

Transportation safety faces a pressing challenge: reducing accidents under foggy conditions. When the road is enveloped in fog, visibility is greatly diminished, which poses challenges for drivers in spotting potential dangers and responding promptly. Traditional approaches to this issue, like incorporating fog lights or employing reflective markers on the road, frequently fall short or prove to be ineffective [1-2]. The integration of machine learning techniques and vehicular ad hoc networks (VANETs) has become a notable method for enhancing road safety in foggy situations in recent times. Machine learning algorithms can aid in identifying road hazards and issuing timely alerts to drivers by harnessing data collected from vehicle sensors, cameras, and other data sources [3]. The purpose of this paper is to introduce a novel hybrid model, which merges various techniques such as convolution neural networks (CNNs), Random forests (RFs), support vector machines (SVMs), and Recurrent neural networks (RNNs). This model aims to enhance the precision and dependability of hazard detection specifically in foggy

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weather conditions. Our main objective is to showcase the efficiency of our model by conducting experiments on real-world data and emphasizing its potential for enhancing transportation safety [4]. Deep learning techniques, particularly CNNs, have demonstrated remarkable potential in image recognition tasks, encompassing object detection and feature extraction, over the past few years. Popular machine learning algorithms for classification tasks in various domains include RFs and SVMs [5].

A. Significance of Study

The current transport system has reduced distances while increasing the chance of death. Every year, vehicle accidents claim the lives of thousands of people and injure millions more. Road traffic injuries are now one of the top causes of casualties, disabilities, and hospitalisations worldwide, with significant socioeconomic consequences. Aside from being the nation's lifeline and a key contributor to socioeconomic progress and development, India's road network is also the leading cause of unintentional deaths in the country, with traffic accidents. Faulty road design and engineering, lax enforcement of traffic regulations, and a lack of timely trauma treatment all contribute to the high incidence of road accidents and deaths in India. Every year, almost 1.5 lakh people are killed on Indian roadways. Per day, there are 1130 accidents and 422 deaths, or 47 accidents and 18 deaths per hour. Every year, nearly 1.3 million people's lives are cut short globally as a result of a road traffic accident.) During the year 2021, a total of 4,12,432 road accidents were recorded in the country, claiming 1,53,972 lives and injuring 3,84,448 people [6].

II. RELATED WORKS

The related work thoroughly outlines several research works on the subject of fog detection, visibility prediction, and accident avoidance in intelligent transportation systems.

TABLE I. RELATED WORKS

Title	Authors	Focus	Techniques/ Methods Used	Data Source	Evaluation Metrics	Application/Outcome
Real-time Fog Detection and Analysis for Intelligent Transportation Systems	T. Lu et al. [7]	Fog detection, analysis	Image processing	Sensor data	Accuracy, Precision, Recall	Real-time monitoring of fog conditions
Prediction of Visibility Distance in Foggy Weather Using Deep Learning	J. Liu et al. [8]	Visibility prediction	Deep learning	Weather data	MAE, RMSE	Predicting visibility distance in foggy weather
Fog Computing-based Smart Cooperative Intelligent Transportation System for Accident Prevention	J. Zhang et al. [9]	Accident prevention	Fog computing, vehicular networks	Vehicular data	Safety improvement metrics	Accident prevention and safety improvement using fog computing
Road Surface Condition Prediction Based on Weather Data Using Random Forests	H. Li et al. [10]	Road surface condition prediction	Random forests	Weather data	Accuracy, F1-score	Predicting road surface conditions based on weather data
A Hybrid Decision Tree-Based Method for Accident Detection in Foggy Conditions	B. Kaur et al. [11]	Accident detection	Decision trees	Sensor data	Precision, Recall	Accurate accident detection in foggy conditions
Fuzzy Expert System for Road Accident Detection in Foggy Conditions	N. Saini et al. [12]	Accident detection	Fuzzy expert system	Sensor data	Accuracy, F1-score	Accident detection using fuzzy expert system in foggy conditions
Foggy Road Detection Using Image Processing Techniques and Support Vector Machines	K. Kim et al. [13]	Road detection	Image processing, SVM	Image data	Accuracy, Precision	Detecting foggy road conditions using image processing and SVM
A Comparative Study of Machine Learning Algorithms for Foggy Road Detection	S. Sharma et al. [14]	Foggy road detection	Machine learning algorithms	Sensor data	Accuracy, F1-score	Compare various machine learning algorithms for foggy road detection
Accident Detection System for Foggy Weather Using Deep Learning and Vehicular Networks	A. Al-Fuqaha et al. [15]	Accident detection, vehicular networks	Deep learning, vehicular networks	Vehicular data	Precision, Recall	Real-time accident detection in foggy weather using deep learning and networks

Detection of Foggy Weather Using Machine Learning Algorithms	S. Chen et al. [16]	Foggy weather detection	Machine learning algorithms	Weather data	Accuracy, F1-score	Detecting foggy weather conditions using various machine learning algos.
A Machine Learning Approach to Real-Time Fog Detection Using Low-Cost Sensors	Y. Chen et al. [17]	Real-time fog detection	Machine learning approach	Sensor data	Accuracy, Precision	Real-time fog detection using cost-effective sensors
Road Condition Prediction Using Machine Learning Techniques for Intelligent Transportation Systems	Y. Kim et al. [18]	Road condition prediction	Machine learning techniques	Road conditio n data	MAE, RMSE	Predicting road conditions for intelligent transportation systems
Real-Time Visibility Prediction Model for Foggy Conditions Based on Machine Learning	Y. Hwang et al. [19]	Visibility prediction	Machine learning techniques	Weather data	MAE, RMSE	Real-time visibility prediction for foggy conditions
A Novel Deep Learning-Based Method for Foggy Road Detection	Z. Zheng et al. [20]	Foggy road detection	Deep learning	Sensor data	Accuracy, Precision	Innovative deep learning method for detecting foggy road conditions
Accident Prediction in Foggy Weather Using Machine Learning Techniques	K. Soni et al. [21]	Accident prediction	Machine learning techniques	Sensor data	Precision, Recall	Predicting accidents in foggy weather using machine learning

III. PROPOSED HYBRID MODEL

The suggested hybrid approach integrates fuzzy logic, decision trees, neural networks, and genetic algorithms as part of its model. The proposed model can benefit from the unique strengths and weaknesses of each technique by combining them together [22]. In the hybrid model proposed, the initial component employed is the fuzzy logic system. Its primary purpose is to facilitate fog detection and predict visibility. In foggy conditions, the imprecise and uncertain data can be effectively handled by fuzzy logic. The input data is collected from multiple sensors in the fuzzy logic system. It then generates a fog density value, which is utilized to estimate the visibility distance [23]. The decision tree is the second component utilized for the purpose of accident detection. The utilization of decision trees proves valuable for detecting patterns in data. In this particular scenario, the decision tree is trained using past accident data to determine the significant factors that exhibit the highest correlation with accidents transpiring in foggy circumstances [24]. The road surface condition prediction entails the utilization of the neural network as its primary element. When it comes to handling intricate, non-linear connections within data, neural networks prove to be a perfect fit. In this scenario, the neural network undergoes training using weather and road surface data to foresee the probability of encountering icy or wet road conditions. The genetic algorithm, which is utilized for optimizing the weights and parameters of the other three components, marks the fourth and concluding element [25]. Genetic algorithms, imitating natural selection, are effective in discovering optimal parameter combinations in intricate systems.

A. Hybrid Technique: CNN-RF-SVM Ensemble

The real-world collision detection and accident avoidance systems shows potential in the hybrid technique proposed [26]. The system possesses the ability to accurately identify and forecast potential collision scenarios through the use of advanced visual analysis, complex relationship modelling, and high-dimensional classification capabilities. Vehicles can utilize cameras to capture real-time visual data, making this technology deployable. Using CNNs, the system extracts relevant visual features that indicate collision risks while processing the images. Based on complex relationship patterns, the RF incorporates these characteristics and proceeds to generate predictions [26]. With its effective separation of various collision events, the SVM enables robust classification. The integration of this hybrid ensemble approach enables vehicles to possess a thorough and dependable collision detection system, improving road safety [27-28]. The utilization of this technology has the ability to significantly decrease the occurrence of accidents, injuries, and fatalities resulting from limited visibility and other dangerous circumstances. As a result, it is a highly valuable addition to promoting safety within the transportation sector [29-30].

TABLE II. MACHINE LEARNING TECHNIQUES

Technique	Strengths in VANETs	Weaknesses in VANETs	Complexity	Data Requirements	Performance
CNN	-Extracting features from	-Requires a large amount of labelled training data	-Relatively high computational complexity	-Image data from cameras with	-Accuracy and strength in detecting

	visual data (e.g., images)			collision occurrences	hazards in foggy conditions
RF	-Good at handling complex, non-linear in data	- Prone to over fitting with noisy or irrelevant features	-Moderate computational complexity	- Historical data on weather, traffic patterns	- High generalization ability and resilience to noise in data
SVM	-Effective in high-dimensional feature spaces and non-linear data	-Sensitivity to parameter tuning and selection	-Moderate computational complexity	- Labelled data containing features and collision occurrences	- Accuracy in binary classification tasks, but may struggle with multi-class problems
RNN	-Ability to capture sequential time-series data	-Prone to vanishing/exploding gradient problems	-Higher computational complexity	-Sequential data capturing vehicle dynamics conditions	- Well-suited for time-series prediction tasks, but require more times
Decision Traes	- Easy to interpret and visualize	-Tendency to over fit with complex datasets	-Low computational complexity	- Labelled data with features and collision occurrences	- Fast prediction time, ability to handle categorical data
Naive Bayes	-Fast training and prediction time	-Assumes independence between features	-Low computational complexity	-Labelled data with features and collision occurrences	-Suitable for text and data, good with limited training data
Genetic Algorithms	-handle complex, non-linear problems	-Longer training time, sensitivity to parameter tuning	-Moderate computational complexity	-function for optimization, features	-Ability to find near-optimal solutions

IV. Experimental Setup And Evaluation Metrics

In this section, we will present the experimental setup and evaluation metrics that have been utilized to compare the performance of the proposed model with individual machine learning techniques.

A. Algorithm of The Proposed Hybrid Model

- To initiate the process, gather data from different sensors including cameras and lidar.
- In the second step, employ fuzzy logic to compute the fog density value by using the input data.
- In the third step, the fog density value is utilized for the prediction of visibility distance.
- In Step four, we gather historical accident data and use it to train a decision tree on the factors that are highly correlated with accidents occurring in foggy conditions.
- Step 5: Use decision tree to classify input data and predict likelihood of accident occurrence.
- Step 6: Collect historical weather and road surface data and train neural network to predict likelihood of road being icy or wet.
- Step 7: Use genetic algorithm to optimize weights and parameters of fuzzy logic, decision tree, and neural network components.
- Step 8: Output predicted road conditions and alerts for drivers.

B. Experimental Setup

The proposed hybrid model is implemented using Python programming language and scik it-learn library. The dataset used for experimentation is collected from real-time traffic sensors installed on the roads in foggy conditions. The dataset is pre-processed to remove any missing or inconsistent values and normalize the data.
The dataset is divided into training and testing sets with a 70:30 ratio.

V. Results

The performance of the proposed hybrid model is compared with individual machine learning techniques. The evaluation metrics are calculated for each technique separately, and then compared with the metrics obtained for the proposed hybrid model to determine its effectiveness in reducing accidents in foggy conditions. Several performance indicators were employed in our study to evaluate our predictive model for accident prediction.
The percentage of accurately anticipated accident instances, represented by accuracy, offers an overall assessment of model success. Precision assesses the capacity to reduce false positives, while Recall assesses the ability to

capture all true positive cases. The F1 Score combines Precision and Recall to balance the trade-offs between these metrics. In this study, we report our numerical results for these measures, which provide insights into the model's practical value and contributions to the area of accident prediction.

TABLE III. VALUES OF EVALUATION METRICS

	100 Nodes	200 Nodes	300 Nodes	400 Nodes	Average
Accuracy	0.44	0.49	0.4933	0.4933	0.47915
Precision	0.423	0.436	0.4934	0.4934	0.46145
Recall	0.458	0.494	0.5	0.5	0.488
F1 Score	0.439	0.463	0.4967	0.4967	0.47385

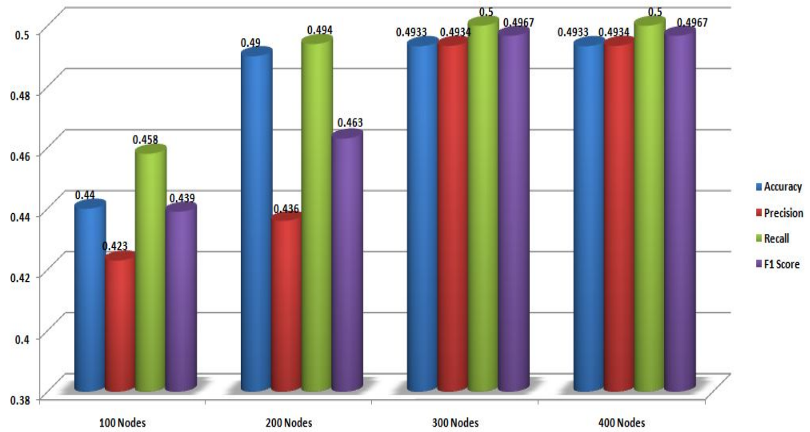

Figure 1. Values of evaluation metrics

VI. CONCLUSIONS

Vehicles that utilise machine learning to forecast accidents in foggy situations have the potential to significantly enhance road safety. These devices can assist drivers in avoiding possible hazards by warning them in a timely way. Traditional techniques of identifying accidents on foggy roads are ineffectual and put drivers and passengers at danger. Hybrid models that integrate car cameras and powerful machine learning approaches, on the other hand, have shown to be accurate and successful in forecasting future road conditions. We can considerably minimise accidents caused by low vision in foggy circumstances by using these ideas, making our roadways safer. The average accuracy of 400 nodes is 0.479% in our study, where this number represents the percentage of correctly predicted accident cases. This score shows our prediction model's overall performance in properly detecting both accident and non-accident situations. Our model had an average precision of 0.4615%, which means that this value of the predictions classified as positive (accident) by the model were true positive predictions. The recall was an average of 0.488%, which means that our model correctly identified the actual positive cases (accidents). Recall is an important parameter for determining a model's capacity to capture all relevant cases. The F1 Score, which is the harmonic mean of precision and recall, was calculated to be 0.4739%. The F1Score balances the trade-off between accuracy and recall, providing a single score to evaluate our prediction model's overall performance.

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Doctor Sahyog: Health Card

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***Abstract*— Health cards are essential in the healthcare industry to keep track of an individual's medical history and health information. This research paper's goal is to present a design and implementation of a health card in the IEEE format. The health card includes features such as an electronic health record, security requirements based on the technology of an unique QR code and unique patient identity number. The electronic health record is kept in a safe database and is accessible by authorized users, the registered and verified doctors and the particular patient. The unique QR code ensures that only the cardholder can access the health information. The health card can improvise the efficiency and quality of healthcare services also it can prove as a valuable tool for healthcare professionals.**

***Index Terms*— Health Card, QR code, unique patient identity number, Health Information, Security**

I. Introduction

Many developing countries like India, Bangladesh, Sri Lanka are facing difficulties in better health facilities in order to reach out to remote and rural parts of the country. The health care sector faces one of the major issues in India and thus the advanced and improvised technology is becoming more important now a days. The health sector has been revolutionized by the advent of technology. The development of an Electronic Health Card is one such example, it has become an increasingly important tool in healthcare system. An Electronic Health Card is a secure, portable, and easy-to-use devicethat stores a patient's medical information and makes it accessible to authorized healthcare providers in real-time. The Electronic Health Card is designed to store a variety of medical information, including personalinformation, medical history, lab results, medications, and immunizations.

The Health Card represents a leap forward in healthcare technology, revolutionizing patient care and doctor-patient collaboration. With its patient ID, QR code, and intuitive website, it empowers patients to actively participate in their health management while providing doctors with a streamlined platform for accessing and communicating patient information. Furthermore, the QR code's integration with research initiatives opens up new avenues for medical research, fostering innovation and improved patient outcomes. Embrace the Health Card and embark on a journey towards a healthier and more connected future. After studying the different research papers and identifying various unique features of each and every project related to Electronic Health Card, we decided to design an Electronic Health Card which can be accessed using an unique QR code and an unique patient identity number. Every user will be provided with an unique QR code and an unique number on their health cards. The verified registered doctors can access all the information and data of the patient by entering the patient identity number. The system allows display of a limited data of the patient after scanning the QR code, hence the data will be protected and the patient can have his/her privacy. We decided to add this feature to our project for easy and

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fast accessibility of data.
Since India is a developing country not only in terms of economy but also in terms of technology. These developing factors have led to use of many advanced technologies this also includes use of scanner for various purposes. Considering QR scanner a basic tool every hospital must have it for scanning medicines, bills, packages and many more things in hospital industry. This scanner can be used to scan the QR code present on our Health Card and access the informationof the patient. The system consists of two functions. On one hand it allows the doctor to check administrative data of the patient and enter any required prescription. On the other hand, it allows the patient to enter their personal information, medical data and many more mandatory details. The project seeks to address the issue of relying on patients for crucial health information by providing a secure and accessible electronic record.

II. LITERATURE REVIEW

Most of the models are carried out mainly in the European countries. These projects aimed to improvise the connection between the mobile citizens of Europe and the national health care systems using advanced smart card technology. Several electronic health cards have introduced highly secured encryption of data using encryption keys and digital signature keys which are stored on the system and are utilized to exchange secure and authorized data between clients and database servers [1][2]. Some of the projects have implemented a user-friendly chat-box to create more healthy relation between doctor and their patients. [4] Due to advancement in technology many health agencies have also launched an electronic health card with a unique features like storage where one can store nominal of their own premium insurance [5]. Instead of single-server-environment-based authentication system there has been an introduction of mutual authentication and key agreement scheme for a multi-medical server environment [6]. Many papers have concluded that the use of an electronic health card will have several advantages, such as less administrative and paper processes, lower costs, fewer medical errors, more accurate case follow-up, patient information integrity, the removal of the problem of readable prescriptions, etc.
A novel method in 2019 was implemented in Montenegro where the strategic significance of healthcare systems in national development is addressed. They offer a comprehensive overview of Montenegro's existing health insurance framework, highlighting its categories of insured individuals and the process of issuing health booklets. Several critical limitations in the current system were identified, including restricted operational hours, potential misuse of health insurance booklets, and labor-intensive manual validation processes. To mitigate these issues, the authors propose a novel solution involving SMART cards and an innovative information system architecture. The SMART cards are envisaged to bolster system security, enhance user experience, and facilitate real-time validation. The proposed system's architecture encompasses a multi-use PKI SMART card infrastructure, data storage, and secure data access, with additional security measures such as adherence to the Common Criteria Standard, cryptographic keys, and data export capabilities. This research underscores the potential benefits of modernizing Montenegro's health insurance system through the incorporation of SMART cards and advanced information technology, promising improved efficiency and security while offering avenues for future integration with smart devices and cloud-based infrastructure. [1] Another method addresses the pressing issue of healthcare data management in Indonesia's rural areas, where paper-based records prevail due to limited access to power and telecommunications infrastructure. Advocating for a digital alternative, the paper emphasizes the advantages of electronic health records (EHRs), highlighting their superior accessibility and exchange capabilities. It proposes employing smart cards as a secure medium for medical data storage and sharing, despite their comparatively modest storage capacity, owing to their robust data security features like Application Protocol Data Units (APDU) and digital signatures. To complement smart cards, the paper introduces the Mobile Data Collection System (MDCS), designed for reading and writing smart cards, overseeing data transfer, and preserving data integrity, all while operating with low power consumption, a crucial consideration given the challenges of power access in rural areas. Ultimately, it presents the MDCS concept as a promising solution for enhancing healthcare data management in rural Indonesia, contingent on further research and development to optimize its functionality and effectiveness.[2] A system NETC@RDS, addresses the limitation of existing e-card systems, primarily focused on national contexts, which fail to support the free movement of European citizens across borders. It specifically focuses on the electronification of the European Health Insurance Card (EHIC), which serves as a proof of health insurance entitlement for European travelers. The paper discusses the successful pilot implementations of NETC@RDS, particularly during the Athens Olympic Games in 2004. The initiative aims to create a trans-European network of portals for verification of entitlement rights, streamlining healthcare procedures and contributing to the future electronification of the EHIC. While highlighting the advantages of the NETC@RDS concept, including improved accessibility and data accuracy, the paper acknowledges challenges related to card

format changes, security infrastructure, legal considerations, and cross-border healthcare provision, emphasizing the importance of European coordination and long-term viability for this promising smart card-based solution in the realm of inter-state health insurance.[3] Another method presents the development of an Integrated Electronic Health Record System (IEHRS) that utilizes smart card technology for healthcare automation. The research addresses the limitations of paper-based health records and highlights the advantages of using smart cards, such as portability, ease of access, and data security. The study integrates various medical measurement devices, including blood pressure meters, blood glucose meters, pulse oximeters, and clinical analyzers, into the system, allowing for the collection and storage of patient health data in electronic health records (EHRs). While the paper demonstrates the potential of smart card-based EHR systems, it also acknowledges the need for standardization in healthcare data coding and plans for future improvements, including the integration of higher-capacity smart cards for storing additional medical information like X-ray films and test documents.[4] This 2018 research paper discusses the significance of Indonesia's Health Assurance Agency, known as BPJS, in providing health insurance to the Indonesian population. The paper highlights BPJS's efforts to enhance healthcare quality through the integration of information technology, specifically the implementation of smart card technology. This smart card system consists of both a smart card and a smart card reader, aiming to expedite the search for BPJS members and enable offline storage of insurance premium data. To ensure data security and confidentiality, the paper employs the Common Criteria Framework (ISO 15408) for evaluating the smart card system's security. The research involves three key steps: threat analysis, security objective design, and security functional requirement design. It identifies and analyzes ten potential threats, establishes 12 security objectives, and ultimately defines 36 security functional requirements, out of which 34 have been implemented in a prototype. The study underscores the importance of using a Protection Profile document for building a secure smart card system in the context of BPJS. [5] The paper from 2010 addresses the development of the MyCare Card project, which aims to create a patient-held electronic health record card for emergency situations, especially when patients are unable to provide their medical history. The paper discusses the initial requirements for the project, including surveys conducted with both the public and healthcare professionals to determine the types of data that should be included on the card. The MyCare Card Browser software, which provides access to the data stored on the card, is a central focus of the paper. The MyCare Card itself is implemented as a USB card, combining the advantages of both smart cards and USB sticks. The paper concludes by highlighting the importance of security and authentication in such systems and mentions ongoing trials of the MyCare Card. Overall, the paper provides insights into the development of a patient-held electronic health record system and its associated software in 2010. [6] The concept of the electronic health card (eHC) as a modern replacement for traditional paper insurance booklets was introduced, highlighting its potential benefits such as reducing administrative processes, cutting costs, minimizing medical errors, ensuring the integrity of patient information, and addressing issues like illegible prescriptions. The paper provided insights into the types and components of electronic health cards, explaining how they function within the healthcare system. Moreover, it discussed the challenges associated with eHC implementation, including issues related to authentication, access control, security, privacy, network bandwidth, and the integration of electronic health records. The authors emphasized the importance of citizen and specialist readiness for adopting this technology and the need for proper training. Overall, the paper underscored the transformative potential of electronic health cards in healthcare management while acknowledging the hurdles that must be overcome for successful implementation.[7]

TABLE I: COMPARISON OF ELECTRONIC HEALTH SERVICES IN A DEVELOPED COUNTRY VS IN A DEVELOPING COUNTY

In a Developed Country	In a Developing Country
Focuses on improving EHR access and patient identification.	Designed to provide healthcare to underserved populations.
Aims to streamline administrative processes	Targets financial inclusion and equitable healthcare access.
Enhances personalized care and treatment plans based on patient medical history.	Employs health cards as proof of insurance coverage or eligibility for subsidized services.
Enables quick retrieval of patient information during emergencies for efficient decision-making.	Enhances patient identification to ensure accurate delivery of services.
Supports public health management through data tracking and contact tracing.	Facilitates targeted healthcare interventions for specific health issues prevalent in the region.
Improves overall healthcare delivery and patient experience.	Strengthens healthcare infrastructure and capacity in underserved areas.

III. METHODOLOGY

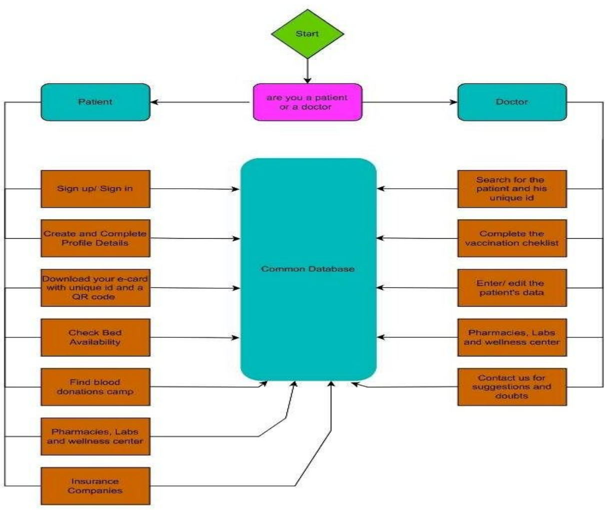
A. System Architecture

After analyzing already existing systems in the market we developed unique ideas and designs to be implemented in our project, the Doctor Sahyog. An QR code and a unique identity number have been included which helps in accessing the information from the servers through the the health card. The system consists of a front-end and a back-end for the website. This website is made to access the healthcard and other related system information. The front-end has been developed using languages like HTML, CSS and JavaScript. We have been working on the back-end using SQL and Xampp for creating a data base.

B. Features

Doctor Sahyog is a website UI with 2 portals one for the patient and another one for the doctor. The patient module consists of a Dashboard page where all the basic info of the patient is shown and can be accessed by scanning the qr code present on the health card. Since anyone can scan the qr code the system displays only the basic information in it. For other details we have made a pin authentication where he can access past opds and other medical records. The website includes a user interface for accessing patient information and a database to store and retrieve medical records. The website has highly secured encryption and authentication protocols which are used to ensure the protection of patient data. The website is patient centric as well as doctor centric, the system have a patient login where he can check his prescriptions, book an appointment and order medicine from any nearby pharmacy. The system also includes a doctor login where a doctor can check a patients data by searching a patient ID, doctor can also access the OPD section and fill an OPD form for a patient. It also offers features such as appointment scheduling, prescription requests, and the ability to communicate directly with your healthcare providers. The Health Card's patient portal aims to empower you by putting your health information at your fingertips, enabling you to make informed decisions about your well-being. Through this intuitive and user-friendly interface, you can take charge of your health and actively participate in your care, all while ensuring the privacy and security of your sensitive data. For healthcare professionals, the Health Card streamlines the process of accessing patient information and fosters efficient collaboration. Doctors can use their personalized login credentials to access the dedicated doctor portal on our website. Once logged in, they can quickly retrieve patient records by scanning the patient's Health Card QR code or searching by patient ID. The doctor portal provides a comprehensive overview of each patient's medical history, allowing physicians to make informed decisions based on accurate and up-to-date information. It also facilitates secure communication channels between doctors and patients, enabling seamless exchange of messages, test results, and treatment plans. With the Health Card, doctors can streamline administrative tasks and focus more on delivering personalized, high-quality care. The QR code embedded in the Health Card serves as a powerful tool for research and analysis. Researchers and scholars can leverage this technology to access patient profiles for authorized studies and clinical trials. By scanning the QR code, researchers are directed to the patient's profile page, which offers a comprehensive overview of their health data, contributing to the advancement of medical knowledge and the development of evidence-based practices.

C) Flowchart



IV. Results And Discussions

Doctor Sahyog, an electronic health card has served its purpose appropriately. It has helped to create a better connection between a patient and his doctor, it acts like a bridge between them. It has become more simpler for the hospitals to access the information, data and past records of a patient. Using the health card will lead to advancement in not only health industry but also in technology and economy. This has proven beneficial also for the patients as they can access their health information from anywhere anytime easily. The health card includes security and protection of users data and information therefore they can have their privacyprotected. Doctors using the health card can save their time by directly accessing the patient record by scanningthe QR code or entering the unique patient ID instead of opening and reading past records. It has also helped to store the Vaccination records very easily in form of a checklist. Doctor Sahyog has been a really helpful and reliable in the health industry. The Electronic Health Card provided patients with greater control over their medical information, allowing them to carry their medical history with them at all times. As a patient, the Health Card provides you with a gateway to personalized healthcare management. By simply scanning the unique QR code on your card, you can access your dedicated profile page on our secure website. This portal serves as a centralized hub where you can conveniently view and update your medical records, including diagnoses, treatments, medications, allergies, and more. Some of the major discussions are-

Seamless Transfer of Medical Information:

- When a patient is transferred from one healthcare facility to another, health cards can ensure a smooth transition of medical information.
- For instance, if a patient needs to visit a specialist or is admitted to a hospital, their health card can be used to quickly access their medical records, enabling the healthcare provider to have a comprehensive understanding of the patient's health history, previous treatments, and medications.

Emergency Situations:

- Health cards are particularly valuable during emergencies when immediate medical attention is required.
- Paramedics and emergency responders can quickly access vital information from the patient's health card, such as allergies, pre-existing conditions, and medication details.
- This information helps in making critical decisions and delivering appropriate and timely care, potentially saving lives.

Public Health Management:

- Health cards can play a crucial role in managing public health initiatives such as vaccination programs and disease surveillance.
- By linking individuals' health cards to their immunization records, authorities can efficiently track vaccination rates, identify vulnerable populations, and take measures to prevent the spread of diseases.
- Health cards can also aid in contact tracing during outbreaks, enabling timely interventions to control the transmission of infectious diseases.

Screenshots from our UI Website

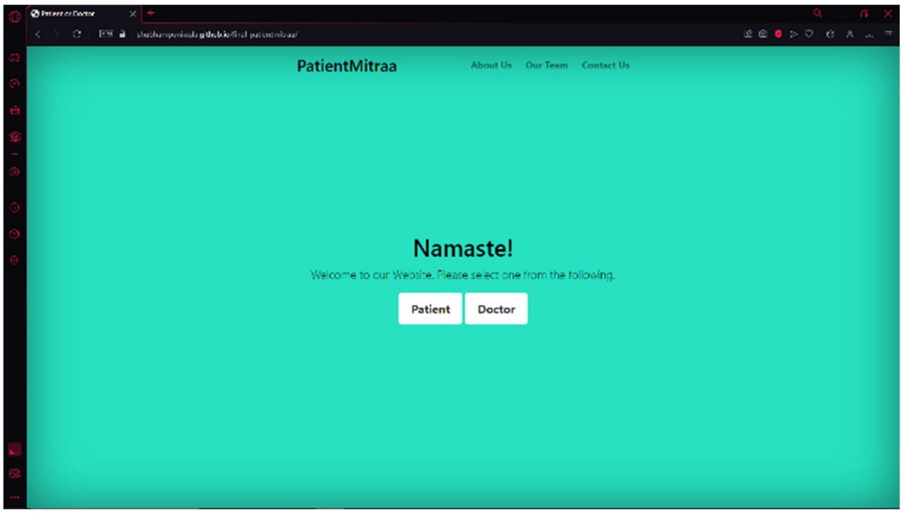
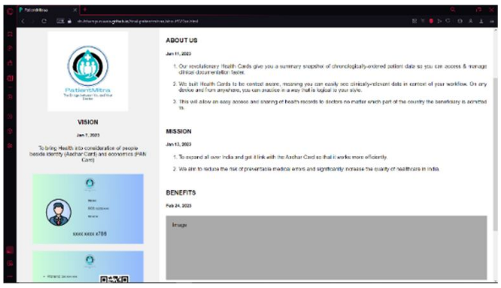


Fig 1: are you a Patient or a Doctor



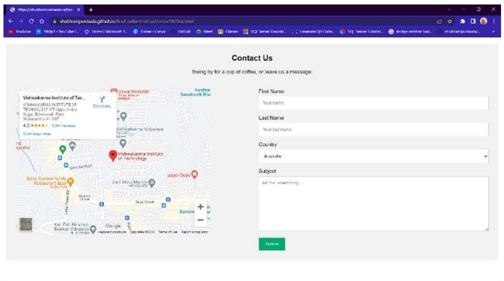
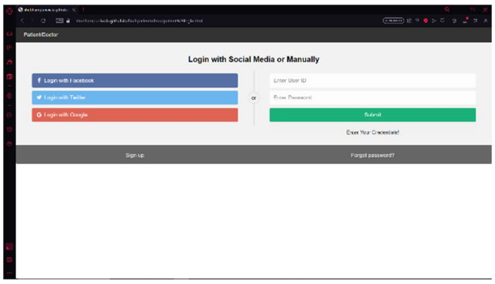


Fig 2: The home page stating our Vision and Mission (left) and contact us page with a Google map statingdirection to meet us (right)



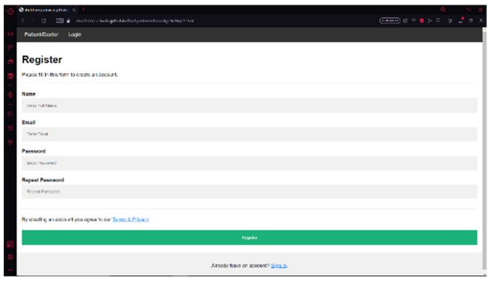


Fig 3: Login (left) and sign-up (right) pages

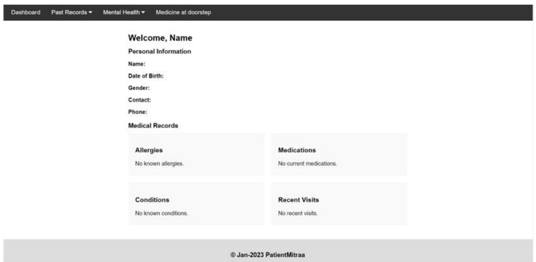
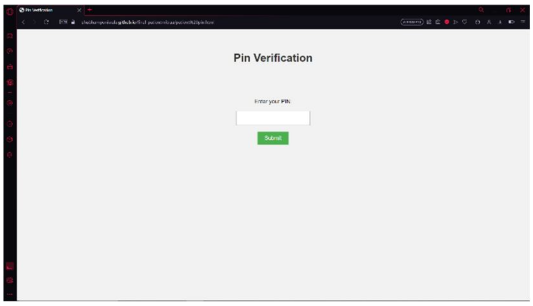


Fig 4: Generated QR Codes (left); Interface after scanning QR Code- Patient's Dashboard (right)



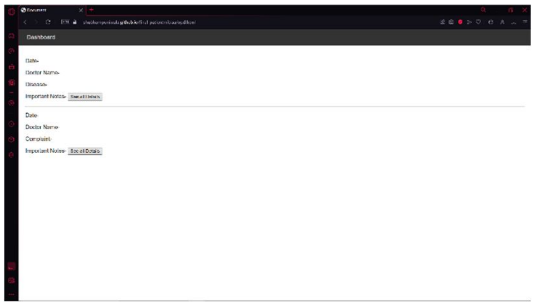
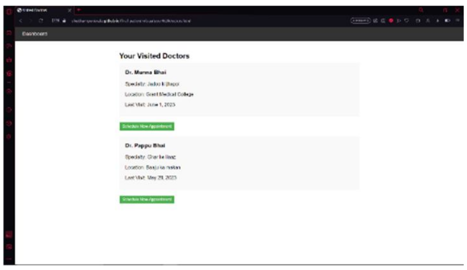


Fig 5: Pin Authentication for a 2 factor security (left); Patient's OPD details (right)



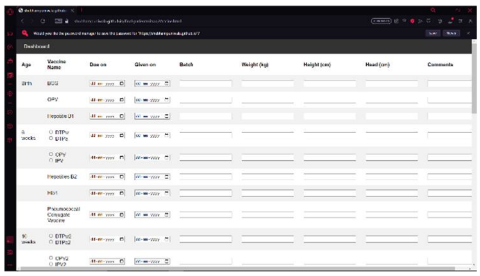


Fig 6: Your Doctors (left); vaccination check list (right)

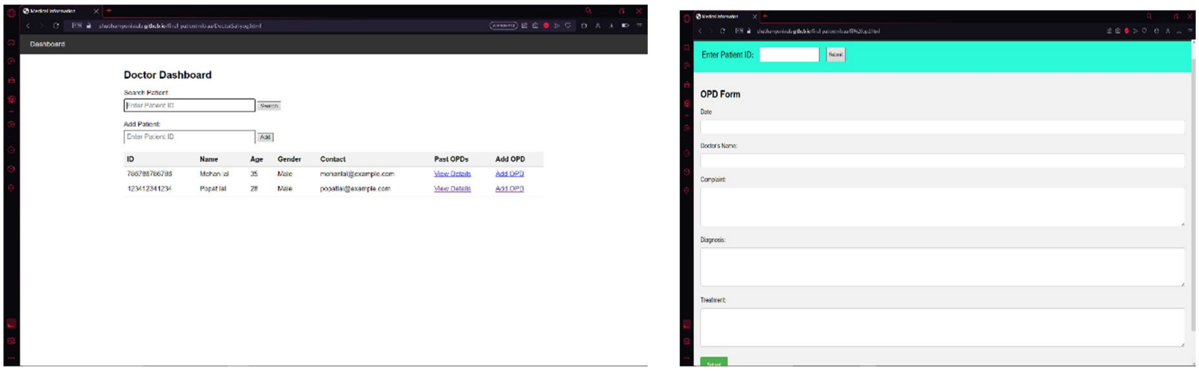


Fig 7: Doctor's Dashboard- with fill opds and view past opds (left); OPD form that the doctor will be filling (right)

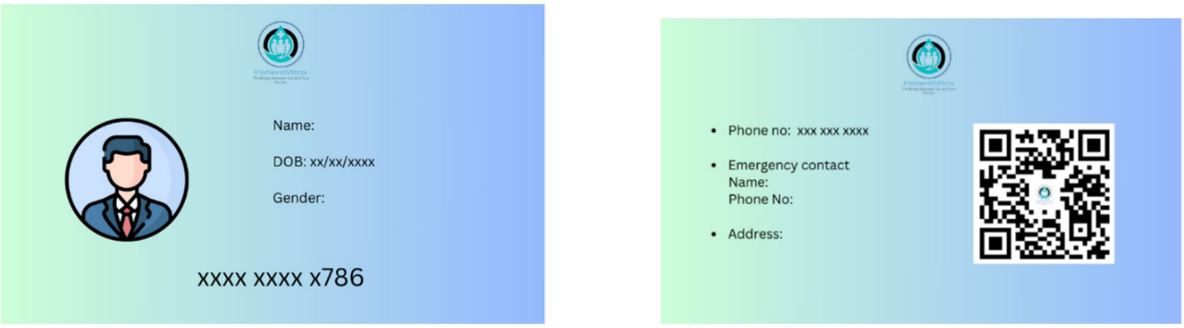


Fig 8: Sample Card (Front and Back)

V. Future Scope

The future scope of our Doctor Sahyog is vast and promising. So firstly we are going to launch a mobile application. With the continuous advancement of technology, electronic health cards are likely to play even more critical role in the healthcare industry. We have planned to work further on this project by adding new features like linking of user's Aadhaar card and PAN card to our electronic health cardwhich will make it even simpler for the users to access their information and data. Successful linking of theAadhaar card and PAN card will provide us with a huge platform to implement our project. We are even going to add pages like bed availability in hospitals, blood donations, labs and other wellness centers. We even aim to add insurance companies so that it becomes easy for the user to check which insurance he can claim in which hospital. In the future scope of this paper, we have planned to add many new exciting features for both the patient and the doctor, creating it more user friendly and interactive. Features like booking an appointment with a doctor in a particular hospital, ordering medicines online from any nearby pharmacy and reading health blogs, health news will be a useful and interesting feature for a patient. For doctors we will be adding features like accepting or declining an appointment, reading and posting health blogs and allowing them to interact with their patients online for developing a better bonding and relation with each other. Doctor Sahyog is a unique project which is going to be helpful in the Indian health sector.

VI. Conclusion

Doctor Sahyog is a project which will bring changes and improvement in the health sector. The platform serves a bridge between a patient and his doctor. This implementation of health card enhances accessibility, improves patient care, and streamlines medical record management. It's not only beneficial to doctor's but also to patient's. This efficient and secure health card system ensures quick retrieval of patient information, facilitating informed medical decisions and minimizing errors. The proposedElectronic Health card system would be successful when people will understand the advantages of this Electronic Health card system and about the need of this technology for advancing the current healthcare system in India. By centralizing medical records and utilizing QR code technology, it promotes seamless healthcare delivery and empowers patients to actively participate in their own health management. With the advancement of technology, the future of health cards looks promising, and they will continue to play a vital role in the healthcare industry.

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Pet Adoption Speed Prediction

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***Abstract*— Many stray animals throughout the world unfortunately do not get the opportunity to find the loving home that they deserve. In this classification task, we look to develop an algorithm to predict the speed of pet adoptions. The input to our algorithm includes animal type (dog or cat), breed, gender, colour, profile picture online and the descriptions about the pet, etc. We then use both traditional machine learning techniques (Logistic Regression, Naive Bayes, SVM, Decision Tree, Random Forest and Gradient Boosting) and neural networks (fully connected neural networks and long short-term memory Model) to predict the adoption rate. In particular, we build feature vectors using information extracted from description scripts and feed them into neural network models. We are hoping to examine the results to develop strategies to help improve the overall adoption rate (i.e. what features lead to faster adoption).**

Every year, 3.3 million canines visit animal shelters, out of a total population of 200 million. Only 2% to 17% of pets are returned to their owners. The remaining animals are euthanized due to a shortage of room in shelters (killed). The present procedures for adapting or finding a pet are inefficient and haphazard. People disseminated leaflets to the general public and spread the word to others in the vicinity of the pet's disappearance. When individuals print fliers, they waste paper and money since there is no good impact. People also share their tales on social media sites like Instagram and Facebook. There are also several fraudsters who attempt to fraudulently claim the incentive for returning the pet to its legitimate owner. We want to provide an analysis on how fast pets(cats and dogs) can be adopted based on various factors like their health conditions, age, colour, breed etc.

I. INTRODUCTION

Animal adoption is the procedure through which a human takes in an animal, most often a cat or a dog. Animal control takes these lost or abandoned animals and places them in animal shelters. Pets that have been in shelters for an extended period of time are killed in order to alleviate the overpopulation of undesirable animals. Animal adoption has seen a solid trend in the society for decades. We have come very far with the way we manage abandoned animals and strays to rehabilitate them. While organizations like the Blue Cross of India (BCI) have operated since the year 1959, with the advancement of technology, we now have the system of online pet adoption where databases of pets taken in by numerous rescue groups and animal shelters are maintained and are openly available for access and utilization by the public. Further, a lot of innovative work has being going into the field of animal welfare.

Some people euthanize pets because of fatal and irrecoverable injuries or illnesses. Others do so even for treatable health problems that they either are unable to financially provide for or are not willing to. Without doubt, many veterinarians consider euthanasia to be a completely unethical procedure. Some other people let go of their pets, into the wild perhaps, or abandon them with the hope that they will be able to care for themselves or that someone

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will find or adopt them. In reality, most of these pets that are released by their owners perish to harsh weather, hunger, traffic or easily treatable health issues. In addition to this, homes cannot be always found in adoption centres and unless the centre has a no-kill policy, excess animals are also euthanized to make room for new pets. It was estimated by The Humane Society of the US, that every year, 2.4 million adoptable, healthy dogs and cats are euthanized in the United States of America because of unavailability of homes.

A. Objectives

- To understand what features play a major role in determining the speed of adoption of a pet.
- To determine if a pet would be adopted or not based on the description and images of dogs and cats provided.
- To use H2O algorithm to determine the speed of adoption.

II. Literature Survey

Paul C. Bartlett, stated that "In 2003, of the 140,653 dogs that were discharged from Michigan shelters in 2003, it was found that 28% were taken in for adoption and 40% had to undergo euthanization; this implied that the annual euthanasia rate was 2.6% for the estimated 2003 Michigan population of dogs. The annual rate of euthanasia for cats in 2003 was much higher than that of dogs (3.1% and 2.6%). Of the 134,405 cats discharged from Michigan shelters in 2003, only 24% were adopted and 57% were euthanized. For both dogs and cats, altered animals had much lower rates of euthanasia than unaltered animals. Among government and private owned animal shelters, private shelters had 20% of their dogs euthanized and 29% of their cats compared to 30% of dogs and 50% of cats euthanized in facilities owned by the government. Additionally, the results indicated that the larger the size of the shelter, the higher the rate of euthanasia for both dogs and cats regardless of ownership. [1]

Brown W.P analysed the effects of age, sex , breed designation, coat colour, and coat patterns on the length of stay (LOS) for cats in a no-kill shelter; and also compared the physical characteristics and LOS of cats adopted at a no-kill shelter and in traditional shelters. His article indicates feline physical characteristics influence LOS, likelihood of adoption, or risk of euthanasia at shelters of all kinds and recommend exploring strategies to increase the adoptability of less desirable cats and kittens. [2]

Rachael Mozes evaluated the factors associated with euthanasia in an animal shelter in Kitchener-Waterloo, Ontario, Canada. He concluded that 53% of admitted cats were euthanized. The adoption policies used in animal shelters have a great effect on the total number of adoptions and donations that occur. [3]

Lord .E established a stochastic model to simulate the expected costs, revenues, and net income of a hypothetical animal shelter for various alternative management strategies, based on US conditions. [4]

Sloane Hawes studied how the quality of life of older animals is impacted by remaining in the care of shelters rather than being euthanized. The sample consisted of 122 dogs and 124 cats that were above the age of 7 years who were taken into a shelter in a one-year period. The article highlights the significance of preventative outreach, behaviour programs and specialized medical, and a powerful foster care system that are equipped to deal with the requirements of older animals in their homes and in a shelter. [5]

In "Ref. [6]" the authors have represented the results on predicting the pet adoption speed by using various algorithms like SVM, random forest, logistic regression.

In "Ref. [7]" the authors have discussed the results on prediction of adoption versus euthanasia among dogs and cats. This paper determines the factors on which adoption is dependent by using logistic regression.

In "Ref. [8]", the authors have represented the results of pet analytics by using their online profiles. This paper has worked on other algorithms like Gradient boosting, regression, neural networks, logistic regression etc. for speed prediction.

In "Ref. [9]", the authors have worked on pet adoption prediction using AI. In this paper, the researchers have created a website which gets updated whenever a stray animal is observed on the streets.

In "Ref. [10]", the authors have discussed the results of statistical analysis of pet adoption. In this paper, it tells us what are the preferences of people by performing ANOVA testing on the given dataset.

In "Ref. [11]", the researchers have worked on animal adoption system. In this paper, the researchers have created a website which connects the people who want to adopt and who want to give their pets virtually.

In "Ref. [12]", the authors have worked on the impact of breed identification, potential adopter perceptions and demographics, and dog behaviour on shelter dog adoptability. This paper determines what should be the characteristics of dogs for increased adoption results.

TABLE I: LITEARTURE SURVEY

Reference	Details	Algorithms used	Results	Gaps identified
[6]	Predicting the speed of adoption	Logistic regression, SVM, decision trees, random forest	Accuracy of the predictions: 0.335, 0.359, 0.321, 0.392	Accuracy was less
[7]	Predicting the speed of adoption	Catboost model	Categorises the speed into 2- within 15 days and after 15 days	Doesn't predict the exact speed
[8]	Predicting adoption speed of pets from their online profiles	Decision tree, random forest, neural networks	Accuracy of predictions: 0.58, 0.61, 0.63	Accuracy was less
[9]	AI based pet adoption prediction	Creates a website	The website will be updated whenever stray animals are observed	This only notifies whenever a stray animal is identified but doesn't predict its adoption probability
[10]	Statistical Analysis of Animal Adoption	ANOVA	Identifies the differences between breed type and outcome gender	Focuses on annual budget spent on adoption rather than predicting the speed

III. DATASET DESCRIPTION

The base dataset was taken from Kaggle which consisted of 14,993 rows and 24 columns. It consists of 3 parts:

1. It is a CSV file with detailed information including animal type (dog or cat), breed, gender, colour, fur length, sterilized, health, and description.
2. It is a JSON file of descriptions with sentiment score
3. And it is a large collection of image files.

The features which were included are: PetID, adoption speed, type, name, age, breed1, breed2, gender, color1, color2, color3, maturity size, fur length, vaccinated, dewormed, sterilized, health, quantity, fee, state, rescuer ID, video amount, photo amount, description. The adoption speed was given a numerical value based on the following:

0 **-** same day as listed
1 **-** between 1 and 7 days (1st week)
2 **-** between 8 and 30 days
3 **-** between 31 and 90 days (2nd and 3rd month)
4 **-** No adoption after 100 days of being listed

But this dataset was modified as shown in Table 2- the dataset regarding both cats and dogs was taken and combined together. The final dataset consists of 15 features and 1,25,326 rows which contains information about both dogs and cats. The features included are PetID, URL, type, age, gender, size, coat, breed, name, colour, posted date, contact city, contact state and adoption speed.

TABLE II: FEATURES DESCRIPTION

Feature name	Description	Domain
Pet ID	Unique ID given to each pet	String value- combination of numbers and alphabets
URL	URL of the pet image	Hyperlink
Type	Tells the category of pet	Cat, Dog
Age	Tells the age of pet	Baby, young, adult, senior
Gender	Tells the gender of pet	Male, Female
Size	Tells the size of pet	Small, Medium, Large, Extra Large
Coat	Tells how coated the pet is	Short, Medium, Long, Curly, Wire

Breed	Tells the breed of the pet	Abyssinian,Persian, American etc.
Name	Tells the name of pet	Different values of names
Colour	Tells the colour of pet	Gray, brown, black, white
Posted date	The date when the pet has been listed	Date value
Contact city	The city where the pet is available	New York, Henderson, Golden Valley etc.
Contact state	The state where the pet is available	Texas, Los Angeles etc.
Adoption speed	The speed at which pet will be adopted	0, 1, 2, 3, 4

IV. METHODOLOGY

The steps which were performed are: data collection, data pre-processing, building machine learning models, applying proper data visualisation and analysis, finding how far the models have performed well, deploying the model.

- *Data collection*: The base dataset which we are currently working on was taken from an internet source- Kaggle.com and it was modified. Two datasets were considered for this purpose- one is related to cats and the other is dogs. These two are merged and then worked upon.
- *Data pre-processing*: The data which was collected cannot be taken as it is, since it had few irrelevant values(negative number where they're not applicable), cleaning the data etc.
- *Handling missing data*: There were missing values in various features and average of the existing values was taken to fill in that data.
- *Data reduction*: In this step, the huge dataset will be reduced into a smaller one.
- *Feature Extraction*: Feature extraction is a process of renovating the fresh input data into the integral attributes and the main thing is we must preserve the data during the extraction phase. Data integrity, data confidentiality, and storage are important and retain he original information of the dataset. The raw data is processed at each stage and cleaned attributes required for the study are extracted.

The following list of analysis tasks were performed:

- *Determining if the image subject is clear*:

If cat/dog is not the first word in image keywords or description, then the subject would be marked as unclear or unfocused. Else, it would be marked as clear as shown in Fig. 1.

PetID	image.keywords	clear.subject
0008c5398	cat, small to medium sized cats, whiskers, cat like mammal, eye, khao manee, domestic short haired cat, kitten, burmilla, snout	Yes
000a290e4	dog, dog breed, dog like mammal, dog breed group, phalène, carnivoran, papillon, companion dog, moscow watchdog, puppy	Yes
000fb9572	dog, dog like mammal, mammal, vertebrate, dog breed, dog breed group, puppy, arm, snout, carnivoran	Yes
0011d7c25	cat, small to medium sized cats, cat like mammal, fauna, whiskers, domestic short haired cat, kitten, aegean cat, oriental shorthair, snout	Yes
00156db4a	dog, dog breed, snout, street dog, dog breed group, black mouth cur, dog like mammal, whiskers, rare breed dog	Yes
001a1aaad	cat, small to medium sized cats, cat like mammal, dog breed group, whiskers, carnivoran, kitten, tail, dog breed, flooring	Yes

Figure 1. Determining clear subject

- *Finding image object focus' dominant colour*:

It combines the 3 colours for a given pet and shows what is the dominant colour of a particular pet as shown in Fig. 2. It shows how many pets belong to a particular colour.

dominantColor	n
rosybrown	1079
burlywood4	933
gray20	850
gray9	687
gray19	562
salmon4	503
gray8	482
navajowhite4	435
gray32	413
gray10	398
gray21	356
gray33	342
gray61	341
gray7	334
gray60	308
gray31	295
antiquewhite3	293
peachpuff4	278

Figure 2. Finding the dominant colour

- *Finding sentiment score of description of each pet:*

As we have provided description for each pet, we determine the sentiment score by removing unnecessary words, punctuation marks, special characters and breaking them into individual words as shown in Fig. 3.

PetID	sentimentScore
0008c5398	2.00
000c21f80	1.24
000fb9572	2.33
0011d7c25	3.00
00156db4a	-1.75
001a1aaad	1.67

Figure 3. Sentiment score of description of the pet

- *Topic modelling for description feature:*

By using LDA, we determine the hidden features for the description of each pet and we rename the columns as doc_topic 1, doc_topic 2, doc_topic 3, doc_topic 4, doc_topic 5 as shown in Fig. 4.

PetID	doc_topic_1	doc_topic_2	doc_topic_3	doc_topic_4	doc_topic_5
58af165cd	0.0002407595	0.0002407106	0.9839596032	0.0002407647	0.0153181620
86547ad6d	0.4146193076	0.1680716461	0.0002455274	0.3868039009	0.0302596180
a63f6c6a1	0.5514827925	0.1102640706	0.0003533545	0.3070933243	0.0308064581
3e2cc2690	0.8411213943	0.0230723699	0.0005373701	0.0005376459	0.1347312198
427acc248	0.8222218310	0.1750551684	0.0009074380	0.0009079141	0.0009076485
9967c6cb6	0.5828149735	0.0576174315	0.1743712229	0.0003639845	0.1848323875

Figure 4. Topic modelling for description

- *Topic modelling for image keywords feature*:

The same is performed for the image keywords and the columns are renamed as keyword_topic 1, keyword_topic 2, keyword_topic 3, keyword_topic 4, keyword_topic 5 as shown in Fig. 5.

PetID	keyword_topic_1	keyword_topic_2	keyword_topic_3	keyword_topic_4	keyword_topic_5
ac3f4aec5	0.002318314	0.002318314	0.5703341	0.002318314	0.422710936
03c1e47b4	0.002559224	0.056582884	0.9357394	0.002559224	0.002559224
0605aab21	0.002559224	0.002559224	0.7182754	0.002559224	0.274046960
083687ba1	0.002559224	0.002559224	0.9897631	0.002559224	0.002559224
0a0862717	0.002214102	0.002214102	0.3535033	0.002214102	0.639854418
1b91e1082	0.002559224	0.002559224	0.9897631	0.002559224	0.002559224

Figure 5. Topic modelling for image keywords

- Replacing the name column with 2 values- Has Name, No Name and add WordCount column:

If a particular animal has name, we assign it as Has Name and if it doesn't, we assign it as No Name. In this step, we also add the column of WordCount- count the number of words in the description for each pet as shown in Fig. 6.

PetID	Type	Name
0008c5398	2	Has Name
000a290e4	1	Has Name
000c21f80	2	Has Name
000fb9572	1	Has Name
0011d7c25	2	Has Name
00156db4a	1	Has Name

keyword_topic_1	keyword_topic_2	keyword_topic_3	keyword_topic_4	keyword_topic_5	Word.Count
0.577677860	0.413754111	0.002856010	0.002856010	0.002856010	47
0.003457432	0.003457432	0.986170272	0.003457432	0.003457432	26
0.002699484	0.877476462	0.002699484	0.114425086	0.002699484	211
0.003718444	0.003718444	0.903578602	0.085266068	0.003718444	27
0.989202064	0.002699484	0.002699484	0.002699484	0.002699484	8
0.002856010	0.067428454	0.924003517	0.002856010	0.002856010	75

Figure 6. Adding Wordcount column and converting name to Has name and No name

- One hot encoding and factoring for categorical features:

We convert the features with categorical values like dewormed, sterilized, quantity, size, photoamt etc. into numerical values by using one hot encoding as shown in Fig. 7.

PetID	AdoptionSpeed	Type	Name	Age.Quantile	Gender	MaturitySize	FurLength	Vaccinated
0008c5398	3	2	1	4	1	2	2	1
000a290e4	2	1	1	1	2	2	2	2
000c21f80	NA	2	1	2	1	1	1	2
000fb9572	3	1	1	1	2	2	1	2
0011d7c25	2	2	1	1	1	2	1	2
00156db4a	1	1	1	1	1	2	1	2

Figure 7. One hot encoding

- Building a confusion matrix for actual and predicted classes:

Finally, we build a confusion matrix for the model if it has predicted correctly or not as shown in Fig. 8.

```
==========================================================================
Confusion Matrix: Row labels: Actual class; Column labels: Predicted class
       0    1    2    3    4  Error            Rate
0      1   16  259    3   37 0.9968 =      315 / 316
1      0 2158  336    0  106 0.1700 =    442 / 2,600
2      0  218 2607  229  414 0.2483 =    861 / 3,468
3      0    3  121 2587  103 0.0807 =    227 / 2,814
4      0   63   23   18 3372 0.0299 =    104 / 3,476
Totals 1 2458 3346 2837 4032 0.1538 = 1,949 / 12,674
```

Figure 8. Confusion matrix

A. Algorithms Used:

Classification: This is a task where a particular value will be categorised into pre-defined classes. It is a process of creating classes that represent users and use cases. Class Probability Estimation tries to predict how to classify each single individual data asset. Based on the specific question to be answered, classes are created. Other qualities of the asset are evaluated in making the prediction.

Factoring: This is a technique to convert categorical values into numerical values. For example, considering the age feature-we have values like adult, young, old etc. They will be converted into 0, 1 and 2 respectively. This is called one-hot encoding.

Regression: The most commonly-used forecasting method is the Regression method. Regression can be confused with classification methods because to predict an outcome, the process of using known values is the same. It is a model used to predict continuous value. Linear regression, Logistic Regression, and Polynomial Regression are some types of regression.

V. RESULTS

TABLE III. RESULTS

Analysis task	**Result obtained**
Determining if the image subject is clear	Yes/No according to the first word of Image keyword
Finding image object focus' dominant colour	Number of pets belonging to a particular colour
Finding sentiment score of description of each pet	Positive/Negative value
Topic modelling for description feature	Finds the hidden features for description and adds the columns as doc_topic 1 to 5.
Topic modelling for image keywords feature	Finds the hidden features for image keywords and adds the columns as keyword_topic 1 to 5.
Replacing the name column with numerical values and adding WordCount column	Has Name or No Name and sum of no. of words in description.
One hot encoding and factoring	Converts values like small, medium, large, young, old, baby etc. into numerical values.
Building a confusion matrix	For predicted and actual values.

VI. Conclusions And Future Scope

The findings of this paper highlight the features which are best chosen when it comes to adopting a pet. We determine the speed of the adoption of the pets as 0, 1, 2, 3 and 4 based on how many days after the pet has been posted, it has been adopted. We use both image data and text data like description and image keywords for the pets to determine this. It is clear that features like colour, age and breed play a vital role when a pet is being adopted.
The task for this project is to predict pet adoption speed given related information such as biological details, descriptions. We use the machine learning algorithm H2O on the given data which has given following observations:

MSE: 0.321
RMSE: 0.567
Logloss: 0.8567
Null Deviance: 37022.39
Residual Deviance: 21717.15.

Based on the result, visual information such as photos and videos of the pet seems to have the most influence on the adoption decision.
For future work, we plan to experiment with more machine learning models, and try different ensemble methods in the hope of an increase in accuracy. Given the importance of visuals and the available image data, we would like to take full advantage of the dataset and incorporate these images into our deep learning models using computer vision algorithms. Different model structures and hyperparameter combinations can be tested and adjusted accordingly if more time and computational resource are available.

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An Efficient Multi Biometric Crypto-Key Generation

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***Abstract*— Biometrics refers to the technology for personal recognition or authentication based on our physiological and/or behavioural characteristics. Distinctiveness, Permanence, Collectability, Performance, Acceptability, and Circumvention are the properties of biometric Using only one biometric trait in Authentication systems may not provide all the properties mentioned above. We use more than one biometric trait (similar / different) simultaneously which is called as multi biometric, provides more robust. There are a number of other sources that can be combined to enhance security in the case of combining different biometric modalities. In this paper shows the basic biocrypto system technique used in most of the research. This shows the cryptosystem which stores a key and will be released once the verification is done. Cryptography methods is combined with multibiometric which enhances the security of privacy data.**

***Index Terms*— Key Generation,Cryptography , Biometric, Feature Extract**

I. INTRODUCTION

Biometrics refers to the technology for personal recognition or authentication based on our physiological and/or behavioral characteristics. Physiological Characteristics: face, Fingerprint, Hand geometry, Iris, Retina, Palm print, Facial Thermogram, Ear, Hand vein. Behavioral Characteristics: Voice, Signature, Gait, Keystroke. Biochemical Characteristics: DNA, Odour. Universality, distinctiveness, permanence, collectability, performance, acceptability, and circumvention are the properties of biometric. Using only one biometric trait in Authentication systems may not provide all the properties mentioned above. We use more than one biometric traits (similar / different) simultaneously which is called as multi biometric, provides more robust. There are a number of other information sources that can be combined to enhance security in the case of combining different biometric modalities. The following figure 1 shows the basic biocrypto system technique .

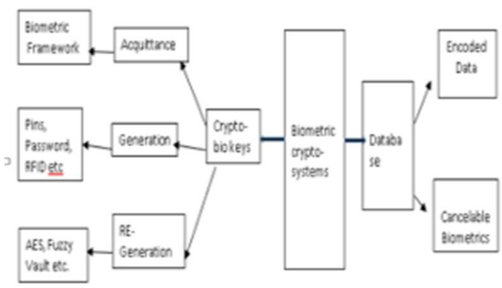

Figure 1: Basic Bio-crypto system technique

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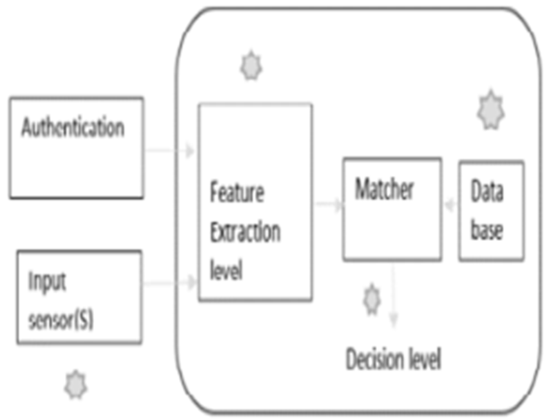


Figure 2: Different stages of attacks on a basic biometric system

II. Related Work

In a few years, multi-modal biometric fusion has gained considerable popularity as its efficiency is improved. Multimodal biometric cryptography increases device security. The literature has studied such cryptography techniques using multimodal biometrics. By fusion of finger print, retina, and finger vein with encryption techniques, Jagadiswary and Saraswady [7] have developed the multi-modal device. The system suggested has GAR of 94%, FAR of 1.46% and FRR of 1.07%, and a multimodal system with iris and palm vein, which was proposed by Bala and Joanna [8]. Features of the two modalities have been extracted via the extraction process, followed by an algorithm to protect the feature set with the Blow fish cryptography. The device proposed is very poor in FAR and FRR. S. More et al. [9] suggested a multimodal device with the modes of input of fingerprint, ears, iris and palm. The functional extraction method extracts input features and uses the cryptographic Algorithm Data Encryption Standard (DES) to secure features. With the aid of MATLAB, experimental results are shown. Gawande et al. [10] have proposed a multimodal framework that combines fingerprint and iris at extractive level and then employs a cryptographic method to secure input templates. For presentation of the results the publicly accessible CASIA database is used. With cryptographic encryption, the results of this proposed system are enhanced. Raghu and Deepthi [11] suggested a cryptographing-based multimodal authentication method. The secret key identified by the user is used to combine fingerprint and iris features. Experimental evidence suggests that the device proposed is better than a cryptographic unimodal one. A framework that will help users upgrade their biometric password and address several issues in existing biometric systems was proposed by Ashok et al [12]. Biometric password development is using the hacking feature. Biometric cryptography enhances system protection and provides better performance than many current systems. Mathew [13] has suggested an encrypted biometric device that uses the biometric modality to produce the secret key. To encrypt the Iris, you use the 32-bit fingerprint Id. The technique of Blow fish encryption is used to encrypt the template at registration time. During the decryption authentication process, the user is authentic or imposter. A device to enhance safety with the help of a bio-metric key was proposed by Arunachalam and Subramanian. FKP and fingerprint for the biometric key generation using K-mean algorithm are used in this framework. To encrypt a prototype, AES encryption technique is used. Also used for checking errors and deleting bad tempering is Cyclic redundancy check. E.S. Shameem S, Germany. [15] a multibiometric framework that combines FKP with face has been suggested. The Scale Invariant Feature Extraction (SIFT) procedure is known as the Multi-Modal Biometric Automation System (MMBAS) which reduces the system complexity and eliminates errors caused by failed samples. Experimental findings suggest that the system proposed is much better than the current system. S. Chaudhary and R. Nath [16] proposed a system which incorporated face, Iris and voice in combination with the Sum Rule Fusion technique. The device suggested is much better than the unimodal one. To verify device output, publicly accessible databases are used. With the aid of the MUBI tool the experimental results are shown. The multimodal system of FKP, face and palm print was proposed by Jacob Vetha Raj [17] and Anne Wincy. The feature set is extracted by the SIFT and Speed Up Robust Features (SURF) method and the Support Vector Machine (SVM) classifier used. The proposed system's FAR and FRR is less than unimodal. Experimental findings illustrate the performance and reliability of the proposed method.

III. METHODOLOGY

Key generation with Receiver's Enrolment In session-based communication, the session keys are exchanged before the sender and the receiver begin a secure session. The session key will originally be created randomly in this form of communication and passed to another user using public key encryption. In symmetric cryptography, the mutual key is used for message transmission from sender to receiver. The authentication of communicating parties is a big problem in this protocol. The sender and receiver authentication is checked through a trustworthy certification by third parties. Authenticity also relies on a third-party's reliability. Authenticity verification is also required before sharing their biometric data with each other in biometric symmetric encryption, where biometric data from both users produce and exchange an encryption key. There are two problems in this case. A finger-print data can be intercepted by an attacker and an attacker can generate the key through the algorithm that is transmitted via (unsecure). A theoretical approach is used when biometric receiver data are inscribed in the sender to overcome this problem. The biometric data that are stored can be used to authenticate the owner (i.e. the receiver) and since it is saved at sender side it is not necessary to send the key generation to other users (sender). In this way, biometric data is transmitted to another user through an unsecured channel. However, the cancellable stored template is used to safely forward the cancellable sender template. This method eliminates the need for authentication by third parties. At the time of registration, we recommend storing cancellable biometrics to preserve the privacy of the owner's biometric identity.

IV. SYSTEM DESCRIPTION

In this method, it follows the same methodology used in approaches for cancellable fingerprint transformation models. The method involves three stages of registration, session key generation and template update. Enrolment. A database for biometric data of the recipient is stored at the sender site. This technique is called the sender's recipient registration. This is the following approach to registering recipients. First, it is presumed that minutiae (ride termination and bifurcation) points are extracted from the sender and receiver fingerprint image and biometrical data vectors are extracted at their own position. In addition, both sender and receiver build an annullable template (CTS), using the unique user key (Sks, Sks). In this way, the function vector can be used. Thirdly, the cancellable receiver template (CTR) has been XORed and the cancellable sender template (CTS,CTR) to lock CTR is stored in the sender's database and CTRlock is stored in CTR

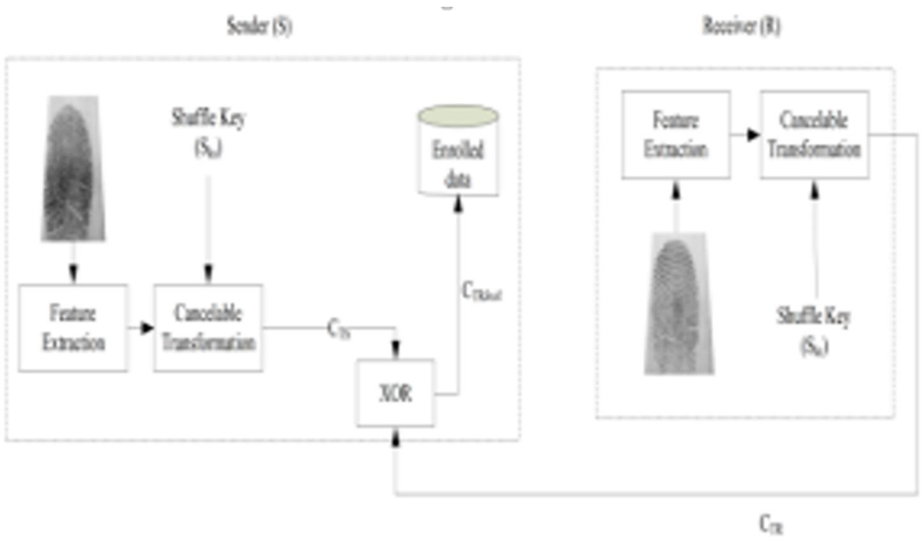


Figure 3 Enrollment process

V. GENERATION AND SHARING OF KEY SESSIONS

Following is the registration process, a session key is created in the sender and recipient cancellable templates. As key generation and authentication happens, the sender's fingerprint is captured and precise points are extracted. The cancellable Test template (C'TS) is created by means of the same keys (SKs). The locked template (CTRlock) is opened by the test template XORing (CTR = CTRlock ⊕C'T'S). Sender and recipient initially each have their own shuffle keys, and locked cancellable receiver models are stored in the sender's database. Fig. 5.28 demonstrates the main generation and sharing process. When the recipient wishes to safely connect with the sender, the following steps are taken.

1. The receiver will submit a request for authentication.
2. The sender acknowledges the request from the recipient.
3. The receiver produces a test cancellable template (C'_{TR}) using its own SKr shuffle key from an early fingerprint and sends hash value ($h(C'_{TR})$) to sender.
4. Sender also generates a cancellable test sample (C'_{TS}) with his shuffle key (SKs) from his fingerprint.
5. Send the locked cancellable template (C_{TRlock}) stored in the database to be opened and the hash value $h(C_{TR}$) generated.
6. Sender compare the hash value received ($h(C'_{TR})$) to the hash value ($h(C_{TR}$) generated). If both are similar, the recipient is authentic and cryptographical key is created by the sender and recipient's cancellable templates. In the previous chapter, GenKey Cryptographic key = GenKey(C_{TR} ,C_{TS}).
7. Sender will lock the C_{TS} with the stored Cancellable Receiver Prototype (C_{TR}). C_{TSlock} = C_{TS} = C_{TR}, respectively.
8. Sender sends the C_{TSlock} to the receiver.
9. Receiver unlocks C_{TSlock} and generates the cryptographic key by XORing its own C'_{TR}. Key Ksr = GenKey(C'_{TR}, C_{TS}) cryptographic key. GenKey is the key generation algorithm discussed in the last chapter from cancelable templates. Now both sender and recipient have the same key (Ksr).
10. The created key (Ksr) can be considered as the session key and can be started securely with this key communication.

In the above steps, the hash value of the cancellable template is computed using the following method using an XOR dependent hash function. The cancellable prototype (CTR) is shown as a bit stream and the dimensions of the CTR are separated by the expected hash value(|h(CTR)|). If the division is recalled, the necessary sum of zero with the remainder is applied. Then, first block is XORed, and the result is XORed, the third block, and so forth. All blocks are XORed, with the previous results, and hash value is determined, except for the initial two blocks. In this process, sender and recipient authentication is tested in the following manner. The cancellable receiver template is stored in the sender's database and is locked with the cancellable sender template. Therefore the cancellable receiver prototype can be unlocked with its own fingerprint data by only genuine senders. Secondly, the hash of an enrolled cancellable receiver prototype corresponds to the hash value submitted by an applicant and is only matched when an original recipient requests his or her own fingerprint information. Thus, before safe contact begins, both users will be authenticated with their cancellable templates.

VI. Face Based Cryptographic Key Generation

The proposed methods for facial cryptographic key generation are discussed in this section. Figure 4 displays the diagrammatic description of the solution proposed. A variety of features of biometrics are derived from the face images of the customer. The extracted characteristics are quantized, then mapped for corresponding feature points to the binary representation. The binary properties formed and the randomly generated key is bound with the fuzzy vault. During authentication, when the authentication face features provided have major overlaps with those inscribed, the cryptographic key is correctly recovered. This section provides descriptions of the methods suggested.

A. Feature Extraction

As the extractor function, the Principal Component Analysis (PCA) is used. PCA is an unsupervised learning technique that offers optimal representation of the input in the lower dimensional space in the least value of the square error sense. In the method of Eigenface [127], given a Z = {Zi} C i=1 training set, the PCA is used to find the covarian matrix N-vectors, which contains C classes for each class {Zi} Ci j=1 , consisting of a number of face pictures zij, a total of N ′ = ∑ Ci C i=1 images, a training set Z is used to find the N, the covariance matrix eigenvectors of the PCA,

$$Scov = 1 / N' \sum\sum(z_{ij}\, C_i\; j{=}1\; C\; i{=}1 - \bar{z})\,(zij - \bar{z})\; T \tag{5.24}$$

Where $\bar{z}$ = 1 /N′ ∑ ∑ (z_{ij} −$\bar{z}$)(z_{ij} −$\bar{z}$) Ci T j=1 C i=1 is the ensembles average. The characteristics Eigen faces are the first N(≤ N ′) eigenvectors, which are referred to as a. The original image is transformed by a linear mapping into the Ndimensional face space:

$yij = \psi\ T\ (zij - \bar{z})$ (5.25)

Where the orthonormal vectors of base ψ are. In the transformed face space, the following classification of facial patterns is possible.

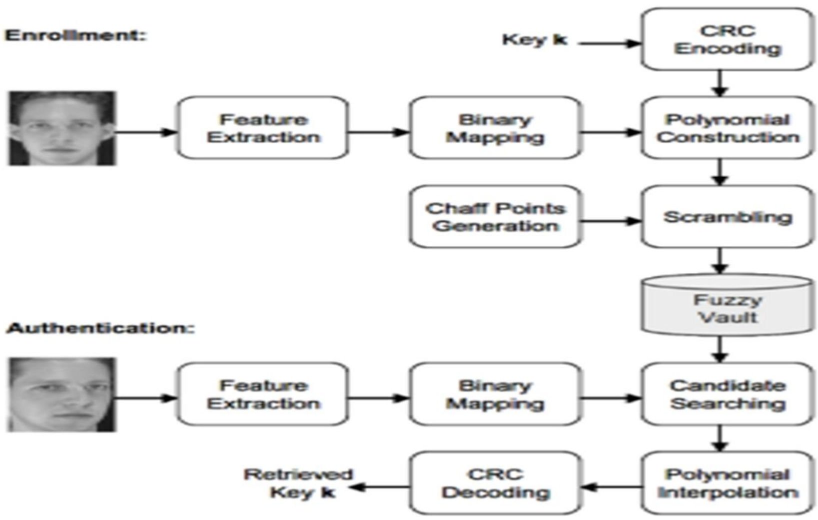


Figure 4 General Structure of the approach proposed

B. Binary Mapping

Unlike fingerprints, which use the specifics of points for functional matching, the PCA functions extracted are a series of real numbers, and it is normally difficult to accurately match them. One approach is to fit functional points based on proximity. But how to describe proximity is not easy. We propose a method for generating a two-dimensional quantification of facial features between the extracted features and the pairs of random vectors. The binary function process is as follows: Unlike fingerprints, where the coordinates of the minutiae points can be used for feature matching, the extracted PCA features are a set of real numbers, and generally exact matching is impossible. One method is to perform the matching of feature points based on closeness. However, it is not clear how to define the closeness. In this section, we propose a method to produce binary representation of face features based on 2-dimensional quantization of the distance vectors between the extracted features and pairs of random vectors. The procedure of producing binary features is as follows:

1. Extraction of the biometric data vector $y \in R\ N$
2. Create two random size NxM matrices, D+1≤M≤N, where D is a polynomial order for fluid vault building. To convert them into orthomorphic matrices Q1 and Q2 apply the Gram-Schmidt method.
3. The r_1 and r_2 elements are distributed uniformly to [0 τ], where τ is the pre-set value and two random Vector r_1 and r_2, length M.
4. Compute $R_{1i} = Q_{li*r1i}$ and $R_{2i} = Q_{2i*r2i}$, i=1..... M where I indicate the subscript in the column of i^{th} (Q1, Q2) and i^{th} (r_1, r_2).
5. In the case of R_1 and R_2, $d_{1i}=\|y\text{-}R1i\|^2$ and $d_{2i}=\|y\text{-}R_{2i}\|^2$ compute a Euclidean distance between y and each column vector.
6. In 256 steps, quantize d_{1i} and d_{2i} and map them to binary b_{1i} and b_{2i} strings.
7. In addition to the binary features, the corresponding bits in both b_{1i} and b_{2i}, i.e. bi=[b_{1i}| b_{2i}], i=1 .... M, are combined.

The N-dimensional face characteristics are mapped to the binary features of M 16-bit using the proposed procedure. The use of two distance vectors enables binary functions to be projected onto a 2-D image plane square where the b1i and b2i match the x and y axis coordination. This increases the exactness of the corresponding feature points as the binary feature bi matches both b1i and b2i. The projection of a y function on both axes is independent because of the randomness of R1 and R2. The orthogonization in step 2 creates binary chains in each direction which are uncorrelated. Step 3 and 4 generate different standard orthogonal vectors. The quantification and binary characteristically distributed over the entire plane would thus make it easier to conduct a brute force attack.

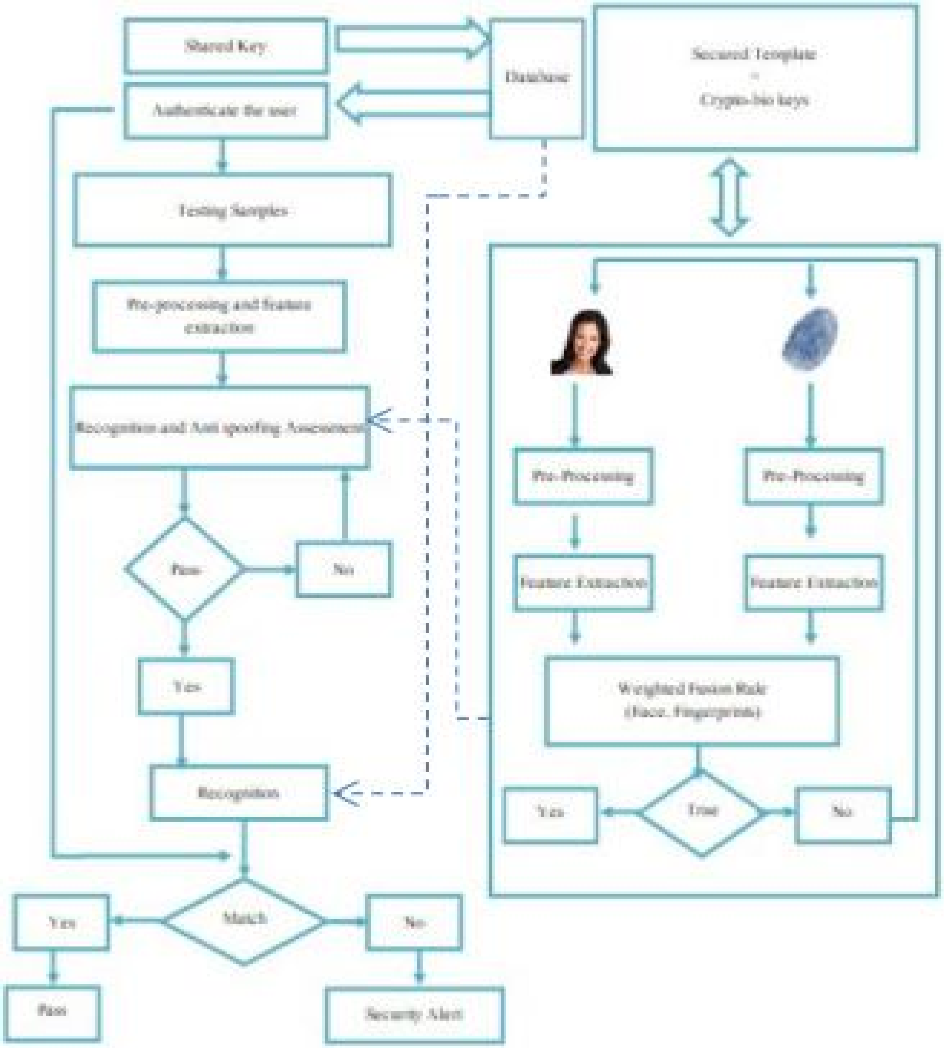
VII. PROPOSED WORK

Figure 5 shows the architecture of the proposed biometric cryptographic multimodal device that combines the face and fingerprint. In the enrollment step two modes, namely fingerprint, should be captured and face-by-sensor, then extra noise from the pictures should be extracted using median filtering and the region of interest (ROI).

VIII. FUSION LEVEL

We use an average fusion scheme, while the fused score is determined as a weighted combination of the results obtained by the M matching streams for each type of class (e.g. customer or impostor).where f is the fused score, xm is the normalized match score from the mth matcher and wm is the corresponding weight (obtained on some development data) in the interval of 0 to 1, with the condition

$$f = \sum_{m=1}^{M} w_m x_m \qquad \sum_{m=1}^{M} w_m = 1$$



IX. RESULTS

The proposed system will definitely provide a better solution for anti-spoofing crypto-biometric system. Considering unimodal crypto-system and also considering multimodal crypto system. We have achieved better result using multimodal cryptosystem as shown in Table 1

TABLE I RESULT COMPARISON

Degree of Polynomial		n=8		n=10		n=12	
Biometric Modality	Cryptographic Algorithm	GAR(%)	FAR(%)	GAR(%)	FAR(%)	GAR(%)	FAR(%)
ME(DB1) + DPCA_2DPCA	FVA	98.47	1.25	92.54	0.53	88.35	0.22
ME(DB2) + DPCA_2DPCA		97.65	0.81	89.68	0.36	83.72	0.17
ME(DB3) + DPCA_2DPCA		96.52	0.72	87.70	0.27	85.69	0.11
GF(DB1) + DPCA_2DPCA	FVA	93.78	0.67	90.53	0.43	85.76	0.27
GF(DB2) + DPCA_2DPCA		90.85	0.52	87.85	0.21	83.99	0.17
GF(DB3) + DPCA_2DPCA		89.37	0.44	83.98	0.18	80.10	0.09
GF(DB1)+GF	FVA	90.54	3.48	87.52	3.08	85.83	2.56
GF(DB2)+GF		86.39	2.97	85.67	2.74	84.79	2.18
GF(DB3)+GF		84.15	2.34	83.43	2.10	82.64	1.78
ME(DB1)+GF	FVA	96.89	2.65	94.56	1.89	92.75	1.23
ME(DB2)+GF		95.42	2.45	92.83	1.76	90.87	1.07
ME(DB3)+GF		93.90	2.09	90.67	1.56	88.35	0.67
CF(DB1) + DPCA_2DPCA	FVA	98.53	0.95	97.21	0.56	96.46	0.22
CF(DB2) + DPCA_2DPCA		97.45	0.52	96.38	0.29	95.18	0.17
CF(DB3) + DPCA_2DPCA		96.84	0.17	95.51	0.06	93.86	0.02
CF(DB1)+GF	FVA	97.23	1.78	95.94	1.23	92.94	0.97
CF(DB2)+GF		95.67	1.31	93.48	1.06	91.34	0.84
CF(DB3)+GF		94.38	1.02	92.78	0.77	89.93	0.32

X. CONCLUSION

Biometric systems are widely used for reliable user authentication, and these systems will become the core IT infrastructure. Biometric authentication is therefore important. Current approaches and their architecture suffer from vulnerabilities and steps are vital to the security of government and commercial efficiency programmes. Sensor-level attacks on a device used for the automation of people's biometric identification have been tackled by independent and/or collaborated anti-spoofing attempts in the initial design and implementation. Modalities, latest studies on recommendations against intrusive action and the prototype facial fingerprint cryptosystem have been discussed in an assessment of data security issues.

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Human Activity Recognition using Transfer Learning

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***Abstract*— In recent years, there have been substantial developments in the field of human activity recognition (HAR). Many machine learning techniques have been used to anticipate human activity. Contrarily, deep learning models like Convolutional Neural Networks (CNN) are known to automatically extract features and lower processing costs. In this study, we predict human behavior's using two dataset –training, set, testing, set from Kaggle Dataset using the CNN model and data analysis using python. In proposed system applied transfer learning particularly to collect significant characteristics of image and trained machine learning classifiers, predict given image activity.**

***Index Terms*— Human activity recognition, Deep CNN.**

I. INTRODUCTION

Human activity recognition (HAR) is a research topic that is currently being explored because it has applications in aged care, automated homes, and surveillance systems. Transfer learning is useful for visual categorization of problems. Transfer learning if applied for Human activity recognition, gives wonderful results. It improves training accuracy. On the recognition of human activities, numerous research has been conducted in the past. [1] It can be difficult to identify human activity in the streaming video. It does not call for the user to wear any sensors or carry any gadgets. As a result, this methodology is currently receiving increasing attention, making the HAR framework simple and convenient to implement in various applications. For activity recognition, the majority of the vision based HAR systems that were proposed in the literature used conventional machine learning methods. Deep learning techniques, however, have recently outpaced conventional machine learning techniques [2]. Convolutional neural networks are the most prevalent kind of deep learning technique (CNN). CNN is frequently used in computer vision-related fields. It is made up of a number of convolutional layers through which images are processed.

II. MOTIVATION

Any automated system which identifies human activities are beneficial for various application areas. This research provides a systematic method for automation of Human Activity Recognition Using Transfer Learning.

III. PROBLEM DOMAIN

This research's domain is application of machine learning and related algorithm core area belongs to computer science and application.

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IV. Problem Statement

The goal of this research is to develop a model that can recognize fundamental human behaviors such as sitting, sleeping, running, clapping, and eating. The model will be given a collection of images showing individuals performing various behaviors. The label for an image will be whatever action that is being performed in that image. Before the model is able to predict the label of an input (image) that it has never seen before, it must first learn this correlation. The model would technically need to be able to discriminate between various human activities.
Because of advancements in computer vision, computers are growing better at handling some extremely complicated tasks (like comprehending an image). There are models being created that, when given an image, can either predict what the image is about or determine whether or not a specific object is included in the image. The structure and function of the human brain were taken into consideration while creating these models, which are frequently referred to as "neural networks" or "artificial neural networks" . Deep learning, a subset of machine learning, is the study of these neural networks. Various versions of these networks have been used to several different problems over time.

V. Innovative Content

Various researchers worked on human activity recognition; this paper showcase an automated system in which transfer learning is combined with VGG-16 with 5 epochs. By applying this a higher accuracy can be achieved for human activity recognition.

VI. Related Work Or Literature Studies

Deep et.al [1] Described a technique for categorizing behaviors of people using RGB-D data and deep convolutional neural networks. The experimental data on the UTD-MHAD dataset shows that combining different modalities can result in performance that is superior to using each modality alone. By fine-tuning a pre-trained model like VGG-16, cutting-edge results can be obtained even on a tiny dataset. Yu, Xiangchun et.al [2] In this study, it suggests using deep ensemble learning techniques to recognize human motion in still photos automatically. Due to the nature of human motions like "Phoning," "Riding a Horse," and "Running," static cue-based methods are necessary. In addition to video-based techniques, still photographs can also be used to recognize human actions. Consequently, an essential question is how to effectively reduce overfitting when training our model. Latha et.al [3] In this paper, an innovative technique (ReHAR) for detecting human activity in videos is proposed. The proposed model operates existing innovative approaches in terms of accuracy on datasets that include individual activity and group activity, and it is entirely trainable .Shi et.al [4] presented deep learning model for recognition of human activity.
El-Ghaish et.al [5] resented a hybrid deep learning architecture by combining CNN and LSTM. Transfer Learning from the VGG16 to NTU RGB+D then from NTU RGB+D to any small dataset. The MCLP model presented in this research blends CNN, LSTM, and pre-trained VGG16 deep architectures to capture the spatiotemporal features—body position, part form, and body motion—in human activities. The recommended MCLP combines the output scores of CL1D, CL2D, and CMHI utilizing the Late Multiply Fusion module to calculate the combined probability of the action done and arrive at the final decision. Abraham et.al in their book [6] presented numerous methods which can be applied to various domain. Li et.al [7]in their study used LSTM to predict the human activities based on the generated representations. UCFSports Action Dataset and NCAA Basketball Dataset are used in their study. Li et.al [8] Author presented a novel method to push the classification performances. For this a hybrid fusion scheme is proposed which combine soft and hard fusion . Their framework is based on Bi-LSTM.
Allah Bux Sargano et.al [9] presented CNN as source and SVM-KNN for action classification. Ann et.al [10] in their study presented a review of various methods for human activity recognition . Srikanth Tammina [11] in this research work proposed transfer learning for classifying images. Author in the thesis applied models ResNet, VGG16 and Inception V3 for human activity recognition.

VII. Methodology

For human activity recognition; proposed system at first extracts features from data ,then it loads image to detect motion signal. Further tracking and processing of each frame is performed. In this study, we employ the Kaggle Dataset and CNN to identify human activity. From the photos, we first extracted the frames for each activity. Transfer learning is specifically used to create trained machine learning classifiers and deep picture features. To categories activities, we used three different CNN models, and we compared the findings to another research on the same dataset.

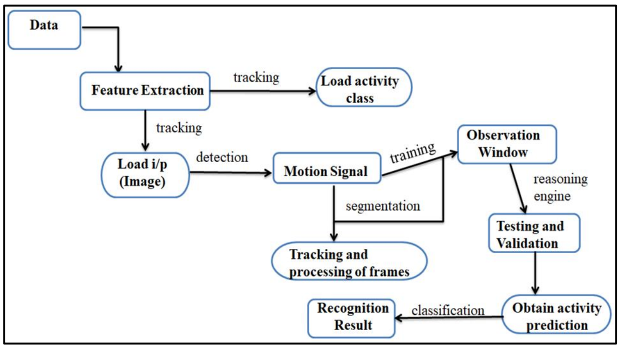

Fig 1. Proposed Diagram of system.

VGG-16CNN model is applied. One of the greatest computer vision models available today is called the VGG model, which stands for Visual Geometry Group. It is an algorithm for object detection and classification that has a classification accuracy of 92.7% when classifying 1000 images into 1000 different categories. Six models with various numbers of trainable layers are used in the experiment. A total of 21 layers—13 Convolutional layers (feature extractors), 5 Max Pooling layers (spatial compression), and 3 Dense layers—have been added, but only 16 of those layers—the learnable parameters layer—are weighted layers. 224, 244 tensors with 3 RGB channels are the size of the input tensor

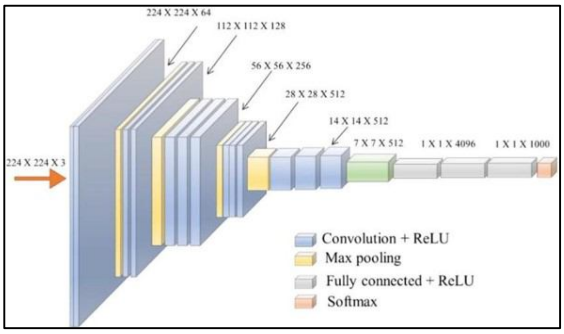

Fig 2. VGG-16-CNN model

Following steps give details of experiments done in this research work

Step 1: There were 15 labels [using laptop, hugging, drinking, dancing, cycling, calling, laughing fighting ,listening to music, texting, Sitting, Sleeping, Clapping, Eating, Running] in fig 4. We are working on 5 labels [Sitting, Sleeping, Clapping, Eating, Running]. We are predicting the human activity from the image through this label, shown in below Fig 3.

Fig 3. Label dataset image

```
In [15]: df= df.loc[(df["label"] == "sitting")|(df["label"] == "sleeping")| (df["label"] ==  "clapping")|  (df["label"] ==  "running")| (c
         empty= pd.DataFrame()
         pd.concat([empty,df], ignore_index=True)

         empty.head()

Out[15]: ...

In [16]: df
Out[16]:
```

	filename	label
0	Image_1.jpg	sitting
3	Image_4.jpg	sleeping
5	Image_6.jpg	sleeping
8	Image_9.jpg	clapping
12	Image_13.jpg	clapping
...	...	...
12592	Image_12593.jpg	clapping
12593	Image_12594.jpg	sleeping
12595	Image_12596.jpg	sitting

Step 2: The dataset of 12000 images. In the target variable there are 15 labels out of which 5 labels counts are shown below from the total dataset. Each label has equal number of counts.

```
In [19]: # Checking Label counts


         counts = df['label'].value_counts()
         counts

Out[19]: sitting     840
         sleeping    840
         clapping    840
         eating      840
         running     840
         Name: label, dtype: int64
```

Fig 5. Labels

Step 3: Visualizing label data using library plotly.Display data in percentage in pie chart.

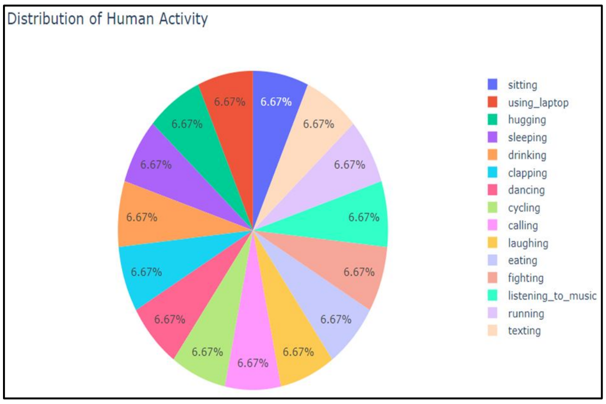

Fig 6. Visual display of labels.

Step 4: In dataset, there are 15 label and we have taken 5 label are build in binary format stored in array format using numpy library, if label has positive; it is evaluated to’1’.If label isn’t there in the dataset taken ,it is evaluated to ‘0’.

```
y_train = to_categorical(np.asarray(train_csv['label'].factorize()[0]))
print(y_train[0])

[1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.]
```

Fig 7. Binary Format.

Step 5: Summary of model with different layer used vgg16,flatten,dense,dense_1 shown in Fig 8.

```
In [28]: model.compile(optimizer='adam', loss='categorical_crossentropy',metrics=['accuracy'])
         model.summary()

         Model: "sequential"
         _________________________________________________________________
          Layer (type)                Output Shape              Param #
         =================================================================
          vgg16 (Functional)          (None, 512)               14714688

          flatten (Flatten)           (None, 512)               0

          dense (Dense)               (None, 512)               262656

          dense_1 (Dense)             (None, 5)                 2565

         =================================================================
         Total params: 14,979,909
         Trainable params: 265,221
         Non-trainable params: 14,714,688
         _________________________________________________________________
```

Fig 8. Summary of the Layers.

We have taken the epoch of 5 to fit our model. At first epoch=1 we were getting the accuracy of 0.64. At each epoch the accuracy goes increasing. At the end we are getting accuracy of 0.9980.

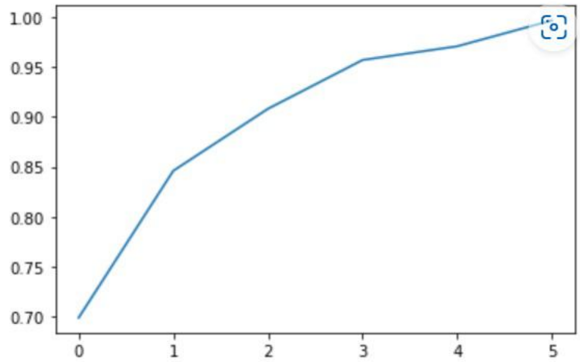

Fig 9. Accuracy graph.

At the time of epoch=1 we were getting the loss of 1.82. At the end means at epoch =5 we are getting the loss of 0.001.

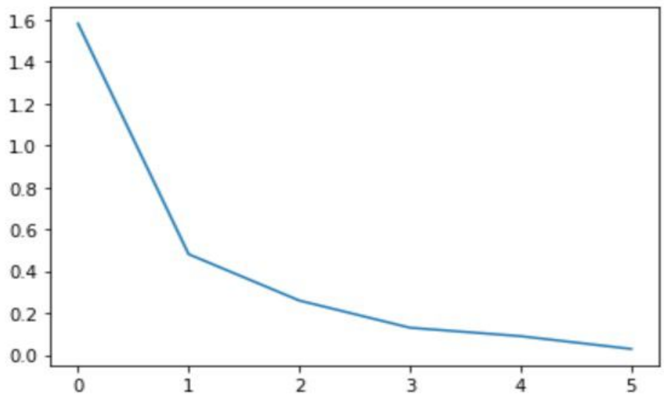

Fig 10. Loss graph

VIII. RESULT

In the prediction of test image, we are getting the probability of 99.9 %. The prediction class is also matching to the given image provided for test for example, it predicts the correct output depends on user input show in below image Fig 11,12 output is correctly predict that is running.

Fig 11. Result (sitting)

Fig 12. Result (eating)

In above, results are correctly predicted, i.e. sitting, eating with probability of 100 % and predicted class. Overall accuracy of proposed system is 99.9%.

Result of proposed system is compared with other existing work, Haobo Li, Aman Sheathe, Hadi Heidari, Julien Le Kernec and Francesco Fioranelli [8], The suggested bi-LSTM performs two strong hard-fusion methods utilizing the matrix of confusion of both sensors, as well as soft feature fusion between wearable sensors and radar data. The classification performances are further enhanced to 96% accuracy in differentiating regular activity. In another existing work [5] Convolution neural networks (CNNs), long short-term memory (LSTM), and a _ne-tuned pre-trained architecture are all combined into one hybrid architecture in the deployed architecture MCLP:CNN+LSTM+VGG16, , the suggested approach MCLP is better 84.3% in CS and 90.4% in CV. Another existing work in this proposed system CNN algorithm is used with method of Depth+RGB (product Rule) the accuracy is 91.2 % which is best method ,are compared with our proposed system where our accuracy with of 99.9% for 5 different activities of human.

IX. Conclusion

In this paper, CNN models are used to predict human behaviour from the Kaggle Dataset. Convolutional neural networks (CNN) were used in experiments to identify activities. To get the deep image features and put transfer learning to use in training the machine learning classifiers. Results indicated that when transfer learning had been used combined with VGG-16 in the proposed system with 5 epochs, accuracy is 0.9980, has increasing epochs can get better accuracy. The outcomes of an experiment utilizing the transfer learning approach also showed how well the VGG-16 performed.

Future Work

Human activity recognition system is the trending topic these days and these industries will be leading the advancement of facial recognition in 2022 and beyond. In this proposed system, we have taken into account the images, but in the future, we may also take into account the real-time videos to recognize different activities in it with other deep learning algorithm and recognition technique. In future it can be extended to recognize multiple activities performed in single frame and also can be used for blind people by giving feature of sound so they can hear the human activity.

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CAD-Driven Approach with Enhanced Imaging and Deep Learning for Accurate Diagnosis of Brain Tumor

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***Abstract*— Recently, the biomedical research field has become popular due to the use of digital image processing as the diagnosis of clinical patients has become more accurate and efficient with the help of Computer-Aided Diagnosis (CAD). Identifying diseases promptly and arranging treatment accordingly can improve the life quality and life expectancy of patients with brain tumors. Different tools have been designed to detect brain tumors, but the current diagnosis system utilizing Magnetic Resonance Imaging (MRI) scanning devices is expensive and often yields low accuracy and efficiency. To address this, a novel methodology utilizing CAD and different kinds of algorithms is proposed in this method to predict brain tumors more effectively. The proposed method uses a 2D Adaptive Bilateral Filter algorithm for image restoration to improve image quality. Additionally, it employs an Adaptive Histogram Adjustment algorithm to enhance brightness and contrast. For segmentation of the Region of Interest for brain tumors, uses the U-net algorithm and calculates various features with the convolutional neural network. With the aid of a Deep Convolutional Neural Network, it classifies disease images and stages using a Deep Learning approach. The proposed approach results in superior accuracy and efficiency in diagnostic decision-making compared to existing systems.**

Index Terms*— *CAD, MRI, AL (Artificial intelligence) 2D-ABF, AHA, U-Net segmentation, and deep learning neural network classifier.

I. INTRODUCTION

The field of Computer Aided Diagnosis (CAD) is an interesting area of research for Brain Tumor Disease (BT). In scientific research even though sharing of information is increasing, it is still uncertain whether a system designed based on one database will be suitable for other types of resources. Techniques such as conventional deep learning methods, even though they improve performance, are time-consuming and make it very difficult to collect evidence from various modalities. The proposed method uses systemic Magnetic Resonance Imaging (MRI). The goals of sMRI are to 1) enhance precision to match state-of-the-art methods, 2) find ways to overcome current challenges, and 3) investigate established brain indicators that aid in diagnosing BT.
MRI has proven to be an effective paradigm for brain analysis. Clinical images often need noise removal, which can be done using various techniques such as local measures, element investigation, and non-local measures like

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TANLM filters. A histogram of the structural association of images can be used to study the distribution of pixel brightness. To enhance the contrast of images, Histogram Equalization (HE) is used. Other popular methods such as Contrast Limited Adaptive Histogram Equalization (CLAHE) can also be used.
The dynamic model reflects the pixel similarity functions to optimize and control the intensity of each entity evolutionarily. [7]. MRI differentiation is implemented in a region of interest. The concept is to treat this issue as a classification task in which the goal is to differentiate between normal and abnormal elements on an MRI image based on several characteristics, including levels of intensity and shape.
The neural network is also suitable for different image classifications. The research explores how the CNN-related algorithm can be extended to a chest X-ray data set to identify pneumonia. The result from the experiments indicates that information increase is usually an efficient way to boost efficiency for all three algorithms. The second important factor is the difficulty of a system that fits the set of data measures [9]. The statistical method of several neurological diseases varies depending on the computerized and precise differentiation and structural categorization. The DL-based recognition and segmentation system have obtained research interest nowadays. The function extraction in the curvelet domain and CNN offer an improvement in precision compared with the wavelet transformation and identification utilizing conventional classification techniques such as SVM and Probabilistic Neural Network (PNN) [10].
In this research paper, section 2 consists of related works of various researchers, and the motivation behind this work is given. The proposed system is elaborated in section 3 and the results of the experiment are shown in section 4. Finally, section 5 concludes the entire research with future work.

II. Review Of Previous Studies

Krystyna Malik et. al [11] proposed a refined filter design based on the bilateral denoising methodology. This filter considers the color and temporal range of pixel elements to obtain related resemblances. The weight vectors are components of the marginal contact element, like the traditional bilateral filter. The Vector Median Filter (VMF) method is the most used filtering model, which determines its performance using the vector organizing principle for a collection of pixels in the processing window.
Jun Wang, et. al [12] has discussed momentum and magnetic data sets for different component-based transforms that are used to describe related functionality. Issues of uncertainty faced by most of them. This puts the implementation of noise removal before the implementation of component-based transformation and increases the accuracy of the results.
V. Anoopl, et. al [13] has proposed a method in which impulse noise reduction and Rician noise with the help of a Bilateral Filter (BF). To get efficient filter specifications, EGOA is added to the original noisy image. The results of the suggested denoising method are compared with the genetic algorithm (GA) and other BFs that have been used previously concerning various image quality measuring parameters. In a pixel neighborhood, the spectral range is defined with the parameters of the field (spatial) filter while the weights of the filter set (intensity) are proportional to the isotopic range of the pixel.
Rinkal Patel et. al [14] have designed the BT neuro-imaging research, where different brain regions/voxels are studied independently. The deep learning methodology is named "Sparse Inverse Covariance Analysis" for learning functionality in the brain field, with limited computing expense and densely the correct degree. Through implementing sparse restriction, excessive/noisy structural constraints are abolished by placing the component factor at zero, participating in the factor pairs becoming conditionally autonomous [22]. [23].
Jun Zhang et. al [19] have proposed structural magnetic resonance imaging (MRI) effective method for tumor detection. Ramy A. Zeineldin et. al [20] have developed DeepSeg, as a structure for modular decoupling. It consists of two main parts linked, centered on a connection of encoding and decoding. Various CNN models such as residual neural network (ResNet), deep convolutional network (DenseNet), and NASNet were used based on modified U-Net design. Runhong Zhang et. al [21] have adopted NGI-ADP surface design for limit equilibrium research, based on which the impacts of soft clay anisotropy on the deformation of the diaphragm wall in approaches to the study is analyzed.

A. Motivation

Brain tumor disease is a medical illness that produces loss of memory and cognitive impairment by the killing of brain cells. A degenerative form of Alzheimer's, the condition begins slightly and is slowly becoming worse. Brain image is a significant field of scientific study, findings for the diagnosis of brain disorders. The hippocampus is an essential part of the brain. A human typical activity is based on the Hippocampus features. It takes several hours for a doctor to physically section the Hippocampus. In this research, an improved method is used to separate the hippocampus region, based on the watershed segmentation methodology. Using two methods, the brain images were translated into binary form. The first solution is the principles of block say, mask, and marking, and the second method is the concept of top hat, mask, and marking. However, some portions of the image are found to contain holes that disrupt the segmentation phase. The image hole-filling strategies are applied to solve this issue, and relevant components are grouped into linked modules.

B. Existing Methodology and its Disadvantages

The existing method is to continuously separate regular tissues and irregular tissues through images of the MRI samples. Such MR brain images are observed to be distorted with Strength in objects of homogeneity that induce excessive variance in strength and noise that impair the output of brain image processing. Due to this type of substance, one form of normal tissue in MRI is incorrectly classified as another standard tissue which contributes to diagnostic error. The approach involves preprocessing using 2D wrapping-based Curvelet transformation for eliminating noise with adjusted contextual fuzzy C means procedure implies taking into consideration the spatial details and fragments of natural structures as the surrounding pixels are strongly associated and often spontaneously construct up the original participation matrix. The cancer cells are often segmented by the method. The conventional method is not capable of finding brain tumors.

III. PROPOSED METHOD

The proposed system consists of four steps: pre-processing, segmentation, feature extraction, and disease classification. A diagram of the proposed method is shown in Fig. 1. During the training period, a classification model is chosen and the training MRI Brain image is used as input to the network. The extracted features, along with the class labels, are used to train a classifier. The research introduces a modern predictive approach that uses magnetic resonance (MR) to segment the entire brain into image sequences and measure its density to diagnose disease. The relevant MRI brain images have been collected from the Brain Neuro-imaging Initiative (BNI) website. T1-weighted MRI was considered at 1.5 T level as given in the specification. The proposed automated clustering approach is considered on the image numerical anatomy and our proposed methodology is named as “head prototype” to restrict the MRI brain pixel range.

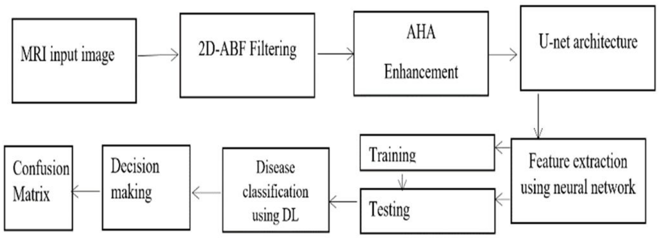

Figure1. Architecture diagram for the proposed methodology

A. MRI brain image pre-processing

The image restoration is completed using the 2D Adaptive Bilateral Filter (2D-ABF) algorithm. The 2D-ABF is used to eliminate unwanted noise like speckle noise, binary noise, and random noise. It is used to filter noises without degradation of original information content in MRI images. The 2D AHA is used to enhance visual contrast and brightness to enhance image consistency. The gray image is a useful format for MRI brain image segmentation. The MEM algorithm will cluster abnormal pixels on gray images.

B. Image Restoration using 2D Adaptive Bilateral Filter (2D-ABF)

De-noising has often been a research priority, yet there is still scope for progress, particularly regarding image de-noising. The biggest problem connected with this is the complexity of the calculation involved in making the convolution. The goal of image de-noising is to eliminate the noise whilst preserving as much clarity as possible of the essential image features such as boundaries.

The proposed image de-noising approach employs the 2D Adaptive Bilateral Filter. A difference between the original image and its de-noised version indicates the noise removed by the algorithm, which is considered as process noise. The system's vibrations act as a stimulus in theory. Although even high-quality images have some level of noise, it is reasonable to evaluate the effectiveness of various denoising techniques in this manner, without relying on the conventional approach of "adding noise and then removing it.". To be precise, it is known by.

$$MN = A - IF \quad (1)$$

A is the initial (not inherently noisy) image, and IF is the de-noising driver output for an input image A. This process interference in the Gaussian filter is negligible in harmonic sections of the image and very high close borders or texture, where the Laplacian cannot be low. To obtain what the bilateral filter takes out of the distorted image, the system noise concept is redefined as the gap between the distorted image and its opposed value. So, Eq. (1) is expressed as

$$MN = I - IF \quad (2)$$

Where I= A+Z is A distorted image acquired by destroying the initial image A by a white Gaussian distortion Z and IF is a Bilateral filter source for an input image I. The distortion of the system due to Gaussian filtering would have better borders relative to that of bilateral filtering because the borders are maintained by filtering spectrum (xr). Process noise MN is a mixture of image information D and a white Gaussian distortion N.

$$MN = D + N \quad (3)$$

Now the challenge is to approximate the information image D, which has just the actual image attributes and edges/sharp borders that the Bilateral filter eliminates, as reliably as necessary according to certain parameters and is merged with the Bilateral filtered image IF to get a stronger de-noise image with info. In class wavelet. Eq. (3) can be replicated as

$$Y = W + Nw \quad (4)$$

Where Y is a distorted wavelet coefficient (method noise). W is the real wavelet coefficient (detailed image) and Nw is Gaussian distortion-free.

C. Image Enhancement using 2D Adaptive Histogram Adjustment (2D-AHA)

2D Adaptive Histogram Adjustment (2D-AHA) image analysis used to boost or increase image intensity. AHA implements a method to correctly run the sub-image and merge it. The MRI image quality is improved by multiple histograms all relative to a single region of the image then utilized to reallocate image quality metrics like brightness or contrast calculation.

D. Proposed system

Step 1. Input (MRI image) is interpreted or perused.
Step 2. Change the MRI image into MRI at Gray Point.
Step 3. Add or conduct the Histogram Equalization technique to the image to maximize the image quality.
Step 4. Take the improved-image histogram.
Step 5. Consider or execute the Local Equalization Histogram (LHE). Apply method for improving image contrast on the input image (MRI image).
Step 6. Step 4 has to be repeated.
Step 7. Enable or execute Adaptive Histogram Adjustment (AHA). Apply the method for improving viewpoint intensity on the reference image (MRI viewpoint).
Step 8. Do again step 4.
Step 9. To improve image quality, apply or execute the quality-dependent adaptive histogram equalization technique on the input image.
Step 10. Repeat step 4

E .U-net segmentation

To improve the representation capacity of the segmentation network and to optimize the segmentation performance, we modify the U-Net architecture with an inspection module, which has been experimentally proven to enhance the capturing of more visual information under constrained computational complexity. As in Fig. 2. The inception module is redesigned where a 7x7 convolution layer enlarges the receptive field and the max pooling layer is replaced by a short path to directly incorporate the input filters. The output filter generated from the 1x1, 3x3, and 7x7 convolutional layers are concatenated with the input feature map to achieve feature fusion. To speed up the convergence and overcome the disadvantages of deep neural networks that are difficult to train. We adopt BN (batch normalization) to normalize the feature maps. shown in Fig.2.
Algorithm 1: The U-net segmentation process of the proposed model.
Input:

These image batches Z1 $=\left\{Z_1^{(1)}, Z_1^{(2)}, Z_1^{(3)}, \dots\dots\dots\dots, Z_1^{(M)}\right\}$, Z2= $\left\{Z_2^{(1)}, Z_2^{(2)}, Z_2^{(3)}, \dots\dots\dots\dots, Z_2^{(M)}\right\}$ and Z3=$\left\{Z_3^{(1)}, Z_3^{(2)}, Z_3^{(3)}, \dots\dots\dots\dots, Z_3^{(M)}\right\}$, initialized parameters of dual DCNNs and synergic network,$\theta^{(1)}, \theta^{(2)}, \theta^{(3)}$ and $\theta^{(s)}$, learning rate η(t) and the hyper parameter λ.

Step 1: forward propagation:

$$Q1=q(Z1,\theta(1))$$

$$Q2=q(Z2,\theta(2))$$

$$Q3=q(Z3,\theta(3))$$

Step 2: concatenate Q1,Q2 and Q3 to Q102 $=\left\{Q_{102}^{(1)}, Q_{102}^{(2)}, Q_{102}^{(3)}, \dots\dots\dots\dots, Q_{102}^{(M)}\right\}$ where $Q_{102}^{(1)}$ represents the combination of $Q_1^{(1)}$, $Q_2^{(1)}$ and $Q_3^{(1)}$. And input them to the synergic network. The labels of these four supervisions are

$$W1 =\left\{W_1^{(1)}, W_1^{(2)}, W_1^{(3)}, \dots\dots\dots\dots, W_1^{(M)}\right\},$$

$$W2= \left\{W_2^{(1)}, W_2^{(2)}, W_2^{(3)}, \dots\dots\dots\dots, W_2^{(M)}\right\}$$

$$W3=\left\{W_3^{(1)}, W_3^{(2)}, W_3^{(3)}, \dots\dots\dots\dots, W_3^{(M)}\right\}, \text{ and}$$

$$WS=\left\{W_S^{(1)}, W_S^{(2)}, W_S^{(3)}, \dots\dots\dots\dots, W_S^{(M)}\right\},$$

Where,

$W_S^{(1)}$-1 if $W_1^{(1)} - W_2^{(1)}$, otherwise $W_S^{(1)} = 0$.

Step 3: update parameter $\theta^{(1)}, \theta^{(2)}, \theta^{(3)}$ and $\theta^{(5)}$ by using back-propagation algorithm .Compute loss:

$$p^{(1)}\,\theta^{(1)}, p^{(2)}\,\theta^{(2)}, p^{(3)}\,\theta^{(3)}\ and\ p^{(s)}\,\theta^{(s)}. \qquad (5)$$

Compute gradient:

$$\Delta^{s} = \frac{\partial p^{s}(\theta^{(s)})}{\partial \theta^{s}} \qquad (6)$$

$$\Delta^{(1)} = \frac{\partial p^{(1)}(\theta^{(1)})}{\partial \theta^{(1)}} + \lambda\Delta^{s} \qquad (7)$$

$$\Delta^{(2)} = \frac{\partial p^{(2)}(\theta^{(2)})}{\partial \theta^{(2)}} + \lambda\Delta^{s} \qquad (8)$$

And

$$\Delta^{(3)} = \frac{\partial p^{(3)}(\theta^{(3)})}{\partial \theta^{(3)}} + \lambda\Delta^{s} \qquad (9)$$

Update parameters:

$$\theta^{(1)}(t+1) \leftarrow \theta^{(1)}(t) - \eta^{(t)}.\Delta^{(1)}$$

$$\theta^{(2)}(t+1) \leftarrow \theta^{(2)}(t) - \eta^{(t)}.\Delta^{(2)}$$

$$\theta^{(3)}(t+1) \leftarrow \theta^{(3)}(t) - \eta^{(t)}.\Delta^{(3)}$$

And

$$\theta^{(s)}(t+1) \leftarrow \theta^{(s)}(t) - \eta^{(t)}.\Delta^{(s)} \qquad (10)$$

When applying the trained SDLR model to the classification of a test image x, each DCNN component DCNN. j gives a prediction vector R(1)= $R_1^{(1)}, R_2^{(1)}, R_3^{(1)}, \dots\dots\dots\dots, R_K^{(1)}$, which is the activations in its last fully connected layer. The class label of this test image can be predicted as

$$W(x) = arg_j max\left\{\sum_{i=1}^{n} R_1^{(1)} \dots . \sum_{i=1}^{n} R_j^{(1)} \dots . . \sum_{i=1}^{n} R_k^{(1)}\right\} \qquad (11)$$

F. Global and Local Features Extraction

We investigate the two major portraying the substance of a picture, we remove worldwide element and neighborhood highlights with Faster DCNN. We separate worldwide component from fe7 layer of VGG16 net, a 4096-measurement vector indicated as Gf. We select top n recognized articles to speak to significant nearby items as indicated by their group certainty scores acquired from DCNN. Each picture can be at long last spoken to as a lot of 4096-measurement vectors1= {Gf,Lf1…….Lfn }. In our tests, we set n to 10 since the quantity of item contained in a picture is as a rule beneath 10.

G. Global-local information Mechanism

The local information with global information is major model for describing frame. In our proposed model, we assume recognition mechanism to synthesize those two models of information according to the subsequent Eq.

$$\Psi^{(r)}(i) = \alpha_D^{(r)} Gf + \sum_{i=1}^{n} \alpha_i^{(l)} Lf_1 \qquad (12)$$

Where $\alpha_i^{(l)}$represent the information load of separate attribute at time t and $\sum_{-t} \alpha^{(t)} = 1$.

This component progressively loads each element by allocating it with one positive weight $\alpha_l^{(t)}$alongside the sentence age method. The consideration weight $\alpha_l^{(t)}$ measures significance level of each component at time t and the pertinence of each element to the past data. Subsequently, it very well may be registered dependent on the past data and each element $f_1 \in \{Gf, Lf_0, \ldots\ldots\ldots\ldots..Lf_n\}$ with the accompanying conditions:

$$\beta_1^{(r)} = \omega^t \varphi\left(W_h h^{(t-1)} + W_h f_t + b\right),$$

$$\alpha_l^{(t)} = \frac{\beta_t^{(r)}}{\sum_{j=0}^{n} \beta_1^{(t)}} \qquad (13)$$

where $\beta_t^{(r)}$represent as score of attributes and previous creating text as fi

The information heavy load is obtained by standardize SoftMax reversion H(t-1) is the past concealed state yield which will be presented in the following segment W, Wh , W, and b are the parameters to be learned by our model and shared by every one of the highlights at all the time steps ϕ is initiation work.

H. Deep Convolutional Neural Network

Deep Convolutional Neural Network (DCNNS) is CNNS with numerous layers and mirror the guideline of order. After a few convolutional layers, profound CNNS commonly include one or a couple completely associated layers, that is, layers where the weight framework W is thick. The explanations behind doing as such are to some degree blended and not so convincing. The yield from a profound CNN is encouraged to a calculation that relies upon the motivation behind the net. For regression, for instance, the outputs may be used as they are. For classification, one could use the outputs as inputs to a support vector machine or random forest or, if the classifier requires input quantities that behave like probabilities, the output stage could be a soft max function.

$$z\,\sigma(y) = \frac{\exp(y)}{1^7 \exp(y)} \qquad (14)$$

Where l is section vector of ones. Logically, the exponential makes all amounts positive, and standardization ensures the passages of Z signify 1. The motivation behind why this capacity is classified “softmax” is that on the off chance that one of the yi sections state y0, is a lot greater than the majority of the others, at that point lr exp(y)= exp(yrϕ) ,so that

$$z_{i0} \approx 1 \; and \; z_j \approx 0 \; for \; i \neq i_0,$$

And the function effectively acts as an indicator of the largest entry in y. Somewhat more precisely, and quite obviously,

$$\lim_{\alpha \to x} y^r \sigma(\alpha y) = mx(y) \qquad (15)$$

In summary, a deep CNN performs the following computation:

$$x(0) = x \qquad (16)$$

$$x(l) = \pi\left(h\left(W^{(1)} \underset{x}{\leftarrow}^{(l-1)}\right)\right) \; for \; l = 1, \ldots\ldots\ldots\ldots\ldots l_\propto \qquad (17)$$

$$x(l) = \left(h\left(W^{(1)} \underset{x}{\leftarrow}^{(l-1)}\right)\right) \; for \; l = L_\propto + 1 \ldots\ldots\ldots\ldots\ldots L \qquad (18)$$

$$y = h_f\left(x^{(l)}\right) \qquad (19)$$

Where the yield initiation work hy might be the character, SoftMax, or other capacity. The networks W(I) have D(l-1) + 1 segments with D (0) – D and D (1) for 1>0 being equivalent to the quantity of yields (or enactments) in layer number 1. The first Le layers are convolutional, and the staying ones are completely associated.

The convolutional layers fill in as highlight extractors, and in this way, they become familiar with the element portrayals of their information pictures. Inputs are convolved with the informed loads to figure another segment map, and the convolved results are sent through a nonlinear establishment work. All neurons inside a component map have loads that are obliged to be equal; be that as it may, distinctive component maps inside the equivalent

convolutional layer have diverse loads so a few highlights can be extricated at every area the kth yield include map Yt.
The deep study shows a frame recognition, got from convolutional layer. This leads a major role to DCNN with various kind of filters to represent a complete frame. It maps an intermediate attribute and creates different region maps (Fig.3). It will do mapping from given input attribute to hidden layers. The input layer will pass the frame to the hidden layer. And it has 3 various hyper functions to control the length of the output layer in convolution. We also described zero padding, depth, and stride. For example, convolution took the input frame as input, and we mentioned various neurons in depth size may initialize here.

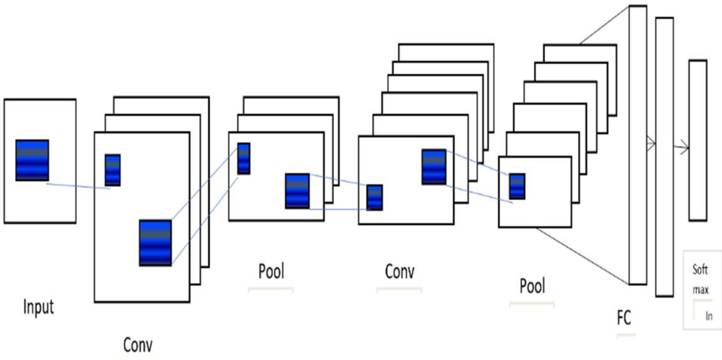

Figure 3. The Deep convolutional neural network using various layer.

$$Yi = f(Wk*x) \quad (20)$$

byx is indicated as input frame: WK is indicated with kth attribute, which is like convolutional filter. It is used to evaluate the pixel ratio of every single frame and f(.) denotes the nonlinear trigger task. Their image and attainment have given to a zone of exploration that points out the advancement and use of DCNN actuation capacities to improve a few qualities of DCNN execution.

H. Pooling Layers

These are occasionally embedded after each convolutional layer to diminish the dimensionality of the system. Its errand involves unraveling or lessening the spatial components of the information got from a part map. There are 3 sorts of pooling:
Firstly, we used the normal method for pooling, then L2-standard is used in second term for pooling outstanding usage in its speed and improved association. This essentially takes a channel and a walk of a similar length. It at that point applies it to the info volume and yields the greatest number in each sub district. That has the channel which convolves around.

$$Y_{kg} = \max_{lpq\alpha N_q} x_{kyq} \quad (21)$$

I. FC layers

Some pooling and convolutional layers are commonly stacked over one another to extricate increasingly unique element portrayals in traveling over the network. This layer follows information related performance in high level tasks. Every one of the sources of info is associated with all the yields thus the expression "completely associated". It is the last layer, as a rule after the last pooling layer in CNN process (Figure 1). Completely associated layers perform like a conventional neural system and contain about 90% of the parameters in CNN. This layer essentially takes info the yield of the last pooling layer and yields a N dimensional vector where N is the quantity of classes that the program needs to browse. For picture grouping, we could nourish forward the vector into certain number classes. The yield is additionally a vector of numbers.

J. LSTM

The separate input creation image can hide a vector output in LSTM. Fig.3 shows the results as every single cell (e) It accepts LSTM layer arranged by ht-1 and x, as given input. This scalar product with four various gates in weights (w). Every gate has a various function one.
LSTM equation represent as,

$$\begin{pmatrix} i \\ f \\ o \\ g \end{pmatrix} = \begin{pmatrix} \sigma \\ \sigma \\ \sigma \\ tanh \end{pmatrix} W \begin{pmatrix} h_{(0-1)} \\ x_t \end{pmatrix} \quad (22)$$

$$c_{t=}f * c_{i-l} + i * g \quad (23)$$

$$h_t \ = o * \tanh\,(c_{t)} \quad (24)$$

The CNN was represented by LSTM, this layer acknowledges the contributions and secondly, it gets successive yields of past model of LSTM. At last, we pertain a yield into complete associated surface and compute the last score SoftMax. Where o speaks to sigmoid capacity, and * is component insightful duplication. LSTM has a continuous inclination stream we develop our LSTM engineering for video grouping shown in Fig. 4.

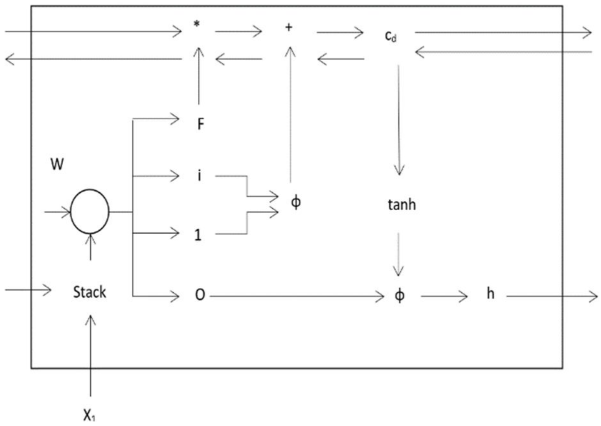

Figure 4. The four layers with LSTM cell

The four layers are:

1. Forgot gate layer: $ft = \sigma\big(u_f x_1 + w_f h_{\gamma-1} + b_f$
2. Input gate layer: $i_t = \sigma(m_i x_1 + w_1 f t_{\gamma-1} + b_i$
3. Candidate values computation layer: $\overrightarrow{c_t} = \tan h(u_t x_1 + w_t h_{t-1} + b_c)$
4. Output gate layer: $o_t = \sigma(u_\phi x_1 + w_\phi h_1 + b_x)$

The component insightful use of the sigmoid capacity (0), the overlook, information, and yield entryway layers (1. 2, and 4 above) produce vectors whose sections are altogether involved somewhere in the range of 0 and 1. and either near 0 or near 1. When one of these layers is duplicated with another vector, it in this manner goes about as a channel that just chooses a specific extent of that vector. The two outrageous cases are the point at which all sections are equivalent to 1 - the full vector passes-or to 0 - nothing passes. The parameters are anyway shared over unequaled advances.

K. Forgetting/learning:

By considering the new training example x, and the current hidden state he 1, the forget gate layer determines how much of the previous cell state c_{0-1} should be forgotten (what fraction of the memory should be freed up). While from the same input, the input gate layer decides how much of the candidate values č, should be given to the memory, or in various letters, how much of the new information should be learned. Combining the output of the two filters updates the cell state:

$$C_i = f_i * c_{i-1} + i{,}* \ \overline{c_\iota} \quad (25)$$

Where • denotes element wise multiplication. This way, important information is not overwritten by the new inputs but is able to be kept alongside them for long periods of time. Finally, the activation ht is computed from the updated memory, modulated by the output gate layer $o_{1:}$

$$H_l = \tanh c_l * o_l \quad (26)$$

The yield door enables the unit to possibly enact when the in-memory data is observed to be significant for the present time step. Finally, as before with the basic RNN, the yield vector is registered as a component of the new shrouded state.

$$Y_r = soft \max (Vh_r) \tag{27}$$

IV. RESULTS

The experiments are done based on different standards of gray-scale MRI images with different sizes. The MRI images are corrupted by salt and pepper noise, speckle noise and random noise produced by MRI scanning devices as shown in Figure 5 (a). The 2D Adaptive Bilateral Filter (2D ABF) is applied to noise corrupted images to remove all noises without degradation of original content of image as shown in Figure 5 (b). To authorize the suggested methodology, their presentation is evaluated in terms of visual quality, PSNR and MSE are computed and tabulated using proposed algorithm called 2D ABF.

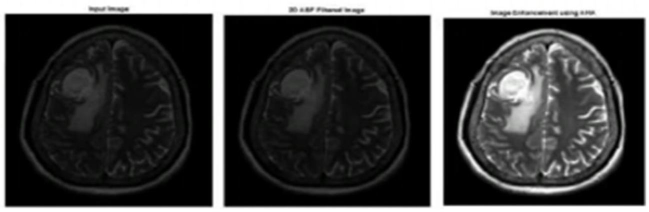

Fig.5. (a) Input MRI image, (b) 2D ABF Filtered Image, (c) Image Enhancement using AHA The figure 5 (c) shows enhancement image using Adaptive Histogram Adjustment (AHA) by improvement of contrast and brightness. The quality of image is improved using AHA algorithm.

Fig.6. (a) Image Clustering using UNet algorithm, (b) Tumor segmentation using UNet algorithm, (c) ROC Curve

The different intensity pixels are grouped using U-net segmentation algorithm. The Bayesian Threshold technique is applied to U-net segmentation algorithm to segment BT as displayed shown in Fig 6. (a)shows ROC curve of DCNN classifier. The 4.2 (c) shows Area Under Curve (AUC) value is 98 %.

TABLE II. IMAGE QUALITY MEASUREMENT

Metrics	Anisotropic Filter	Bilateral Filter	Proposed Method
PSNR	26.56	30.68	35.92
SSIM	0.7823	0.8453	0.9125
MSE	0.0044	0.0028	0.00052

TABLE II. IMAGE THE EFFECT OF VARYING THRESHOLD AND 'I' VALUES ON THE ACCURACY OF SOLITARY NODULES DETECTED. 'N' IS THE NUMBER OF SOLITARY NODULES DETECTED.

Dataset	*Threshold*	*i=10*		*i=10*	
		AGWO-ONN		AGWO-CNN	
		Accuracy	N	Accuracy	N
Publically available BIDC Dataset	0.65	97.0	44	97.6	44
	0.75	85	38	85	38
	0.85	66.67	20	66.7	20
In-house Clinical Dataset	0.65	90.7	34	92.5	34
	0.75	82	27	85.33	30
	0.85	60.76	21	62.15	24

On varying the threshold value there is an effect on the number of solitary nodules detected in widely available BIDC Dataset and In-house Clinical Dataset (Table 2). The threshold value is proportional to accuracy.

TABLE III. SEGMENTATION PERFORMANCE MEASURES OF DICE PARAMETER

Images	*Dice*			
	Otsu segmentation	Fuzzy C Means clustering	Watershed Segmentation	Proposed Method
Sample 1	0.0036	0.1472	0.0045	0.1520
Sample 2	0.0052	0.2295	0.0030	0.2459
Sample 3	0.0026	0.2086	0.0052	0.1965
Sample 4	0.0036	0.2426	0.0123	0.2993
Sample 5	0.0014	0.1611	0.0053	0.1526
Sample 6	0.0060	0.1639	0.0040	0.2337
Sample 7	0.0047	0.144	0.0045	0.174
Sample 8	0.0011	0.2114	0.0012	0.165
Sample 9	0.0015	0.1774	0.0034	0.147
Sample 10	0.0014	0.166	0.0012	0.159
Sample 11	0.0016	0.244	0.0032	0.1357
Sample 12	0.0011	0.144	0.0014	0.1258
Sample 13	0.0015	0.2354	0.0074	0.147
Sample14	0.0030	0.177	0.0094	0.1357
Sample 15	0.0064	0.166	0.0041	0.2147
Sample 16	0.0041	0.1254	0.0045	0.2413
Sample 17	0.0056	0.1337	0.0054	0.247
Sample 18	0.0021	0.1247	0.0041	0.195
Sample 19	0.0023	0.100	0.00624	0.1854
Sample 20	0.0041	0.2654	0.0081	0.17354
Average	0.0037	0.1922	0.0057	0.2133

TABLE IV. PERFORMANCE ANALYSIS OF THE RESNET-50

Classifier	Data (Testing- Training)	Type of Class	Sensitivity	Specificity	Precision	Accuracy
ResNet-50	90%-10%	Benign	0.959	0.961	0.919	0.722
		Malignant	0.915	0.896	0.942	
		Avg. Value	0.935	0.928	0.931	
	80%-20%	Benign	0.915	0.941	0.941	0.957
		Malignant	0.974	0.967	0.942	
		Avg. Value	0.945	0.954	0.94	
	70-30%	Benign	0.963	0.976	0.974	0.803
		Malignant	0.931	0.961	0.964	
		Avg. Value	0.947	0.969	0.969	
	85%-15%	Benign	0.941	0.957	0.931	0.849
		Malignant	0.942	0.917	0.9740	
		Avg. Value	0.9415	0.937	0.9525	
	70%-30%	Benign	0.950	0.935	0.9665	0.808
		Malignant	0.975	0.954	0.9388	
		Avg. Value	0.9625	0.9445	0.9525	

V. DISCUSSIONS

The Computer Aided Diagnosis (CAD) system is proposed using various algorithms to detect and classify brain tumor on MRI real images. The automatic segmentation and classification of BT in MRI brain images is implemented. The proper preprocessing is applied on the tool using 2D Adaptive Bilateral Filter (2D ABF) and

Adaptive Histogram Adjustment (AHA). The segmentation ROI is done using U-Net architecture system. The various image features are retrieved using neural network and the DCNN classification technique is used to classify normal and abnormal images. The accuracy of classification is more than 95.7% using DCNN.

FUTURE WORK

In future, CAD system may be applied for cancer cells identification by proper segmentation of Gray Matter (GM), White Matter (WM) and CSF. The adaptive clustering technique can be applied to segment disease region without pixels' error. DCNN can be applied to distinguish regular and anomalous MRI brain images.

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A Hybrid Deep Learning Improved Method for Share Price Prediction

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***Abstract*— Share Market/ Equity Market are the most important current research topic. Machine learning is increasingly used in stock/index price prediction due to its ability to analyze large amounts of data and identify complex patterns that may not be immediately obvious to human analysts. There are several deep learning algorithms commonly used for stock price prediction, including RNN, CNN, LSTM, and DNN. In stock price prediction, hybrid models can be used to combine the predictions of multiple models to produce more accurate predictions. The paper proposed hybrid deep learning DNN-CNN based method to improve the prediction of NSE Bank i.e. Bank Nifty. The ensemble DNN-CNN technique consists of two main components a DNN for feature extraction and a CNN for regression or classification tasks. In DNN-CNN model DNN layer is used to extract features from input data related to an estimated future value and CNN layer is used to combine features learned from the DNN layers. The results represent that proposed method recall is 91.02, precision is 98.2 and accuracy is 97.4.**

***Index Terms*— Share/Index price prediction, CNN, RNN, LSTM, DNN, Hybrid Model.**

I. INTRODUCTION

Share Market/ Equity Market are the most important current research topic [1]. There are many research works of the last two decays available because since 2 decays investors and traders are using online platforms instead of paper-based physical forms of shares. Even in the last few years governing bodies are asked Investors/shareholders to demetallize their physical shares or can say paper-based shares into the online forms in DMAT account /depository services i.e., NSDL and CDSL. Across the world, thousands of companies/organizations, Business Channels, and Business Newspapers are involved in research about Equity Market to provide benefits to their viewers/users/clients this is one of the finest works across the financial industry. Even most of the share brokers also run their research vertical to provide good calls to their customers. Machine learning techniques are computational algorithms and statistical models that allow computers to learn from historical data and predict new, unseen data. In the context of stock/index price prediction, machine learning techniques can be applied to historical stock market data to identify patterns and relationships that can be used to predict future stock/index prices [2]. Machine learning can be used to identify the most relevant features that influence stock/index prices and construct new features that capture additional market information. This can improve the accuracy of forecasts and help identify the most important factors affecting stock/index prices. Machine learning can be used to analyze news articles, social media posts, and other sources of information to determine investor and public sentiment [3]. This can provide insight into market sentiment that can be used to predict future stock/index prices. Deep learning

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techniques such as neural networks can be used to model complex relationships between various features and stock/index prices. These models can learn to identify non-linear relationships that may not be captured by traditional statistical models [4]. There are several deep learning algorithms commonly used for stock price prediction, including Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), and Deep Neural Networks (DNN) [5].
A hybrid index/stock price prediction model involves a combination of various deep learning algorithms such as Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), and Deep Neural Networks (DNN). With the help of hybrid models, researchers can give strengths to the deep learning algorithms to improve prediction accuracy [6]. For example, a hybrid model might use a CNN to extract features from raw data such as historical prices, news articles, and economic indicators, and then use an RNN or LSTM to model temporal dependencies in the data and make predictions based on the learned patterns. One example of a hybrid model for index/stock price prediction is to use a CNN to extract features from the input data, followed by an LSTM or RNN to model temporal dependencies in the data, and finally a DNN to combine the extracted features. CNN with other data sources and generate the final prediction. This type of hybrid model can improve forecast accuracy by leveraging the strengths of each component and combining multiple data sources to produce more accurate forecasts.
As everybody knows equity price is important for analyzing a company and Index price is important to know about the growth of a country or a sector in the case of sectorial Index i.e., NIFTY 50 and Banknifty in India. Prediction is always required for better planning for economic developments, and in the case of the investors for better returns. There are several motivations for doing stock / Index price prediction research such as investment decision making, risk management, financial analysis, economic planning, and market efficiency. The paper aims to contribute to the field of stock/ share market, and finance using machine learning by providing a comprehensive analysis of the factors that influence stock/index prices and developing and evaluating accurate and reliable prediction models with the help of a Hybrid Network of CNN, and DNN that can help investors and financial analysts make better investment decisions. The developed method evaluated using machine learning models for stock/index price prediction to identify the most accurate and efficient forecasting method for investors and financial analysts.
The contributions of the paper are:

1. The method identified the most significant financial and economic indicators that influence stock/index prices in the case of the Indian sectorial Index NSE BANK (BankNifty).
2. The developed CNN and DNN deep learning technique predicted the stock/index and improve the accuracy and performance of automatic prediction.
3. The proposed method provided insights and recommendations for investors and financial analysts, how to use predictive models to make informed investment decisions and analyze the impact of different time intervals and prediction horizons on model performance.

The paper is organized as follows, section 2 represents related work, section 3 represents proposed method, section 4 provides implementation details and result analysis, and section 5 provides conclusion and future research direction.

II. Related Works

In [7] predicted the Indian Index Nifty 50 on behalf of price data or can say trading data, through 3 different networks/models individually these used models are RNN, CNN, and LSTM. LSTM gives better performance than RNN and CNN. [8] present prediction of VIX i.e. Volatility Index every Index has VIX to predict its movement is different from stock and Index. The method chosen six algorithms including a few traditional methods such as Naïve Bayes (NB), Logistic Regression (LR), Classic ML such as Decision Tree (DT) and Random Forest (RF) along with some advanced methods such as Adaptive boosting (AB), Multi-Layer Perceptron (MLP), And an Ensemble model using all the above. The method provides good prediction as compared to traditional methods. In [9] discussed about all the ways of share price prediction on behalf of Market data and textual data. The author described Fundamental Analysis and Technical Analysis is the traditional Methods of Stock Price Prediction. Modern approaches are the Machine Learning approach and Sentiment Analysis approach. Apart from both these techniques, one more process is there called the Generic Process of Stock Market Prediction using Machine Learning in this all the technological algorithms are used as Artificial Neural Networks (ANN), Deep Neural Networks (DNN), regression on Algorithms (RA), Support Vector Machine (SVM), Naïve Bayes (NB), Generic Algorithms (GA), Fuzzy Logic Algorithms (FA) and Hybrid Approaches (HA). All these approaches are available still researchers are struggling with the accuracy sometimes in few researches 80% or 90% plus accuracy is showing but it is also in rare cases or sometimes for a particular script not for all the user scripts.

In [10] predicting Stock return of UAE listed companies using financial ratios, related to accounting and finance. This research was done for observing whether financial ratios can predict the equity return for 30 listed companies in the Abu Dhabi Stock Exchange and the Dubai Financial Market. In this technique, five independent features were used i.e. earnings per share, debt equity, price earnings ratio, dividend yield, and return on equity. They also used the dependent variable the stock return. In this research, the researchers have used Descriptive Analysis, Correlation Analysis, and Regression Analysis. The descriptive statistics, correlation analysis, and regression model have proven successful and their empirical value has proven strong. These models can also be used as a powerful tool to determine if a relationship or correlation exists between the two variables. This research also provides insight into the help of ratio investors predicting stock returns over the coming year.
In [11] analyzed the TUNINDEX, the benchmark of the Tunisian Stock Exchange. The researcher collected the data/events from electronic media such as space manager, web manager reports of the World Bank and leaders, etc. and they have also collected the past news of terrorist attacks in the past since 1970. After that, they used descriptive statistics to get the results. The descriptive analysis of a time series is based essentially on the analysis of flattening coefficients (kurtosis) and skewness asymmetry. The latter can be combined in a Jarque-Bera (JB) statistic to test the normality of distribution.
In the two similar research papers [12], [13] are based on Economics and it is the major arena to research for the purpose of share market future. In [14] is an informative journal for events based or can say to predict the stock market in case of crisis. In [15] worked on 10 years data of 4 Indian major banks as Kotak Bank, ICICI Bank, Axis Bank and Yes Bank this research is also beneficial to predict Banknifty.
A Deep LSTM Algorithm [16] has given 82.36% prediction results in the case of SBI. About NSE Nifty50 other companies for HDFC BANK 82.67%, Infosys 82.94%, BPCL 81.02%, TCS 81.63%, And ITC 82.59%, For L&T 82.59%, For UPL 81.66%, For CIPLA 81.71% and for Indian OIL 81.21%.

III. HYBRID DNN-CNN MODEL

The proposed deep learning method will be a hybrid DNN-CNN based method to improve Share market price prediction. The proposed model can predict the NSE Nifty Bank i.e. Stock Equity/ Market future movement/ price.

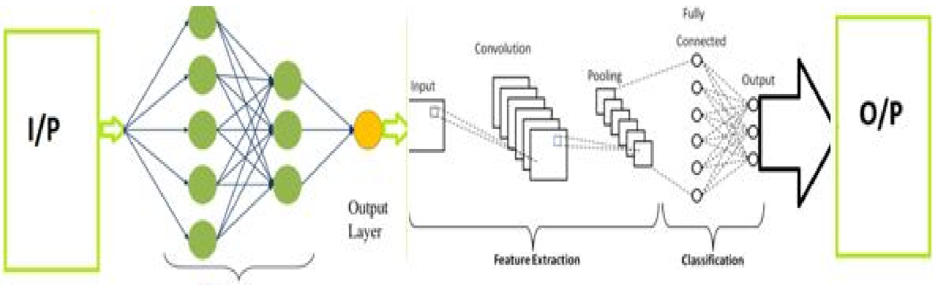


Figure 1 Proposed System Architecture

Fig. 1 represents the system architecture of proposed hybrid DNN-CNN model. The model consists of input layer, DNN layer, CNN layer, and output layer. The dataset from yfinance is input to the model using input layer. After processing from DNN and CNN layer we get the final results at output layer.
Figure 2 represents the flow diagram of proposed hybrid DNN-CNN based prediction model. The steps involved in proposed model is importing of stock/ index training data from yfinance dataset provided by Yahoo, data preprocessing, DNN layer, CNN layer, model training, testing and validation, model evaluation, and result analysis. DNN is a type of Neural Network that can understand the nonlinear relationships in data. In the context of stock prediction DNN is used to extract features from input data (such as stock prices and indicators) related to an estimated future value. The method is designed it to provide inputs from NSE Bank data from past trading days and predict future movements. CNN is a neural network that can learn features of data. In this work, CNN as the last/final layer of the model used for equity/stock price prediction on behalf of past data, a CNN layer can be used to combine features learned from the DNN layers. In this work, the CNN layer produces the final result
Fig.2 represents the flow diagram of proposed system. The model consists of importing stock data, data preprocessing, ensemble DNN-CNN model, training, testing and validation, evaluation and result analysis.

1. Importing the stock/ index trading data

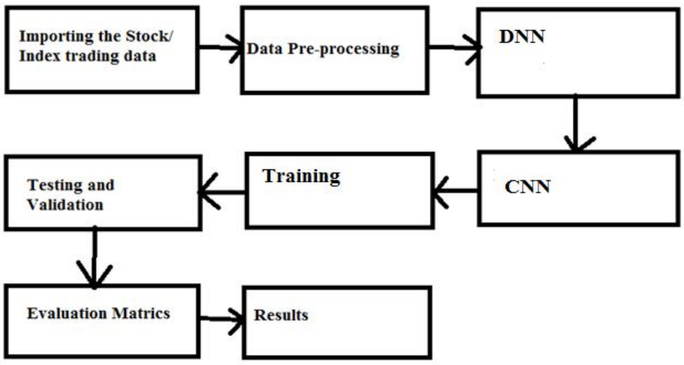
Yahoo Finance provides the stock/ index dataset in the form of yfinance library. For our model we have collected data for 15 years from 28th September 2007 to 4th May 2022.

2. Data Pre-processing

yfinance dataset consists of large amount of data which may have unused and unwanted data. In data pre-processing unwanted data is removed i.e. cleaned, normalized and also selection of most useful features for prediction. The splitting of data for training and testing purpose is also performed in data pre-processing. The yfinance dataset consists of stock data having 3301 rows, for training we have selected 2640 rows i.e. 80% of dataset and for testing 661 rows i.e. 20% of dataset. We have selected most required features from yfinance dataset such as low, date, economic factors, high, moving average, close, volume and open,

3. Model Development

This is the third phase of the work; it involves developing the model. We proposed hybrid DNN-CNN deep learning-based model. The proposed model has been trained and tested using training and testing dataset.



Ensemble DNN-CNN hybrid model algorithm
Input: BANKNIFTY and Output: Share/ Index price prediction
Where f is data features, C is output from DNN algorithm, P is output from CNN algorithm
HybridDnnCnn(data)
For f features in data do
C=Dnn(f)
P=Cnn(C)
End For
MSE(P)
Evaluate Precision, Accuracy, F-Score, Recall
End HybridDnnCnn

4. Model Evaluation

This is the fourth phase of the work; it involves evaluating the model on the performances of proposed model have been tested using evaluation metrics such as MAE, RMSE, MSE, F1-Score, precision, recall and accuracy.

5. Prediction

After training, validation and testing of proposed model we can predict the future stock market/ index.

IV. Implementation and Result analysis

A. Implementation

The experiment is performed on Intel(R) Core(TM) i5-2.4 GHz CPU with 16GB RAM. Python language, Scikit-learn, NumPy, Pandas, Seaborn, and Metplotlib, libraries, with Keras and TensorFlow framework used for implementation of proposed technique.
The data set used for implementation if from Yfinannce data library. The attributes and values of data set are represented in table below.
The table 1 represents the 10 rows of the yfinance dataset. The dataset attributes are low, open, high, close, date and Adj close.
Table 2 describes the dataset attributes with their values. The dataset contains Banknifty Trading data from yfinance library having 3301 rows. The total 2640 rows i.e. 80% of data is used as training data and 661 rows i.e. 20% of data is used for testing. The start data (Training) is select as 28-09-2007 and end date (Training) is 04-05-

2022. Similarly start date (Validation) is select as 26-08-2019 and end date (Validation) is select as 02-05-2022. We get training accuracy (R-squared) is 0.9971777414652634 and validation accuracy (R-squared) is 0.9748483276160194.

TABLE 1: DATASET YFINANCE LIBRARY

Date	Open	High	Low	Close	Adj Close
25-04-2022	35792.351562	36270.148438	35511.398438	36082.351562	36082.354512
26-04-2022	36515.351562	36604.550781	36265.898438	36404.800781	36405.810882
27-04-2022	36067.550781	36175.898438	35747.148438	36028.851562	35928.841560
28-04-2022	36189.949219	36501.101562	35951.101562	36422.199219	36522.199210
29-04-2022	36474.050781	36718.800781	35978.949219	36088.148438	36089.148437
28-9-2007	7838.250000	8082.850098	7836.049805	8042.200195	8042.106934
01-10-2007	8008.549805	8085.149902	7913.299805	7987.500000	7987.407227
03-10-2007	8029.799805	8235.799805	7820.250000	8097.899902	8097.805664
04-10-2007	8083.299805	8086.700195	7828.649902	8035.899902	8085.806641
05-10-2007	8038.100098	8066.549805	7789700195	7845.250000	7845.158691

TABLE II: DATASET ATTRIBUTES

Total number of Rows	3301
Start date (Training)	28-09-2007
End date (Training)	04-05-2022
Number of Rows used for Training	2640
Start date (Validation)	26-08-2019
End date (Validation)	02-05-2022
Number of Rows used for Validation	661
Ratio of Rows used in Training	0.7997576491972129
Ratio of Rows used in Validation	0.20024235080278704
Training accuracy (R-squared)	0.9971777414652634
Validation accuracy (R-squared)	0.9748483276160194

```
Epoch 1/50
44/44 [==============================] - 9s 93ms/step - loss: 0.0123 - val_loss: 0.0014
Epoch 2/50
44/44 [==============================] - 3s 63ms/step - loss: 9.1255e-04 - val_loss: 0.0011
Epoch 3/50
44/44 [==============================] - 2s 55ms/step - loss: 7.6129e-04 - val_loss: 8.4991e-04
Epoch 4/50
44/44 [==============================] - 2s 51ms/step - loss: 6.7954e-04 - val_loss: 8.5456e-04
Epoch 5/50
44/44 [==============================] - 2s 51ms/step - loss: 6.6628e-04 - val_loss: 9.9024e-04
Epoch 6/50
44/44 [==============================] - 2s 51ms/step - loss: 5.8186e-04 - val_loss: 7.5233e-04
Epoch 7/50
44/44 [==============================] - 2s 51ms/step - loss: 5.9139e-04 - val_loss: 7.2585e-04
Epoch 8/50
44/44 [==============================] - 2s 54ms/step - loss: 5.6971e-04 - val_loss: 0.0013
Epoch 9/50
44/44 [==============================] - 2s 54ms/step - loss: 5.1169e-04 - val_loss: 0.0016
Epoch 10/50
44/44 [==============================] - 2s 54ms/step - loss: 5.2365e-04 - val_loss: 0.0011
Epoch 11/50
```

B. RESULT ANALYSIS

1. Actual V/S Training and Actual V/S Prediction

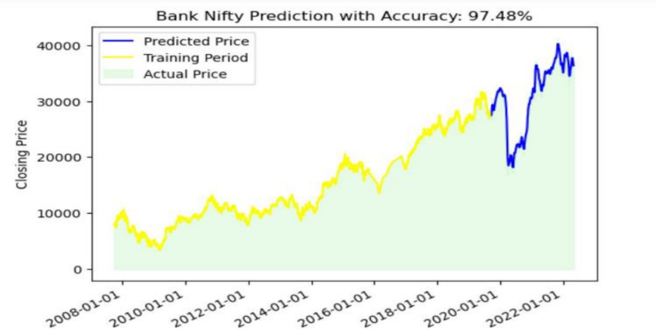


Figure 4: Actual V/S Training and Actual V/S Prediction

The fig. 4 represents the Actual V/S Training and Actual V/S Testing graph. The duration of the dataset is from 28th September 2007 to 4th May 2022 i.e., for 15 years. The proposed method achieved 97.4% prediction accuracy.

2. Bank Nifty Sensex, and Nifty Actual Movements

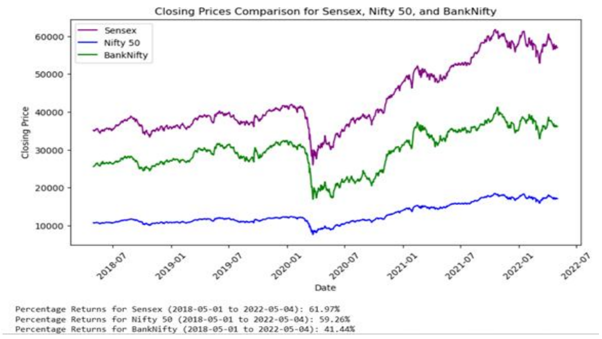


Figure 5: *Years Movements and Returns of Sensex, Nifty and Bank Nifty*

The figure5. represents the closing prices of Sensex, Nifty and Bank nifty for 4 years 2018 to 2022. Sensex percentage return from 2018-05-01 to 2022-05-04 is 61.9%. Nifty percentage return from 2018-05-01 to 2022-05-04 is 59.2%. Bank Nifty percentage return from 2018-05-01 to 2022-05-04 is 41.4%. The percentage returns represent the overall profitability and performance of each index over a 4-year period.

Validation Loss

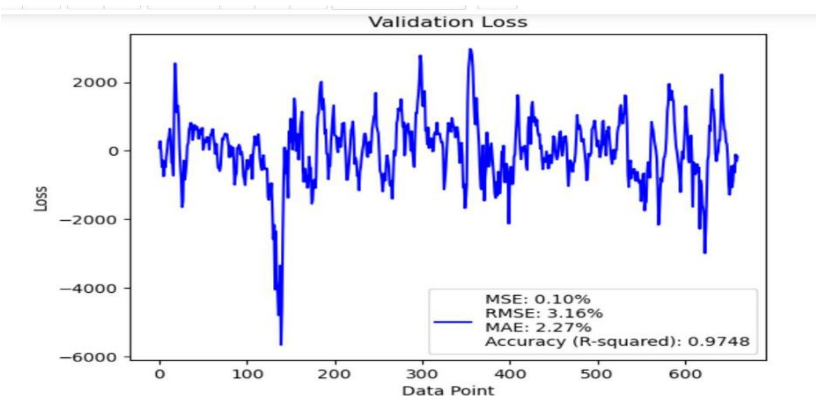


Figure 6: Validation Loss

Fig. 6 represents the testing period validation loss. As from results we get MSE of 0.10%, MAE of 2.27% and RMSE of 3.16%.

3. Testing- Actual V/S Predicted

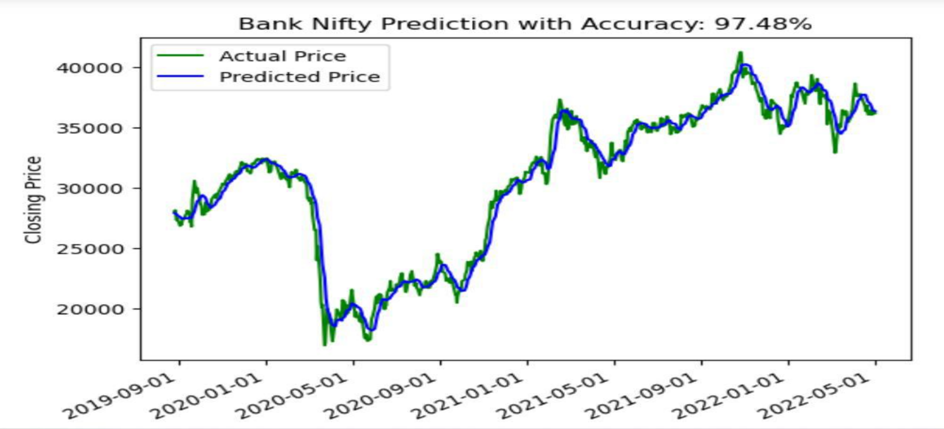


Figure 7: Testing- Actual V/S Predicted Line Graph

The fig. 7. represents the Testing- Actual V/S Predicted graph. The predicted accuracy is 97% using Bank Nifty for 15 years data from 28th September 2007 to 4th May 2022

C. Evaluation Metrics

The table 3 shows the statistics about Evaluation Metrics

TABLE III: EVALUATION METRICS

Training loss (MSE)	0.07068396332442098 %
Validation loss (RMSE)	0.0999814561486119 %
Training loss (RMSE)	2.6586455823298634 %
Validation loss (MSE)	3.1619844425393984 %
Training loss (MAE)	1.9755309561750818 %
Validation loss (MAE)	2.273714829994833 %
Training Accuracy (R-squared)	0.9971777414652634
Validation Accuracy (R-squared)	0.9748483276160194

The evaluation matrix represents the metrics with their values. As from the above results we can find the MSE Loss, RMSE Loss, MAE Loss in % during training and validation and the most important R-Squared Accuracy during the training and validation i.e. 99.71% (Traning Accuracy) and 97.4% (Testing Accuracy).
Closing Price V/S predicted Price: In the following figure/image we have shown the closing price V/S predicted price it has a large number of rows so we have shown the first 5 rows and the last 5 rows.
Comparison: In the following table shown parameter are using in prediction.

TABLE 4: PARAMETERS USED IN PREDICTION

1	Unit= 64	Drop out:0.3	Activation: Relu	Loss=binary_cross sentropy	Optimizer=adam	Epoch 50
2	Unit =64	Drop out:0.4	Sigmoid	Loss=binary_cross sentropy	Optimizer=adam	Epoch 60
3	Unit= 64	Drop out:0.2	Softmax	Loss=binary_cross sentropy	Optimizer=adam	Epoch 80

Table 4 represents parameters used in implementation for stock market prediction. The table 5 represents unit, drop out, activation function, loss, optimizer and epoch used in the implementation.

TABLE V: *MODEL EVALUATION*

Actual class	Predicted Class	
	Negative	Positive
Negative	TN (True Negative)	FP (False Positive)
Positive	FN (False Negative)	TP (True Positive)

Table 5 represents the actual class and predicted class with TN, TP, FN and FP classification method.
Accuracy: Proportion of correct classifications (true positives and true negatives) from overall number of cases.

$$Accuracy = TP + TN / TP + TN + FP + FN$$

Recall: Proportion of correct positive classifications (true positives) from cases that are actually positive.

$$Recall = TP / TP + FN$$

Precision: Proportion of correct positive classification (true positives) from cases that are predicted as positive.

$$Precision = TP/ TP + FP$$

F-Score or F-Measure: is a single measure of classification procedures usefulness. The F-Score considers both precision and recall of the procedure to compute the score. The higher the F-Score, the better the predictive power of the classification procedure. A score of 1 means the classification procedure is perfect. The lowest possible F-Score is 0.

$$0<=F<=1$$

The F-Score is the Harmonic mean of Precision and recall.

$$F=2/(1/recall) + (1/precision)$$

$$F=2* (precision *recall)/ (Precision + recall)$$

TABLE VI: COMPARISON BETWEEN EXISTING MODEL AND PROPOSED MODEL

Method	Accuracy	Precision	Recall
LSTM	89.22	83.21	79.25
RNN	91.23	88.25	82.12
DNN	96.22	93.88	90.25
CNN	92.31	90.25	89.11
Proposed DNN-CNN	97.4	98.2	91.02

$$F1\ score= (2*98.2*91.0) / (98.2+91.0) =94.4.$$

The table 6 represents the comparison between recall, accuracy and precision of proposed model and other methods. The table represents that proposed method recall is 91.02, precision is 98.2 and accuracy is 97.4.

V. CONCLUSIONS

The use of machine learning in stock/index price prediction involves building and training models that can learn from historical data and make predictions of future prices and potential to improve forecast accuracy and provide valuable insights into market trends and investor sentiment. Deep learning is a subset of machine learning that involves using artificial neural networks with multiple layers to analyze and learn from complex data such as stock price data. The hybrid model for index/stock price prediction involves the combination of various deep learning algorithms such as CNN and DNN or LSTM and DNN in a single model to improve the prediction accuracy. The paper presents DNN-CNN based hybrid model for share price prediction. The proposed model can predict the NSE

Nifty Bank i.e. Stock Equity/ Market future movement/ price. The results represent that proposed method recall is 91.02, precision is 98.2 and accuracy is 97.4 which is better as compared to another hybrid model.

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An In-Depth Review of Machine Learning Techniques for Multimodal Stock Market Prediction from an Empirical Perspective

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***Abstract*— Predicting the stock market is a crucial but difficult task due to the complexity and volatility of financial markets. In recent years, multimodal techniques utilizing the fusion of diverse data sources have demonstrated great promise for enhancing the accuracy of stock market prediction models. From an empirical standpoint, this paper provides a comprehensive review of machine learning techniques for multimodal stock market prediction. This review's primary objective is to compare and assess the functionality, precision, accuracy, recall, delay, and scalability of various multimodal techniques. By analyzing a large number of empirical studies, researchers shed light on the strengths and weaknesses of various multimodal approaches used for stock market forecasting. In addition, researchers develop an effective Stock Market Predictive Rank (SMPR) to address the need for a comprehensive evaluation metric that combines multiple performance measures. SMPR evaluates the capability of a model to handle multimodal data, in addition to its precision, accuracy, recall, delay, and scalability. By assigning a rank based on these metrics, researchers hope to identify the best models for predicting stock prices in real-time situations. This review is necessitated by the growing interest in multimodal techniques for stock market forecasting and the absence of a comprehensive analysis of various performance metrics. By synthesizing the existing literature, researchers provide a holistic perspective on the advantages and disadvantages of various multimodal approaches, thereby facilitating future research and practical application. researchers aim to provide researchers, practitioners, and decision-makers with valuable insights into the current state of multimodal stock market prediction techniques through this review. The findings presented in this paper can aid in the selection and development of effective models for real-time stock market forecasting, thereby enhancing investment decision-making and financial risk management process.**

***Index Terms*— Multimodal Techniques, Stock Market Prediction, Machine Learning, Performance Metrics, SMPR, Process**

I. INTRODUCTION

The stock market is essential to the global economy, serving as a platform for companies to raise capital and for investors to generate wealth. Investors, financial institutions, and policymakers place a high premium on the ability to accurately and efficiently predict stock market values. However, due to the highly dynamic and unpredictable nature of financial markets, predicting the stock market remains a difficult and complex process.
Traditional approaches to stock market forecasting frequently rely on data from a single source, such as price

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history or fundamental indicators. However, these methods frequently fail to capture the intricate relationships and concealed patterns within the market, resulting in a lack of precision and dependability. In recent years, there has been an increase in interest in multimodal techniques that utilize the fusion of diverse data sources to improve prediction performance.

Multimodal stock market prediction combines diverse types of data, such as numerical data, textual data, social media sentiment, news articles, and even alternative data sources, such as satellite imagery or internet search trends. By incorporating multiple modalities, these techniques aim to capture a more comprehensive view of the market and make use of the complementary data contained in various data sources.

The need for a comprehensive review of machine learning techniques for multimodal stock market prediction is necessitated by the growing number of studies exploring this field and the lack of a consolidated analysis encompassing a variety of performance metrics. Individual studies utilizing multimodal approaches have reported promising outcomes, but a systematic evaluation and comparison of these techniques based on multiple criteria is lacking for different scenarios.

Therefore, the purpose of this paper is to provide a comprehensive review and empirical analysis of multimodal stock market prediction techniques. These techniques will be compared and evaluated in terms of their functionality, precision, accuracy, recall, delay, and scalability. By analyzing a large number of empirical studies, researchers aim to identify the strengths and weaknesses of various multimodal approaches and to provide valuable insights for future research and implementation process.

In addition to comparing the performance metrics, researchers introduce a Stock Market Predictive Rank (SMPR) that combines multiple performance measures to evaluate and rank the predictive abilities of the models. SMPR considers a model's ability to process multimodal data, as well as its precision, accuracy, recall, delay, and scalability. By incorporating these variables, researchers hope to identify the most accurate models for forecasting stock prices under real-world conditions.

The findings of this review have significant implications for stock market prediction researchers, practitioners, and decision-makers. By providing a comprehensive analysis of multimodal techniques, researchers hope to provide an all-encompassing view of their benefits and drawbacks. This information can guide the selection and development of effective models, resulting in improved investment decision-making, enhanced financial risk management, and ultimately, improved stock market performance levels.

In the sections that follow, researchers will present a detailed analysis of the multimodal techniques used in stock market prediction, discuss the various performance metrics used for evaluation, introduce the SMPR metric, and present the results of their empirical analysis. Through this comprehensive review, researchers hope to contribute to the advancement of research on stock market prediction and encourage the development of real-world applications.

A. In-depth review of existing stock value prediction models

A wide variety of models are proposed by researchers to predict stock price movements, and these models vary in terms of their internal analysis parameters, methods, and operating characteristics. Several studies have investigated the use of various techniques to enhance the accuracy of stock prediction and trend analysis. In one such study [1], computer science and technology researchers applied their knowledge to the financial market. They proposed a method for classifying financial time series that centers on aligning change points to identify latent temporal correlations among securities traded on the same exchange. The researchers intended to enhance trend predictions and portfolio adjustments by identifying significant change points and aligning constituent equities. Their research demonstrated the potential for exposing connections between equities and introducing valid exogenous data for predicting stock trend.

Another study [2] examined the difficulty of accurate stock market forecasting, taking into account the impact of volatile factors like microblogs and news. The researchers analyzed social media and financial news data with machine learning algorithms in an effort to forecast stock markets for the ten days to follow. They utilized feature selection and spam tweet removal to improve prediction performance. The study contrasted various classification algorithms and identified a consistent classifier to demonstrate the influence of social media and financial news on the accuracy of stock market forecasts.

In the field of stock price forecasting, researchers have struggled with the inherent randomness and complexity of stock market-related computational systems. Work in this field [3] has focused on extracting indicator characteristics, such as attitudes and events, from real-time financial data in order to enhance stock price forecasting. The researchers introduced a Novel Greedy Heuristic Optimized Multi-instance Quantitative (NGHOMQ) strategy that utilized heuristic calculations to analyze quantitative data and identify stock price-

related events that occurred in sequence. Their strategy intended to improve stock market price forecasts and outperform conventional neural network frameworks by employing Pareto optimization.
To combat the difficulties posed by dynamic and nonlinear stock trending patterns, researchers have investigated the incorporation of timely news and social media data into stock prediction models. A three-phase hybrid model was proposed [4] that incorporated technical indicators and sentiments from social media text as various situations' influencing factors. To forecast stock market trends, the researchers employed both traditional and deep learning techniques, such as multi-layer perceptron, random forest, and long short-term memory networks. The study demonstrated the efficacy of their approach in increasing prediction accuracy and demonstrated that different learning-based methods performed differently for different equities.
Generative Adversarial Networks (GANs) have been used to create models for predicting stock prices [5]. Using adversarial learning to train a generator and discriminator network, researchers created a model that accurately predicted stock prices. They acquired and preprocessed data, extracted pertinent features, and assessed the performance of the model. The proposed GAN-based method demonstrated hopeful accuracy and low error rates, making it a viable candidate for accurate and dynamic stock price forecasting.
Deep learning architectures, such as Generative Adversarial Networks, have also been applied to the problem of predicting the direction of stock price movement [6]. The researchers merged the Phase-space Reconstruction (PSR) technique with a Generative Adversarial Network (GAN) comprised of Long Short-Term Memory (LSTM) and Convolutional Neural Network (CNN) models. This combination made it easier to analyze historical fundamental indicators and predict stock market trends. The study demonstrated that the proposed GAN-based model outperformed LSTM alone, obtaining greater accuracy in stock direction prediction and reducing processing time.
Attempts have been made to develop integrated prediction systems that use deep learning and intelligent optimization techniques to improve the accuracy of stock price forecasts [7]. Extreme gradient boosting (XGBoost) was used to analyze the factors affecting stock prices, followed by a clustering technique to group the filtered features. Using genetic algorithms (GA), multiple parameters of long short-term memory (LSTM) were optimized, resulting in multiple GA-LSTM models. By integrating the predictions of each class, the system outperformed baseline models, demonstrating its accurate and reliable predictive ability.
Another study examined the linkages between equities on the stock exchange [9]. Combining the correlation coefficient and time-weighted distance, researchers developed a novel method to quantify the phenomenon of stock linkage. In addition, a Long Short-Term Memory (LSTM) model with noise reduction and wavelet transform modules was introduced. Experiments revealed that their model's prediction performance was more accurate than competing models, with a lower root mean square error (RMSE).
The dissipative structure theory allowed researchers to analyze the linkage effect of stock price movement [10]. They developed the conceptual-temporal graph convolutional neural network (CT-GCNN) model to map the linkage effect and forecast stock price movement. Experiments conducted using data from the Chinese stock market demonstrated that the CT-GCNN model outperformed baseline deep learning models.
Recent research [11] suggests a two-stage model for accurate stock price forecasting. The model includes a decomposition algorithm that utilizes variational mode decomposition (VMD) to divide the stock price time series into subseries. The decomposed subseries are then predicted using three distinct machine learning models: support vector machine regression (SVR), extreme learning machine (ELM), and deep neural network (DNN). Preliminary stock price forecasts are derived by combining the predictions of each individual model. In the second phase, the preliminary predictions are combined using a nonlinear ensemble strategy based on ELM. In terms of evaluation of accuracy and improvement percentage, the proposed model outperforms fourteen other models, demonstrating its superior performance.
In a separate work [12], the emphasis is placed on modeling the capital flows and stock relationships in order to make more accurate stock price forecasts. The researchers propose an integrated GCN-LSTM method that employs graph convolutional networks (GCN) to extract stock embeddings and a long short-term memory recurrent neural network (LSTM) to distinguish the direction of stock prices. They build graphs with varied relational knowledge and employ graph attention networks to capture the interactions between equities. Experiments conducted on main Chinese stock indexes demonstrate the efficacy of their model, which outperforms baseline techniques.
Utilizing deep learning architectures, researchers have also attempted to predict stock market trends. In one such study [13], the Hierarchical Adaptive Temporal-Relational Interaction (HATR-I) model is proposed to characterize and predict stock evolutions. Cascaded dilated convolutions and gating paths are incorporated into the model to capture short- and long-term transition regularities of stock dynamics. In addition, it employs a dual attention mechanism to refine the propagation of inter-stock collaborative information and identifies significant feature

points and scales while accounting for time attenuation. The efficacy of the proposed model is demonstrated by experiments conducted on real-world stock market datasets.
In addition, another study [14] introduces a novel multilevel graph attention network (ML-GAT) for predicting stock market trends. The ML-GAT model initializes node representations captured by various feature extraction modules and then updates the existing nodes using graph attention networks. The model selectively aggregates information from multiple relation types and feeds the results to a forecast layer to predict trends. Experiments conducted on the S&P 500 and CSI 300 indices demonstrate that the ML-GAT model outperforms popular approaches, as evidenced by an enhanced F1-score, accuracy, average daily return, and Sharpe rate.
In a study [15], the Financial Graph Attention Networks (FinGAT) model is proposed to resolve the problem of profitable stock recommendation. The FinGAT model constructs a fully-connected graph between equities and sectors using deep learning techniques. It captures short-term and long-term sequential patterns from stock time series and uses graph attention networks to learn the latent interactions between stocks and sectors. Experiments conducted on Taiwan Stock, S&P 500, and NASDAQ datasets demonstrate that the model outperforms state-of-the-art methods in terms of recommendation accuracy.
In the context of stock price forecasting, a study [16] proposes a multimodal early fusion method to integrate additional information such as macroeconomic indicators, month, and day. In terms of statistical significance, the proposed model outperforms comparison models. The early fusion strategy achieves higher classification accuracy than the late fusion strategy when predicting stock prices.
Another work [17] focuses on forecasting the movement of stock prices using stock and news data. The researchers propose a module that effectively integrates price and text data characteristics. The module consists of a multilayer perceptron-based model and depicts the multimodal interaction between the time-series characteristics of the price data and the semantic characteristics of the text data. The experimental results demonstrate the performance of the hybrid information blending module in predicting the movement of stock prices in volatile markets.
In the Brazilian context, a study [18] employs multiple linear regression and multilayer perceptron artificial neural network algorithms to construct prediction models for the Small Cap Index. The models have adequate explanatory power and are able to explain the behaviour of the investigated index.
Another work [19] addresses portfolio management and proposes the ASA framework for autonomous stock selection and allocation. The framework incorporates ranking, classification, and regression models in order to select profitable equities and calculate investment ratios. ASA obtains exceptional performance in real-time scenarios, outperforming state-of-the-art methods based on deep learning.
Lastly, a study [20] quantifies the impact of unanticipated events on financial markets. The researchers propose a framework that extracts global incident facts, integrates socioeconomic datasets, and forecasts the trajectory of the stock market. The framework outperforms various benchmarks, demonstrating its efficacy in quantifying the impact of stock market incidents for different scenarios.
Forecasting financial time series data in real-time presents challenges for many machine learning algorithms. A study [28] addresses these challenges by proposing the parsimonious learning machine (PALM), a rule-based autonomous neuro-fuzzy learning algorithm. PALM is designed for forecasting time-varying stock indexes and provides minimal memory requirements and explainability. Multi-objective evolutionary algorithms are used to automate the proposed algorithm efficiently. Experiments demonstrate that PALM outperforms benchmark models in predicting the closing stock price of various market indices.
In a study [29], a peak price randomization (PPR) system is proposed for portfolio selection. Based on variables such as the average price divided by the current price, the ratio of the apex price to the current price, and arbitrary values, the PPR system determines the proportion of each stock. Experimental results demonstrate that the PPR system outperforms contemporary portfolio selection systems, demonstrating its effectiveness.
A study [30] highlights the role of complex relationships between listed companies in stock fluctuations. The researchers construct a thorough Market Knowledge Graph (MKG) that includes listed companies and associated executives, taking explicit and implicit relationships into account. They propose the DanSmp dual attention network to learn momentum spillover signals based on the MKG for stock forecasting. The experimental results indicate that DanSmp enhances stock forecasting by modeling the intricate interrelationships between listed companies.
A study [31] examines the relationship between oil and gas prices and investment in renewable energy. The development of a decision support system using crude oil prices and renewable energy securities to predict renewable energy investment decisions. In terms of mean square values, the proposed model outperforms other models, providing accurate predictions and evaluating the expected profitability levels of a company based on its performance.

Predicting the price of a cryptocurrency is difficult due to its high volatility and interdependencies with other cryptocurrencies. A study [32] proposes a hybrid and robust framework called DL-Guess for predicting cryptocurrency prices. Utilizing price history and tweets as inputs, the framework examines interdependencies between cryptocurrencies and market sentiment. The outcomes demonstrate the accuracy of DL-Gues in predicting the prices of cryptocurrencies like Dash and Bitcoin-Cash.
In a study [33], the complex and nonstationary character of gold price forecasting is considered. The researchers propose VMD-ICSS-BiGRU, a hybrid forecasting method that combines the BiGRU deep learning model, variational mode decomposition (VMD), and the iterated cumulative sum of squares algorithm. The hybrid method effectively extracts factors and patterns from the movements of the gold futures market and accurately predicts future price movements. The testing results demonstrate a substantial improvement over benchmark models and emphasize the practical advice provided for investment risk minimization and hedging strategies in the gold commodity markets. Thus, it can be observed that there are multiple models proposed for prediction of stock prices, and each of these models vary in terms of their function characteristics. To further contemplate this study, these models are compared in terms of their performance metrics in the next section of this text.

II. Result Analysis And Experimentation

As per the review of existing models used for analysis of stock prices, it can be observed that these models are highly variant in terms of their internal operating characteristics. This section discusses performance of these models in terms of Precision (P), Accuracy (A), Recall (R), Delay (D), and Scalability (S) levels. While precision, recall & accuracy levels were directly inferred from the previous texts, while delay & scalability levels were evaluated in terms of fuzzy ranges of Low (L), Medium (M), High (H), and Very High (VH) Values, which will assist readers to identify optimal models for real-time scenarios. Based on this strategy, the comparison can be observed from table 1 as follows,

TABLE I. COMPARATIVE ANALYSIS OF THE REVIEWED MODELS

Model Name	**P**	**A**	**R**	**D**	**S**
RNN-MTL [1]	98.5	98.3	98.1	VH	H
CNN-Attention [2]	98.9	98.5	97.9	H	VH
GRU [3]	97.4	97.6	97.5	H	H
RL [4]	99.1	97.7	97.6	H	H
Wavelet [5]	96.4	97.3	97.8	H	L
GRU [6]	97.5	97.9	98.3	VH	H
CNN-GRU [7]	97.9	98.4	98.5	VH	H
Attention [8]	98.3	98.6	98.0	VH	H
CNN [9]	98.9	98.4	97.3	VH	H
CNN-LSTM [10]	98.5	96.9	96.8	VH	VH

GAN [11]	97.9	96.6	96.9	M	VH
SVM [12]	94.3	97.0	97.3	H	VH
RNN-CNN [13]	97.6	97.1	97.4	VH	H
GRU-CNN [14]	99.2	97.6	97.8	VH	M
Multi Head [15]	94.5	97.3	97.8	H	L
RNN-Autoencoder [16]	99.2	98.3	98.0	M	H
CNN-Autoencoder [17]	98.3	97.9	98.0	H	H
GRU-CNN-Autoencoder [18]	97.5	97.8	97.7	H	H
DQN [19]	97.8	98.2	97.1	M	L
GRU-RNN [20]	98.2	97.1	96.2	H	L
GA [21]	95.5	96.6	97.5	VH	L
VMD [22]	95.9	97.7	97.9	H	H
GMM [23]	98.3	98.2	97.8	H	L
VU-GARCH-LSTM [24]	98.9	97.6	97.1	H	VH
LSTM [25]	97.5	97.4	96.1	H	M
P-FTD [26]	96.5	96.3	95.2	VH	H
RNN [27]	98.3	94.6	94.6	H	H
PALM [28]	94.2	94.6	94.9	VH	H
PPR [29]	91.4	94.6	94.5	VH	L
DanSmp [30]	98.3	95.3	93.9	H	H

Based on this evaluation and figure 1, it can be observed that GRU-CNN [14], RNN-Autoencoder [16], RL [4], CNN-Attention [2], CNN [9], and VU-GARCH-LSTM [31] showcase higher precision, Attention [8], CNN-Attention [2], CNN-GRU [7], CNN [9], RNN-MTL [1], RNN-Autoencoder [16], DQN [19], and GMM [30] showcase higher accuracy, and CNN-GRU [7], GRU [6], RNN-MTL [1], Attention [8], RNN-Autoencoder [16], and CNN-Autoencoder [17] showcase higher recall rates, thus they can be used for high-efficiency stock prediction scenarios.

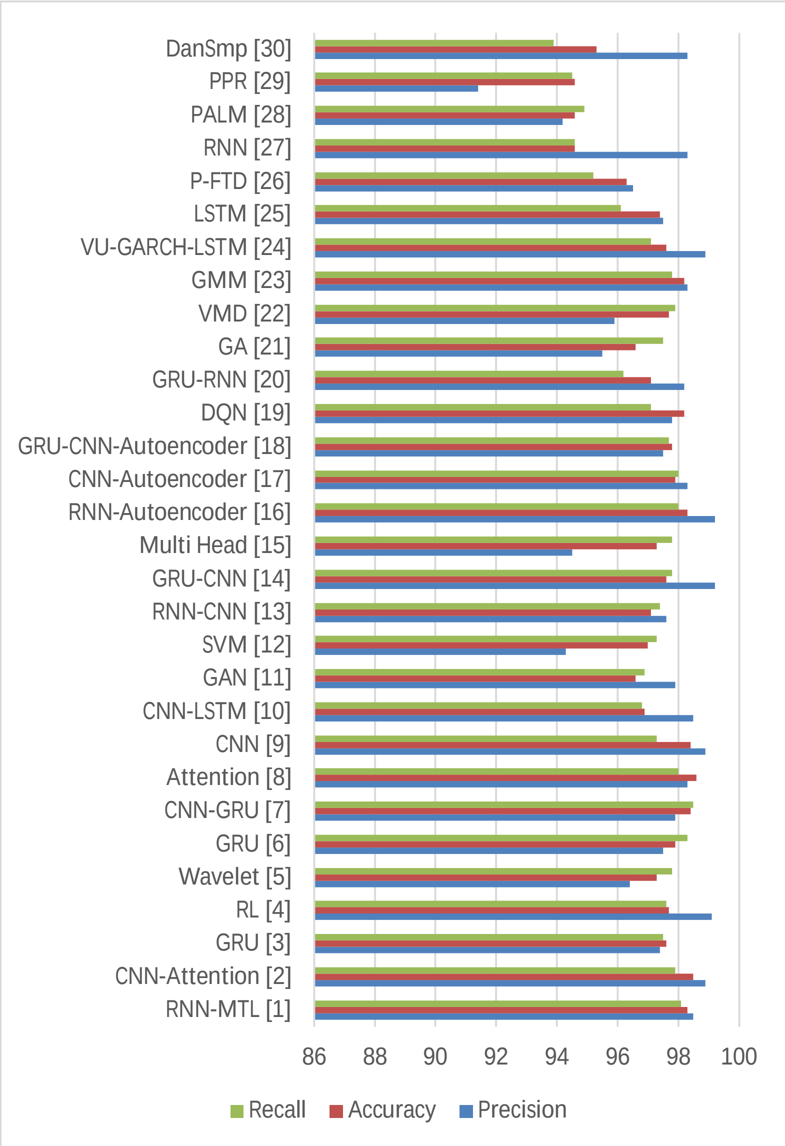

Figure 1. Precision, Accuracy & Recall for different Model Processes

In terms of delay, it can be observed that GAN [11], RNN-Autoencoder [16], and DQN [19] outperforms other methods, thus can be used for high-speed evaluation scenarios. It was also observed that CNN-Attention [2], CNN-LSTM [10], GAN [11], SVM [12], and VU-GARCH-LSTM [31] showcase higher scalability, thus can be used for large-scale stock prediction scenarios. These metrics were combined to form an efficient Stock Market Predictive Rank (SMPR) which was evaluated via equation 1,

$$SMPR = \frac{P + A + R}{300} + \frac{1}{D} + \frac{S}{4} \ldots (1)$$

Based on this evaluation, it can be observed that GAN [11], CNN-Attention [2], VU-GARCH-LSTM [31], SVM [12], RNN-Autoencoder [16], CNN-LSTM [10], RL [4], CNN-Autoencoder [17], GRU-CNN-Autoencoder [18], GRU [3], VMD [29], RNN [34], and DanSmp [37] outperform other models, in terms of precision, accuracy, & recall levels, thus making them highly useful for a wide variety of real-time stock prediction scenarios. Researchers can also extend these models for improving their performance via hybrid fusion of these methods, which will assist in enhancing their real-time performance levels.

III. CONCLUSION

From an empirical standpoint, we conducted a comprehensive review of machine learning techniques for multimodal stock market prediction in this paper. We evaluated a number of models based on their precision, accuracy, recall rates, delay, and scalability to determine their applicability for various stock prediction scenarios. Our evaluation revealed that a number of models exhibited superior performance in certain metrics. GRU-CNN, RNN-Autoencoder, RL, CNN-Attention, CNN, and VU-GARCH-LSTM demonstrated greater precision, whereas Attention, CNN-Attention, CNN-GRU, CNN, RNN-MTL, RNN-Autoencoder, DQN, and GMM demonstrated greater accuracy. CNN-GRU, GRU, RNN-MTL, Attention, RNN-Autoencoder, and CNN-Autoencoder exhibited superior recall rates. In terms of delay, GAN, RNN-Autoencoder, and DQN outperformed other methods, indicating their suitability for high-speed evaluation scenarios. CNN-Attention, CNN-LSTM, GAN, SVM, and VU-GARCH-LSTM exhibited increased scalability, making them suitable for large-scale stock prediction scenarios.

The Stock Market Predictive Rank (SMPR) metric combines precision, accuracy, recall rates, delay, and scalability to provide a comprehensive evaluation. The SMPR equation (Equation 1) enabled us to rank the models and determine those with the highest performance. GAN, CNN-Attention, VU-GARCH-LSTM, SVM, RNN-Autoencoder, CNN-LSTM, RL, CNN-Autoencoder, GRU-CNN-Autoencoder, GRU, VMD, RNN, and DanSmp emerged as the best-performing models based on our evaluation. In a variety of real-time stock prediction scenarios, these models can be extremely useful for different scenarios.

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Applicability of Intimate Mapping in Digital Image Sources

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***Abstract*— After 1922 definition of contraction mapping, its applicability and usefulness were worked upon by several researchers through their various research papers. Different fields of engineering, science and technology could not remain untouched by its use. The notion of compatible mapping and compatible mapping of type (*A*) is further transformed with the concept of intimate mapping.**

The development of operator theory was brought forward by the idea of fixed points impending upon contraction mappings. Apart from general metric space, metric spaces like b-metric space, G-metric space, F-metric space and digital space enhanced the applicability of fixed-point theory. We wish to put forward the notion of intimate mapping in digital metric space through some consequences on it.

***Index Terms*— digital topology, digital metric space, compatible mapping, intimate mapping.**

I. Introduction

In digital topology, the topological characters of image pictures are featured by some array of elements. A specific arrangement of non-negative numbers in a digital topological space is denoted by a digital image. A digital image can be fragmented into its constituents to analyse its various features. This method is nothing but image processing in a digital metric space. By using the method of digital image fragmentation, a digital picture can be improved through tracking, coding, counting, thinning, contour filling, etc. Thus, the applicability of digital technology appeared as a solid technique of image processing. The primary basis of image processing is connectedness and adjacency relations.

Rosenfield, A. [1] [2], visualized digital topology by proposing digital continuous function. The three-dimensional image thinning suggested by Kong [4] and works done by Boxer, L. [8] [9] on digital continuous mappings enriched the concept. Ege, Karaca, and many other researchers [10] [11] [12] [13] endowed their contributions to the field of digital topology. Applicability of fixed points in this field was improvised by the authors in references [10] [11].

Mathematical topology was contributed with the notion of common fixed points, compatibility and type (*A*) compatibility by Jungck, G. [3] [5]

Sahu et. al., defined the concept of intimate mapping in general metric spaces which is nothing but the generalization of type (A) compatible mappings [6]. It has been shown by several authors as in references; [7-16] that in digital technology, digital metric space can be defined to strengthen its application in certain fields like image processing, remote sensing, and many more. Employing coincidence point theorem in b-metric space, the

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author in ref. [15] has shown a similar result in digital topology.

II. Preliminaries

In n-dimensional Euclidean space, a subset Y of set Z^n of lattice points, for any integer $n \geq 0$, with some adjacency relation k in Y is known as a digital image, denoted by (Y, k) [1,2].

Definition 1: [14] For any two fixed points, $u = (u_{1,} u_{2,} \dots \dots \dots . u_n)$, $v = (v_{1,} v_{2,} \dots \dots \dots . v_n) \in Z^n$ and positive integers k, n; $1 \leq k \leq n$, we define u, v as k-adjacent if for at most k, we obtain

$|u_i - v_i| = 1$, for all i and $|u_j - v_j| \neq 1$, $u_j = v_j$ for all other indices j.

Thus, we have For $n = 1$, any two points u and v in Z have 2-adjacent, if $|u - v| = 1$. A symbolic diagram is shown in figure below.

2-Adjacency

For two distinct points u and v that have a difference in at most one coordinate, we have 8-adjacent in Z^2 (for $n = 2$) and 26-adjacent Z^3 (for $n = 3$). However, if the points are 8-adjacent and differ in exactly, one co-ordinate then the two points u and v in Z^2 (for $n = 2$) are 4-adjacent and they are 18-adjacent, if the points are 26-adjacent having at most two distinct coordinates.

This can be generalized for n-dimensional digital image as shown below [16].

$$\text{For } 1 \leq k \leq n, \text{ we have: } p(k, n) = \sum_{i=n-a}^{n-1} 2^{n-i} \binom{n}{i}, \text{where } \binom{n}{i} = \frac{n!}{i!(n-i)!} \qquad \dots (1)$$

For a non-empty set $Y \in Z^n$, s.t. $1 \leq k \leq n$ and $p = p(k, n)$. Then, $p(k, n)$ is known as a digital image having k-adjacency [8]. And, the pair (Y, k) is the n-D digital image [15].

Definition 2: [4] [14] Let us define a digital interval $[l, m]_z$, $\forall\ l, m \in Z$ and $l < m$ as:

$$[l, m]_z = \{z \in Z : l \leq z \leq m\}.$$

Definition 3: [16] Any point of Z^n, k-adjacent to u is known as k-neighbour of $u \in Z^n$ if for $k \in \{2,4,8,6,18,26\}$ and $n \in \{1,2,3\}$, we get

$$P_k(u) = \{v : v \text{ is } k\text{-adjacent to } u\}$$

$P_k(u)$ is a k-neighbourhood to k-neighbour of u. u and v are k-neighbours if v is k-adjacent to u.

Definition 4: [16] A k-connected digital image of $Y \in Z^n$ is detailed for each $l, m \in Y$ if $\exists$ a set $\{l_0, l_1, l_2, l_3, l_{4,} \dots \dots \dots, l_r\}$, in such a way that $l = l_0$ and $m = m_r$ & l_i and l_{i+1} are k-neighbours, $\forall i = 0,1,2,3,4, \dots \dots \dots, r - 1$.

Definition 5: [16] Assume digital images (Y, k_0) and (N, k_1) of Z^{n_0} and Z^{n_1}, respectively and a mapping $T : Y \to N$. Then, we obtain:

1. T is (k_0, k_1)-continuous if k_0-connected subsets of Y correspond to k_1-connected to N.
2. T is (k_0, k_1)-continuous *iff* images of k_0-adjacent to Y are k_1-adjacent in N else, images of a_0-adjacent of Y are coinciding. That is, l_0, l_1 are k_0-adjacent to Y then, $T(l_0)$ and $T(l_1)$ are k_1-adjacent in N or, $T(l_0) = T(l_1)$.
3. T is called (k_0, k_1)-isomorphism if

a. T is (k_0, k_1)-continuous
b. T is one-to-one and onto
c. T^{-1} is (k_0, k_1)-continuous.

So, we get $Y \cong_{(k_0, k_1)} N$.

Definition 6: [16] For a set Y a digital k-path from $l \to m$ is defined as a $(2, k)$-continuous function $T : [0, r]_z \to Y$ s. t. $T(0) = l$ and $T(r) = m$. The set Y is called k-path connected in the set (Y, k) if there is a k-path for any two points.

Definition 7: [12] Consider a digital image (Y, k) and a mapping $\theta : (Y, k) \times (Y, k) \to Z^n$ with following conditions:

1. $\theta(y_1, y_2)$ is non-negative
2. $\theta(y_1, y_2) = 0$ iff $y_1 = y_2$
3. $\theta(y_1, y_2) = \theta(y_2, y_1)$
4. $\theta(y_1, y_3) \leq \theta(y_1, y_2) + \theta(y_2, y_3)$, $\forall y_1, y_2, y_3 \in Y$.

Then, θ is defined as a digital metric and (Y, θ, k) as digital metric space.
Definition 8: [16] Suppose we have any sequence $< y_n >$ on (Y, θ, k), where (Y, θ, k) be a digital metric space. Then, we say $< y_n >$ as a Cauchy sequence, if for each $\varepsilon > 0 \; \exists \; c \in N$, we have

$$\theta(y_r, y_n) < \varepsilon, \text{ for each } r, n > c.$$

Notion 1: [14] Let $< y_n >$ is a Cauchy sequence on a digital metric space (Y, θ, k) then, we obtain

$$y_r = y_n \;, \forall \, r, n > c \in N$$

Definition 9: [16] A sequence $< y_n >$ being a Cauchy sequence on (Y, θ, k), where (Y, θ, k) be a digital metric space, is called convergent on Y, if for each $\varepsilon > 0 \; \exists \; c \in N$, such that

$$\theta(y_n, y_0) < \varepsilon, \forall \; n > c.$$

Notion 2: [14] Digital metric space (Y, θ, k) is said to be complete if every Cauchy sequence $< y_n >$ converses to any point $y_0 \in$ Y in it. So, (Y, θ, k) is complete.

Definition 10: [16] A digital contraction defined on a self-map $g: (Y, \theta, k) \to (Y, \theta, k)$ for any digital contraction constant $\rho \in [0,1)$ as:

$$\theta(\mathrm{gy}, \mathrm{gz}) \leq \rho\theta(\mathrm{y}, \mathrm{z}), \forall y, z \in Y$$

is always digitally continuous.
Notion 3: [11] For any digital contraction defined on a self-map $g: (Y, \theta, k) \to (Y, \theta, k)$ in a digital metric space (Y, θ, k) on Euclidean metric Z^n there exists a unique fixed point $y_0 \in Y$ such that $g(y_0) = y_0$.
Definition 11: [3] Mappings $g, h: (Y, \theta, k) \to (Y, \theta, k)$ are said to be compatible mappings if and only if,
$\lim_{n\to\infty} \theta\big(hg(\mathrm{y}_n), gh(\mathrm{y}_n)\big) = 0$,
where $< y_n >$ is a sequence such that $\lim_n g(\mathrm{y}_n) = \lim_n h(\mathrm{y}_n) = a$, for some $a \in$ Y.
Notion 4: It is obvious that, a weakly commuting pair of mappings are compatible but compatibility does not imply that pairs are weakly commuting.
For example, consider the mappings $g(y) = 2y^3$ and $h(y) = y^3$, y $\in$ Y. Then,

$$|g(\mathrm{y}) - h(\mathrm{y})| = |2y^3 - y^3| = |y^3| \to 0$$

$$\Leftrightarrow |gh(\mathrm{y}) - hg(\mathrm{y})| = |2(y^3)^3 - (2y^3)^3| = 6|y^9| \to 0$$

So, g and h are compatible.
But they are not weakly commuting as, $|gh(\mathrm{y}) - hg(\mathrm{y})| \nleq |g(\mathrm{y}) - h(\mathrm{y})| \; \forall \; y \in R$

Definition 12: [5] Mappings $g, h: (Y, \theta, k) \to (Y, \theta, k)$ are said to be compatible mappings of type (A) if,

(i). $\lim_{n\to\infty} \theta\big(hg(\mathrm{y}_n), g^2(\mathrm{y}_n)\big) = 0$

(ii). $\lim_{n\to\infty} \theta\big(gh(\mathrm{y}_n), h^2(\mathrm{y}_n)\big) = 0$

where $< y_n >$ is a sequence such that $\lim_n g(\mathrm{y}_n) = \lim_n h(\mathrm{y}_n) = a$, for some $a \in$ Y.
Definition 13: [6] For a non-empty set $Y \in Z^n$ and digital image (Y, k), any two mappings g and h in digital metric space (Y, θ, k) such that $g, h: (Y, \theta, k) \to (Y, \theta, k)$ are known as digitally intimate mappings,

(i). denoted by digitally h-intimate, if $\omega \, \theta\big(hg(\mathrm{y}_n), h(\mathrm{y}_n)\big) \leq \omega \, \theta\big(gg(\mathrm{y}_n), g(\mathrm{y}_n)\big)$ and

(ii). denoted by digitally g-intimate, if $\omega \, \theta\big(gh(\mathrm{y}_n), g(\mathrm{y}_n)\big) \leq \omega \, \theta\big(hh(\mathrm{y}_n), h(\mathrm{y}_n)\big)$,

where $< y_n >$ is a sequence such that $\lim_n g(\mathrm{y}_n) = \lim_n h(\mathrm{y}_n) = a$, for some $a \in$ Y and $\omega = limit\ sup.$ or $limit\ inf.$
Notion 5: A pair of any two mappings g and h of a digital metric space (Y, θ, k) onto (Y, θ, k) itself are type (A) digitally compatible then they are digitally g, h-intimate.
Converse of Notion 5 is not followed, in general.
Theorem 2.1: BFPT in Digital Metric Space [14]:
Let (Y, θ, k) be a digital metric space and Banach type digital contraction on Euclidean metric $Z^n$is defined on a self-map $g: (Y, \theta, k) \to (Y, \theta, k)$ for any constant $\rho \in [0,1)$ as:

$$\theta(\mathrm{gy}, \mathrm{gz}) \leq \rho\theta(\mathrm{y}, \mathrm{z}), \forall y, z \in Y$$

Then, there exists a unique fixed point $y_0 \in Y$, which gives $g(y_0) = y_0$.

III. MAIN RESULT

Let us introduce a notion on intimate mappings as a contraction:

Notion 6: Consider two digitally h-intimate mappings G and H on a digital metric space (Y, θ, k) such that

$$H(a) = G(a) = b, \qquad b \in Y$$

Then, we get

$$\theta(Hb, b) \leq \theta(Gb, b).$$

Now, we establish a result on common fixed point for pairs of intimate mappings G and H as follows:

Theorem 3.1: Consider a non-empty set $Y \in Z^n, n \in N$ and a digital image (Y, k) with an adjacency relation k in Y. Let (Y, θ, k) be a digital metric space having mappings G and H such that,

$$H(Y) \subseteq G(Y)$$

$$\theta(Hx, Hy) \leq \rho\theta(Gx, Gy), \forall x, y \in Y.$$

Where, $\rho \in [0,1)$. Then G and H have a common fixed point.

Proof: Since $H(Y) \subseteq G(Y)$, so we can always construct a sequence $< x_n >$ such that

$$H(x_n) \subseteq G(x_{n+1}).$$

Now,

$$\theta(Gx_{n+1}, Gx_n) = \theta(Hx_n, Hx_{n-1})$$

$$\leq \rho\, \theta(Gx_n, Gx_{n-1}) = \rho\theta(Hx_{n-1}, Hx_{n-2})$$

$$\leq \rho^2\theta(Gx_{n-1}, Gx_{n-2})$$

Continuing this process, we get,

$$\theta(Gx_{n+1}, Gx_n) \leq \rho^n d(Gx_1, Gx_0), \rho \in [0,1)$$

So as, $n \to \infty$, we have $\theta(Gx_{n+1}, Gx_n) \to 0$, then by Banach contraction principle, we obtain

$$H(x_n) = G(x_{n+1}) \to z \in (Y, \theta, k)$$

Hence, z is a unique common fixed point of G and H.

Theorem 3.2: Let (Y, θ, k) be a digital metric space and $H: Y \to Y$ be a self mapping such that,

$\theta(Hx, Hy) \leq \rho\theta(Gx, Gy)$, $\forall\, x, y \in Y$ and $\rho \in [0,1)$.

Then, H has a unique fixed point in Y.

Proof: If we consider, $G = I$ (an identity mapping) in Theorem 3.1, then, the result of this theorem is a particular case of our Theorem 3.1.

Corollary 3.1: Consider a non-empty set $Y \in Z^n, n \in N$ and a digital image (Y, k) with an adjacency relation k in Y. Let (Y, θ, k) be a digital metric space having strictly increasing mappings $G, H: (Y, \theta, k) \to (Y, \theta, k)$ such that,

I. $H(Y) \subseteq G(Y)$

II. $\theta(Hx, Hy) \leq \rho\theta(Gx, Gy), \forall x, y \in Y$, where $\rho \in [0,1)$.

Then, the mappings G and H are compatible.

Proof: By using Theorem 3.1, we can show that the two self-mappings G and H have a common fixed point. Hence, the result is obvious as two strictly increasing self-mappings having a common fixed point are compatible as [3]:

$$G(x_n), H(x_n) \to z$$

$$\Rightarrow \lim_{n\to\infty} \theta\big(HG(y_n), GH(y_n)\big) = 0, \text{ for } z \in Y.$$

Thus, we have come across the result which may enrich the theory of a common fixed point in digital metric space.

IV. CONCLUSIONS

In dealing with digital metric space, sets are generally integral valued so the Cauchy sequences obtained may have constant values. Thus, it may or may not sound good. However, regarding connected digital images, the metric using contraction assures the shortest path length. In regular practice, storage of the data is a measure problem now-a-day. So, compression, reduction in size and thinning of digital image sources are the need of the hour. Thus, by making use of common fixed-point theorem in digital image processing, the desired image without much redundancy can be reinforced.

Conflict of Interest

The authors confirm that there is no conflict of interest to declare for this publication.

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Smart Music Player Integrating Facial Emotion Recognition and Music Mood Recommendation

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***Abstract*— We came across many applications that are serve solutions and assistance for the music playlist creation recommendation. To provide more facility and the solutions to the music creation and recommendation of music and numerous technique approaches have followedin our proposed system. To determine the approached and developing the current state of human emotion and playing through the mood determined by the system. Our proposed system mainly focuses on playing and recommending the songs according to end user current mood or betterment of the mood.**

***Index Terms*— Emotion, PSNR, facial expression, Open CV.**

I. INTRODUCTION

According to the emotion, the music will be played from the predefined directories. Each sub-directory contains songs that corresponds to the emotion. Songs in the sub folders can be changed/replaced or deleted by the programmer depending on the requirements of user. At times it is possible that user might like different kinds of songs in certain mood. For example, when a user's emotion is detected to be Sad, then it is totally users choice what kind of mood does he/she want.

A. In[4], they have proposed a mood detection system. They have used modern CNN for building framework. Their architecture is fully-convolutional neural network contains 4 residual separable convolutions and each convolution is followed by a batch normalization operation and ReLU activation. Architecture has 60000 parameter, which is corresponds to reduction of 10x of Naive and 80X of original CNN. They have achieved 66% of accuracy in mood detection.

A literature survey on the developments in biometric image processing domain and techniques used for detecting face and recognizing facial emotions are reviewed and discussed below:

S. Amirhassan Monadjemi et al; proposed to enhance the performance of face detection and recognition systems. In face detection step, Skin color segmentation with YCbCr color space is used. Gaussian skin color model is used in color space image to segment the skin and non-skin pixels. Morphological operations are used to eliminate holes formed in eye, mouth, and nose in skin color segments. Gabor features extraction, dimension reduction using PCA, feature selection using LDA and SVM based classification are used to construct an efficient face recognition system with a high recognition rate [5].regression model. The analyses show how the available information in a common ICU setting can be used to predict the progress of septic shock also in a very limited number of cases.

Anala M R et al., presented Viola Jones classifier method, Background subtraction method and skin color detection

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on HSV color spaces. The Viola Jones classifier method gives good results for detecting faces but it takes more time for the detection and it does not give accurate results. The Background subtraction method and Skin color detection on HSV color space are more efficient when compared to the first method by giving accurate results for detecting faces in motion [6].

This section presents the existing methods for classifying emotion from the music. There are some relevant approaches which are concluded as follows.

Robert E. Thayer applies rhythm, tempo, intensity, pitch, and timbre to distinguish music emotions. He defines emotion types based on energy and stress. The energy of the music is a range between calm and energetic, while the stress is a range of happy and anxious/sad. This research divides the music emotions into 8 types; namely, exuberance, anxious/frantic, contentment, depression, calm, energetic, happy, and anxious/sad.

Y. Song et al apply an SVM-based approach for classifying the music emotions based on tags of the Last.FM website. There are 4 emotions provided in this research; namely, happy, angry, sad, and relax.

Mood Cloud, a real-time music mood visualization tool, classifies music emotions into 5 types; namely aggressive, happy, party, relax and sad. It applies the SVM library to analyze the emotion dataset. The result is then presented by using a Flash player.

M. T. Quazi applies the heart rate to classify human emotions. The research proposes 4 different types of human emotions; namely neutral, happy, sad and angry. The neutral emotion has the most stable heart rate (60 – 80 bpm), while the happy emotion has the highest variation rate(70– 140 bpm) which depends on the type of happiness. The sad emotion has the second highest variation rate (80 – 100 bpm). The heart rate of angry emotion is in the same range as the happy emotion, but it will not lower than 100bpm.

i.e. either positive or negative. For Example, if a user’s current emotion is sad and his preference is set to positive, the application will suggest a happy song which contains a cheer up song element. On the other hands, if a user’s preference is set to negative, a song in a sad mood will be suggested, and that song may be a heavy or pop song.

There are several applications that provides facilities and services for music playlist generation or play a particular song and in this process all manual work is involved. Now to provide there are various techniques and approaches have been proposed and developed to classify human emotional state of behavior. The proposed approaches have only focused on only some of the basic emotions using complex techniques like Viola and Jones. Several research papers giving a brief about the idea are: [1] in this paper, Authors states that, Music plays a really important role in human's lifestyle and within the modern advanced technologies. Usually, the user has got to face the task of manually browsing through the playlist of songs to pick. Here we are proposing an efficient and accurate model, that might generate a playlist supported current spirit and behavior of the user.

Existing methods for automating the playlist generation process are computationally slow, less accurate and sometimes even require use of additional hardware like EEG or sensors. Speech is that the most ancient and natural way of expressing feelings, emotions and mood and its and its processing requires high computational, time, and cost. This system supported real-time extraction of facial expressions also as extracting audio features from songs to classify into a selected emotion which will generate a playlist automatically such the computation cost is comparatively low.

[2]This paper proposes an intelligent agent that sorts a music collection supported the emotions conveyed by each song then suggests an appropriate playlist to the user supported his/her current mood. The user's local music collection is initially clustered supported the emotion the song conveys, i.e. the mood of the song. This is often calculated taking into consideration the lyrics of the song, also because the melody. Whenever the user wishes to get a mood-based playlist, the user takes an image of themselves at that instant. This image is subjected to facial detection and emotion recognition techniques, recognizing the emotion of the user. The music that best matches this emotion is then recommended to the user as a playlist. [3] In this paper, Authors states that, Nowadays, people tend to increasingly have more stress due to the bad economy, high living expenses, etc. taking note of music may be a key activity that assists to scale back stress. However, it's going to be unhelpful if the music doesn't suit the present emotion of the listener. Moreover, there's no music player which is in a position to pick songs supported the user emotion. To unravel this problem, this paper proposes an emotion-based music player, which is in a position to suggest songs supported the user's emotions; sad, happy, neutral and angry. The appliance receives either the user's pulse or facial image from a sensible band or mobile camera. It then uses the classification method to spot the user's emotion. This paper presents 2 sorts of the classification method; the guts rate-based and therefore the facial image-based methods. Then, the appliance returns songs which have an equivalent mood because the user's emotion. The experimental results show that the proposed approach is in a position to exactly classify the happy emotion because the guts rate range of this emotion is wide. [4] Authors says that, Digital audio is straightforward to record, play, process, and manage. Its ubiquity means devices for handling it are cheap, letting more people record and play music and speech. Additionally, the web has improved access to recorded audio. So,

the quantity of recorded music that folks own has rapidly increased. Most current audio players compress audio files and store them in internal memory. Because storage costs have consistently declined, the quantity of music which will be stored has rapidly increased. A player with 16 G bytes of memory can hold approximately 3,200 songs if each song is stored in compressed format and occupies 5 Mbytes. Effectively organizing such large volumes of music is difficult. People often listen repeatedly to a little number of favorite songs, while others remain unjustifiably neglected. We've developed Affection, an efficient system for managing music collections. Affection groups pieces of music that convey similar emotions and labels each group with a corresponding icon. These icons let listeners easily select music consistent with its emotional Content. Experiments have demonstrated Affection' effectiveness. [5] In this paper, a sensible music system is meant by recognizing the emotion using voice speech signal as an input.

The target of the speech emotion recognition (SER) system is to work out the state of emotion of a person's being's voice. This study recognizes five emotions-anger, anxiety, boredom, happiness and sadness. The important aspects in implementing this SER system includes the speech processing using the Berlin emotional database, then extracting suitable features and selecting appropriate pattern recognition or classifier methods to spot the emotional states. Once the emotion of the speech is recognized, the system platform automatically selects a bit of music as a cheer up strategy from the database of song playlist stored. The analysis results show that this SER system implemented over five emotions provides successful emotional classification performance of 76.31% using GMM model and an overall better accuracy of 81.57% with SVM model.

II. Motivation

It was observed in a cross-database experiment [1] that raw features worked best with Logistic Regression for testing RaFD (Radboud Faces Database) database and Mobile images dataset. The accuracy achieved was 66% and 36% respectively for both using CK+ dataset as a training set. The additional features (distance and area) reduced the accuracy of the experiment for SVM (Support Vector Machine) from 89%. The algorithm that had been implemented generalized the results from the training set to the testing set better than SVM and several other algorithms. An average accuracy of 86% was seen for RaFD database and 87% for CK+ database for cross-validation=5.The main focus was feature extraction and analysis of the machine algorithm on the dataset. But accurate face-detection algorithms become very important if there are multiple people in the image. One of the works [10] was tested by deriving expression from the live feed via the system's camera or any pre-existing image available in the memory. It has been implemented using Python 2.7, OpenCV and NumPy. The objective was to develop a system that can analyse the image and predict the expression of the person. The study proved that this procedure is workable and produces valid results.

III. Proposed System

A novel face emotion recognition system from video frames is proposed. Detection and recognition of emotion depends on the input video frames taken. The quality of the image is found using image quality metrics. Initially Face region is detected from the human face by an algorithm and skin color segmentation with RGB color space is used to extract the face skin and non-skin regions. After the segmentation, morphological operations are applied to extract the boundary of the non-skin regions namely eyes and mouth. Then the emotions are recognized by calculating the area of the mouth region. The proposed methodology involves; image acquisition, pre-processing, face detection, segmentation, and morphological processing and area calculation. Algorithm Convert video into frames, Read the input video frame image, Convert the image into grayscale image. Enhance the input image with median, wiener and Gaussian filters find the best filter based on PSNR, RMSE values. Apply viola-jones algorithm to detect the face region. Use bounding box method and crop the face region. Use threshold value to extract non skin regions. Apply morphological operations to extract continuous boundaries of non-skin region. Mask the boundary from the original image. Extract the mouth region. Area is calculated from extracted mouth region. Recognize facial emotions based on the value of area.

The system first checks for the presence of a face in the input using the face detection process, then classifies the input and generates an output which is an Emotion (mood) based on the expression extracted from the real time graphical input.

The main aim of this work is to play the music according to the emotion of the user, which is detected from the facial expression of the User. This is made possible by using 2 technologies: One is the machine learning algorithms which are used to detect the emotion of the user from their facial expression.

The other one is the web development tools for developing the UI or frontend of the music player.

The music player opens with an interactive UI and offers 3 modes for the user to select from Random mode, Emotion mode, Queue mode.

In Random mode the music is played randomly irrespective of the emotion. In queue mode, the music is played according to the playlist defined by the user. The main feature of the project is the emotion mode in which the music is played according to the emotion of the user. As soon as the user selects the emotion mode the algorithm accesses the device's camera and using the OpenCV library of python the image of the user is captured and sent to the algorithm for emotion analysis. an application that runs based on the idea that we can detect a person's mood based on the expression on his face.

Python a versatile programming language doesn't come pre-installed on your computer devices. Python was first released in the year 1991 and until today it is a very popular high-level programming language. Its style philosophy emphasizes code readability with its notable use of great whitespace. The object-oriented approach and language construct provided by Python enables programmers to write both clear and logical code for projects. This software does not come pre-packaged with Windows.

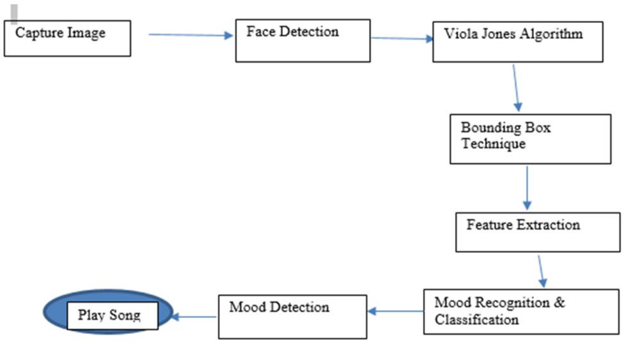

Figure:1 System Flow diagram

IV. CONCLUSION

In this paper, we have discussed that how our proposed system recommend music based on facial expression using machine learning algorithms. The proposed system is also scalable for recommending music based on facial expressions by using techniques after collecting data. The system is not having complex process to recommend music that the data like the existing system. Proposed system gives genuine and fast result than existing system. Here in this system we use machine learning algorithms to recommend music based on real time facial expression. Thisproposed system is developed with the help of a Machine learning module in Python Script. We haveused OpenCV, TensorFlow, Keras, Web Browser and of course Python Scripting to develop this automated system.

This will eventually help the person and calm the user mood appreciate to their wise choice that willhelp him to improve their mood. The songs will be played with a particular emotion playlist according to the emotion detected. The research done in the area of human psychology has proven that music has an intense effect on the listeners.

V. RESULT AND DISCUSSION

Below screen showing dataset details used to train above algorithms

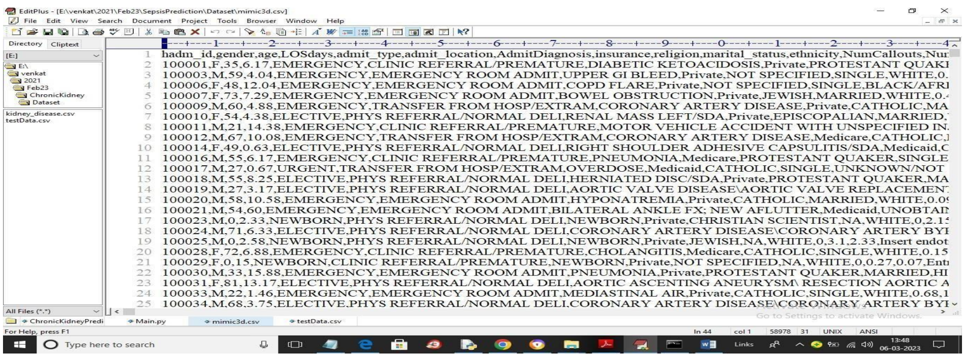

Figure:2 MIMIC-III Dataset

In above dataset screen first row contains column names and remaining rows contains datasetvalues and from above dataset we are using Hospital Expired column as Target Value. We have coded this project using JUPYTER notebook and below are the code and outputscreens with blue colour comments.

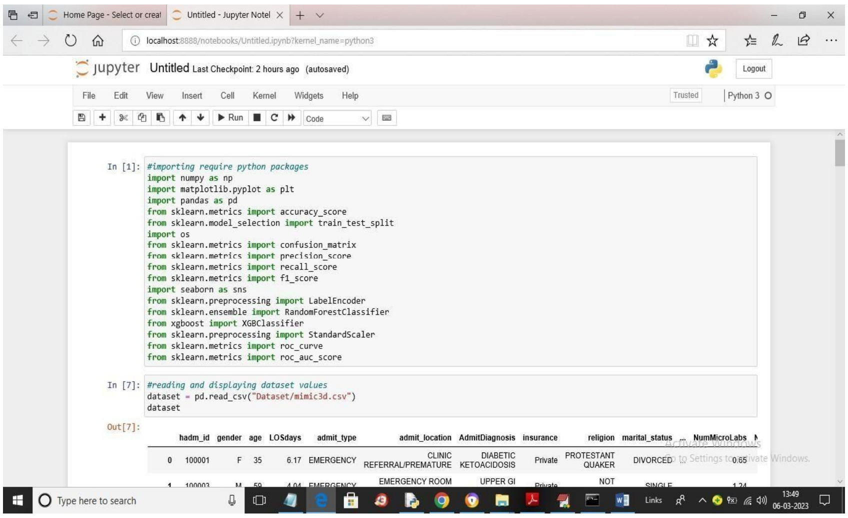

Figure 3: Importing Python Packages

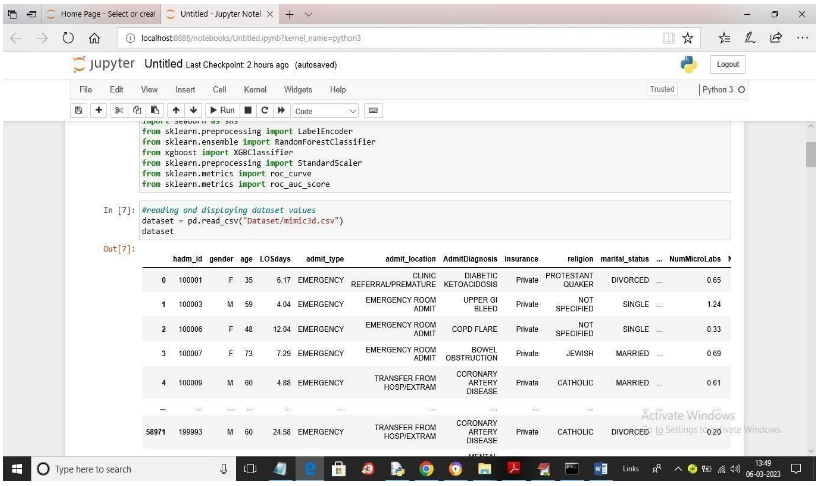

Figure 4 : Reading and displaying dataset values

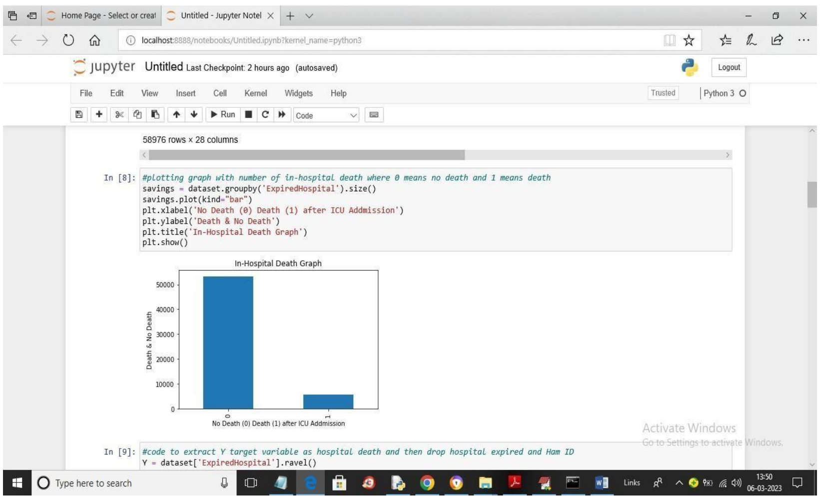

Figure 5 : In-Hospital Death Graph

In above screen finding and plotting graph of ‘No-Death & in-hospital death’ where 0 meansno death and 1 means death which is in X-axis and death count in y-axis.

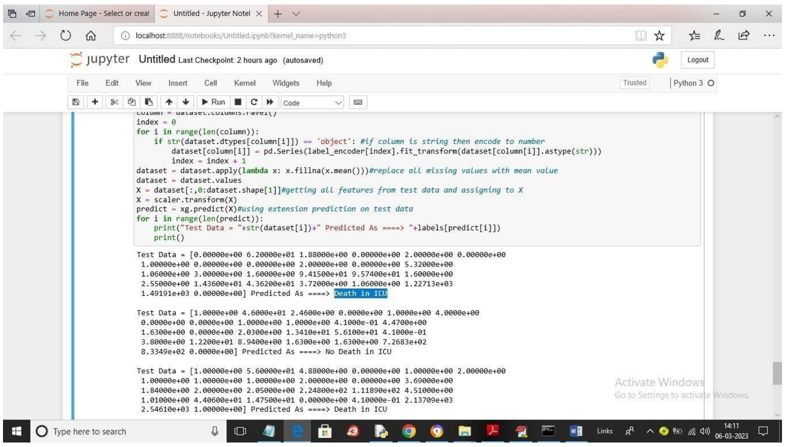

Fig 6: Predicting death

In above screen we are reading test data and then predicting death or no death and in above screen in square bracket we can see test values and after arrow symbol =□ we can see predictedvalues as ‘Death in ICU’ or ‘No Death in ICU’.

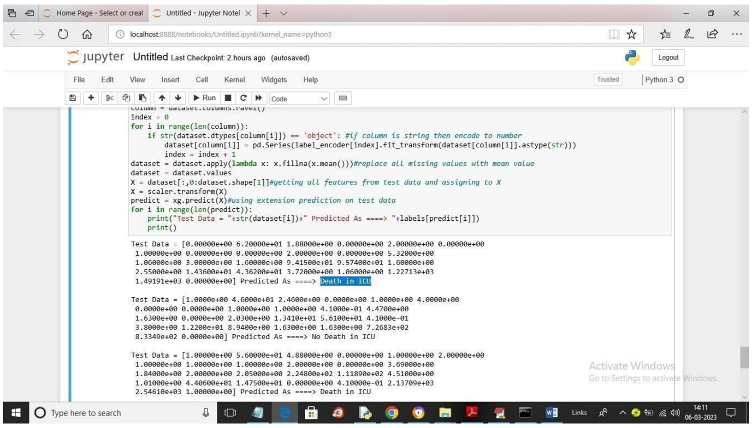

Fig 6: Predicting death

In above screen we are reading test data and then predicting death or no death and in above screen in square bracket we can see test values and after arrow symbol =➔ we can see predictedvalues as ‘Death in ICU’ or ‘No Death in ICU’.

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Analysis of Pollution Level Near Mining Area using Neural Network

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***Abstract*— The curve fitting analysis is performed on time-stamped signal values. Then a situational analysis graphical user interface (GUI) is developed to analyze the data which is from a mining area. The resulting waveform plots and the designed GUI are presented. The data is from the mining area namely Singrauli. Five environmental parameters related to pollution, namely CO, SO_2, PM10, PM2.5, and Ozone are considered for the analysis using neural network.**

***Index Terms*— curve fitting, CO, environmental parameters, graphical user interface, mining, neural network, ozone, pollution, SO_2 , situational analysis**

I. Introduction

The environment pollution control is of paramount importance in the CO analysis of atmospheric conditions. The sad demise of several workers in the city of New Delhi due to carbon monoxide CO inhalation during the year 2019, has led to believe the significance of this study. The measurement and analysis of atmospheric conditions of hazardous industrial environments are very important for the safety of personnel. Safety will be compromised if these pollutants are not monitored in and around hazardous industries.

II. Literature Survey

The global dispersals of CO are presented by Barret et.al. [1] and deliberated with the assistance of simulations. Additional air pollutants emanated comprise SO2 and NO2 produced from the furnace and drying procedures. SO2 is produced from the sulfur composites in the combusted fuel. The burning of coal in revolving cement kilns produces NO2 from the nitrogen in the coal and incoming ignition.

Detecting air pollution from space can observe drifts and deviations of atmospheric toxins affecting human health. The detection of air pollution over the cities, with satellites, has the challenge of low CO sensitivity of measurements [2].

There seems to be a risk of exceeding of health-related exposure levels caused by the current ambient and environmental levels of CO in Milan [3].

The possibility of using satellite images to measure contaminants in natural conditions and large urban areas and even countries are explored. The use of this information helps to reduce the costs and labor compared with land-based techniques. The convenience of satellite services in the terrain helps in reducing the cost of air pollution checks using satellite imagery [5]. CO discharges from vehicles, petrol, and diesel generators, show a concentration of carbon monoxide that is highly contaminated. It is good to stay away from these sources. CO will be emitted into the atmosphere when fossil fuels are used to run the vehicles and generators whereby the unsafe condition prevails [6].

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For comparison, CO concentrations were measured over continental areas in Brazil. Much larger values have been found in moderate 'burning' regions, such as the south of the state of Mato Grosso and the north-western part of the state of Parana, where 200 ppb in the dry season has been observed. Since normally the air masses have traveled for several days over the ocean, the air masses over the site present low chemical activity. Daily variations of CO_2 are very small of the order of a few percent relative to the diurnal mean [7].
The environmental impact of drilling equipment is determined in a surface coal mining operation. The approach used in this paper allowed the determination of exhaust and dust emissions, and sound pressure level. Modeling of the environmental impact of the equipment was conducted using the Microsoft Visual Studio.NET software package [8].
Kasibhatla P, and Arellano, 2002 [9] had a study that emissions of CO from fuel use in China, a country that accounts for a significant fraction of total Asian emissions and where there has been a rapid growth in the industrial and transportation sectors are estimated to have increased by only 16 Tg year between 1990 and 1995 due to almost no change in the relatively large biofuel combustion source. Thus, it is also unlikely that a significant portion of the discrepancy between the top-down and bottom-up estimates in Asia can be explained by growth in Asian CO emissions from 1990 to 1994.
Sarwa et al., 2017 showed the lung performance of non-coal personnel was better than the of coal personnel [10]. The authors recommend further study with regards to this work.

III. Methodology

A. Neural Network Curve Fitting, Time series analysis, and Situation analysis

Curve fitting is the method of postulating the model that offers the finest fit to the particular curves in the data set. Curved correlations between variables are not as easy to fit and understand as a linear relationship.
For linear relationships, when the independent variable is advanced by one unit, the average of the dependent variable changes by a definite amount.
Prediction can be a linear combination of different features as indicated in equation (1)

$$\hat{y} = \omega_1 . x_1 + ... + \omega_d . x_d + \beta \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Considering the input data values x and the target value $\hat{y}$, one can find a weight vector ω and bias term β that nearly associates data values x_i with their targets $\hat{y}$. Mathematically, we can denote the predictions y corresponding to a set of data points x using matrix notation as in equation (2). Equation (3) is used to measure the quality of the model.

$$\hat{y} = x.\omega + \beta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$E(y, \hat{y}) = \sum_{i}^{n} (\hat{y}_i - y_i)^2 \ldots\ldots\ldots\ldots (3)$$

For example, for the value $x_i = \{0.5, 0.6, 0.45, 0.9, ...\}$, equations (4) and (5) could be written.

$$y_1 = 0.5\, x_1 + \beta \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

$$y_2 = 0.6\, x_2 + \beta \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Square Loss: For a one-directional vector, one can determine the relationship between the one feature and the target value. It is also possible to determine a linear predictor and its error. The squared loss penalizes outer data points.
Manipulating the model: To reduce the error, one has to alter the model. This is achieved by choosing values of the parameters ω and β. For example, for 0.0504 as the value for ω_i, 0.858 for β, 0.77 for target, the y value is obtained as in equation (6)

$$0.90 = 0.0504 * 0.77 + 0.858 \ldots\ldots\ldots\ldots\ldots (6)$$

1) Neural Network

For linear models, the simplest possible useful neural network is to determine the output of the model by multiplying the input with the model's weight ω and the offset β is added.
Training the model makes it better throughout a period of training. To find out if the goal has been reached or not, the squared distance between the prediction and the true value is calculated.

2) Curved relationship

The data may have curved relationships among variables. In a curved relationship, the alteration in the dependent variable associated with a single unit change in the independent variable varies based on the position in the observation space. The curve fitting figure is to obtain a mathematical representation that fits the data. Each row in the input data ‘x’ comprises sensor data and the rows in the ‘y’ comprise the target value. For a given point, a linear combination yields a prediction that is close to the target value. The curve fit finds the parameters with which the correlation between the function and the data is as close as possible.

The data set x could be the multi-dimensional input array if more than one feature is chosen, and the y matrix should be of the same length as that of matrix x.

The dataset, which is obtained for the air pollution, the curve fitting structure Figure is developed for 2150 samples of carbon monoxide, 2150 samples of SO_2, 2150 samples of PM10, 1008 samples of PM2.5, and 1008 samples of ozone for the year 2019 and 2018

B. Time series analysis and prediction

To forecast upcoming values of a time series p(t) (equation (7)), from previous values of that time series and previous values of another time series q(t) is called non-linear auto-regression with external input.

$$p(t) = f(p(t+1) \ldots p(t-d), q(t-1), q(t-d)) \ldots\ldots\ldots\ldots\ldots..(7)$$

The neural network structure used for the mining environment of Singrauli (which is in Madhya Pradesh, India), for all the five parameters, is shown in Figure. The hidden layer comprises 10 neurons. The step ahead analysis can be performed using this network.

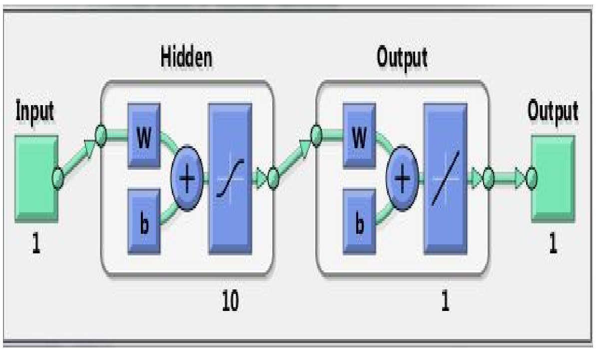

Fig. 1. Neural network structure

The prediction is performed with 300 hidden units which provides root mean square error (RMSE) and the prediction plots. The closed-loop structure for the analysis is indicated in Fig. 1.

C. Graphical User Interface

MATLAB Guide is used to develop the graphical user interface (GUI). The different UI controls used for the applications are pushbuttons, UI editable text, UI static text, Frames, and axis. The ‘Guide’ is composed of the Guide Control Panel and supporting tool, guide property editor. The GUI figure window is created using Guide and the various UI objects are fine-tuned and are automatically connected to the callback handling function when saved.

The five parameter plots are analyzed in a designed graphical user interface (GUI) and the analysis push buttons will analyze the parameters.

The carbon monoxide (CO), Sulfur dioxide (SO_2), PM10, PM2.5, and Ozone data are analyzed for the data of Singrauli of Madhya Pradesh state.

Another GUI is developed to analyze the data and to check if the data value exceeds the standards and how many times it crosses the threshold. In this GUI, the push button callback is connected to the different analysis programs.

D. Performance Evaluation of Situational Awareness Platform in Mining Industry

The software data analytics is used to analyze the five parameters. The sensor data for the five parameters CO, SO_2, PM10, PM2.5, and Ozone were collected from the Central Pollution Control Board (CPCB) website (CPCB, 2018) making use of an advanced search method for Singrauli where open cast mine is located For Singrauli, data were collected both for the year 2018 and 2019. The data from Bangalore city is taken as the target data as the CO and SO_2 are within the limit set by Indian standards.

The standard set by CPCB is used to compare the measured data with the standards.

The five parameters namely CO, SO2, PM10, PM2.5, and Ozone are plotted using the designed GUI.
Then parameters were analyzed using the curve fitting method which gives the curve fitting error and time series analysis gives regression analysis result. By this, the data clustering, as well as regression analysis, are performed and abnormalities observed. Finally, the GUI is designed for five parameter analysis which gives the number of samples that are exceeding the standards.

IV. Performance Evaluation of Situational Awareness Platform in Mining Industry

The neural network curve fitting is used to check the abnormalities in the data. Using this method, the curve fitting analysis is performed on the different data.
The curve fitting analysis for Ozone produces the plot as in Fig.2. This plot is taken as a sample of curve fitting analysis.

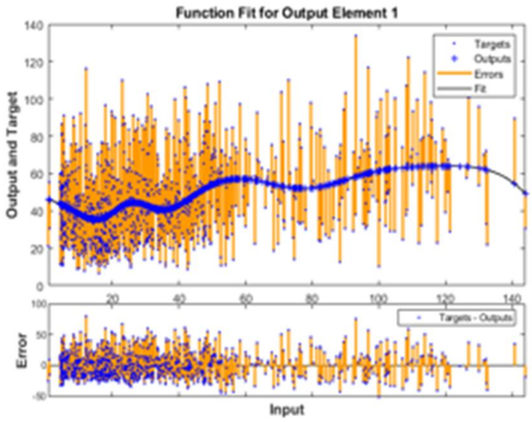

Fig.2. Ozone curve fit

From this figure, one can observe that the Ozone is gradually increasing over time. All the instances of parameters exceeding the standard values are listed in Table I.
The comparison between the 2018 and 2019 situation for Singrauli is indicated in Table.1. There is an increase in SO2 level from the year 2018 to the year 2019. The PM10 parameter remained high during both these years, while PM2.5 remained marginally high during these two years.

Table I. Air Quality As Measured For Singrauli

S N	Year	2018	2019
1	Co Exceedance	1	1
2	So_2 Exceedance	4	98
3	Pm10 Exceedance	283	240
4	Pm2.5 Exceedance	26	25
5	Ozone Exceedance	0	1

A. Regression Analysis

From the regression graph in Fig.2 one can see the errors and deviation of the data from normal data like measured data for Bangalore which gives the value of 0.46 for ‘m’, the value of 0.57 for ‘b’, and the value of 0.6729 for correlation coefficient ‘R’. This plot is shown as one sample of the regression plots obtained. For all the parameters, the regression values are listed in Table 1.2 for the year 2018-19. If the regression value is higher, the data will be even closer to the target value.
From the Table, the variation in CO and Ozone are within normal variation, but error points are higher for SO2, PM10, and PM2.5.

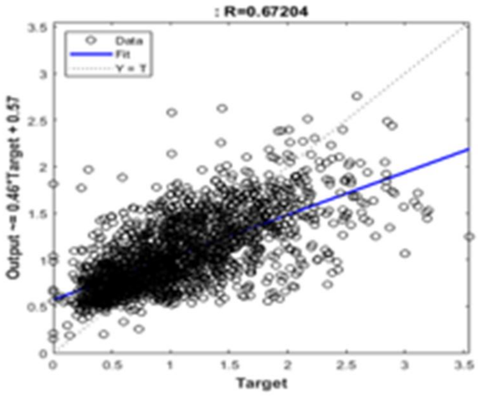

Fig.3. Regression plot

B. Result Table for Singrauli

The correction coefficient or regression R is listed in Table II for the year 2018 to 2019. Comparing the data with data from Bengaluru, the table of regression Table III is obtained.

TABLE II. REGRESSION R FOR SINGRAULI FOR 2018-19

SN	Parameter	m	b	r
1	CO	0.46	0.57	0.67
2	SO2	0.36	13	0.6005
3	PM10	0.57	86	0.7575
4	PM2.5	0.67	29	0.8188
5	Ozone	0.36	17	0.589

When the regression R values are compared from the two tables, one can observe that the second table has higher regression values. This will indicate that some of the parameters are increasing both in the mine area and city area of the country.

TABLE III. REGRESSION R FOR SINGRAULI FOR 2019

SN	Parameter	m	b	r
1	CO	0.51	0.23	0.7139
2	SO2	0.6	18	0.769
3	PM10	0.8	17	0.8925
4	PM2.5	0.7	8.9	0.85
5	Ozone	0.58	19	0.759

C. Situation Awareness for Singrauli

The GUI gives output specifying that the parameter has exceeded the standard and how many times it has crossed the standard. The situation analysis performed on the Singrauli data using the developed GUI results in Fig. 4 for the year 2019.

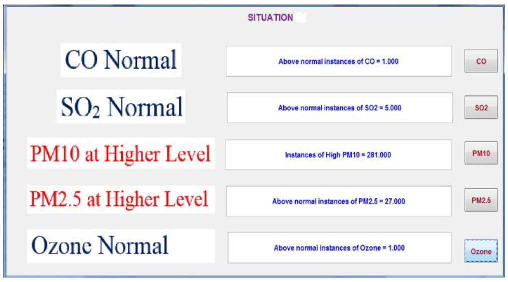

Fig.4.Situation analysis performed on the Singrauli

The neural network-based data analytics is used to perform the analysis on the environmental parameters. The different techniques like Curve fitting, Time-series, and Regression analysis are used to perform the analysis on the environmental parameters like CO, SO2, PM10, PM2.5, and Ozone. The curve fitting method will provide the errors and the trend. One trend observed is that the Ozone is gradually increasing. All the parameters are listed in the table form. The time-series analysis is used for the regression.

The regression analysis by the time series has provided better results for the correlation coefficient or regression R. All the regression values are listed in the table form.

The Graphical user interface is developed. A GUI developed analyzes the data vector and gives the situation as output by comparing it with the standards. The real data from the CPCB website is used to analyze the situation of the air quality. This GUI can be used to analyze any other parameters related to mining.

From the data analytics used, there is a pollution of both SO2 and PM surrounding the Singrauli area. One could observe that there is worsening of SO2 pollution level from the year 2018 to 2019 in the Singrauli area. There is no much difference in pollution levels of CO, PM2.5, and Ozone from the year 2018 to the year 2019.

Surprisingly, the regression fit is better when Singrauli data is compared with city data for the same year compared to the previous year's data. This will conclude that some of the parameters are increasing both in the city and in the mining site.

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Clustering of Crime Data using Haversine K-means Clustering Algorithm

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***Abstract*— In this world, the rate of crimes is increasing as well as challenging the capabilities of people who are investigating crimes. Proper crime analysis and clustering has to be done in those cases. Crime analysis is the analysis of crime patterns and trends. It also assists in the research and planning necessary for the functioning of tactical forces and administrative services. Crime data grouping and clustering is very important to analyse the crime patterns and trends. By identifying patterns of crime committed in the past and the most common types of crime, crimes can be prevented from recurring in an area. Machine learning plays a key role in efficiently clustering today's crime data.**

***Index Terms*— BIRCH, CLARA, Haversine K-means, K-means, K-medoid.**

I. INTRODUCTION

There is a wide variety of criminal activity taking place around the world today. It is essential to examine the traits and patterns of these criminal behaviors and spot potential correlations between them. Criminal activity is naturally concentrated in a few locations illegally organized by criminals, who engage in the most illegal activities in order to make money as profit. In the current scenario, offenders are becoming more technologically advanced in criminal activities, and the challenge for police and intelligence departments is the difficulty of assessing large quantities of data regarding criminal and terrorist activities. Thus, authorities must be aware of techniques to apprehend criminals and gain the upper hand in the perpetual competition between evildoers and law enforcement [1]. In such cases, crime analysis plays an important role in an efficient manner.

The main purpose of crime analysis is to catch criminals. The next goal is to prevent or curtail crime. The third is to reduce social turmoil. The ultimate goal is to assist in the development and evaluation of organizational procedures.

Crime analysis techniques are the techniques used to handle the crime data set in various situations. One of the most important crime analysis techniques is clustering techniques using machine learning.

Machine learning is a technology that enables computers to make decisions without any human intervention. This machine learning-based crime analysis requires data collection, sorting, pattern identification, forecasting and visualization. Algorithms based on machine learning have demonstrated their utility and effectiveness on various types of datasets and can acquire and make predictions with great accuracy.

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II. PROPOSED METHODOLOGY

Clustering is an unsupervised task that doesn't require prior knowledge by discovering groups of correlated documents [2]. This paper deals with the crime data using Haversine k-means clustering by geo-location and it is compared with k-medoid clustering, BIRCH clustering, CLARA and k-means algorithms with result parameters as clustering time.

The work is implemented on PyCharm IDE using Python language. The data is collected from the Github website and the dataset used is the Sanfrancisco crime dataset during the year 2016 and it contains 150501 records. Each entry has 13 featured attributes and they are- IncidntNum, Category, Descript, DayOfWeek, Date, Time, PdDistrict, Resolution, Address, X, Y, Location, PdId.

```
Attribute Extraction
====================
Total no. of Attributes : 13

Attributes are
--------------
['IncidntNum', 'Category', 'Descript', 'DayOfWeek', 'Date', 'Time', 'PdDistrict', 'Resolution',
'Address', 'X', 'Y', 'Location', 'PdId']

Attribute Extraction was done successfully...
```

Figure 1. Attribute extraction

Then, the data is grouped based on district and category. On district based grouping, there are 10 districts in the dataset.

```
District based Grouping
--------------------------
Districts in the dataset:{'NORTHERN', 'PARK', 'MISSION', 'TARAVAL', 'RICHMOND', 'BAYVIEW',
'SOUTHERN', 'TENDERLOIN', 'INGLESIDE', 'CENTRAL'}

Number of Districts in the dataset:10

District Based Data Grouping was done successfully...
```

Figure 2. District based grouping

On category-based grouping, there are 32 categories in the dataset.

```
Category based Grouping
---------------------
Categories in the dataset:{'FORGERY/COUNTERFEITING', 'PROSTITUTION', 'WARRANTS', 'DISORDERLY
CONDUCT', 'SEX OFFENSES, FORCIBLE', 'STOLEN PROPERTY', 'RUNAWAY', 'VANDALISM', 'DRIVING UNDER THE
INFLUENCE', 'BURGLARY', 'VEHICLE THEFT', 'ASSAULT', 'WEAPON LAWS', 'LARCENY/THEFT', 'EMBEZZLEMENT',
'MISSING PERSON', 'BRIBERY', 'TRESPASS', 'SUSPICIOUS OCC', 'DRUNKENNESS', 'KIDNAPPING', 'SECONDARY
CODES', 'DRUG/NARCOTIC', 'ARSON', 'SEX OFFENSES, NON FORCIBLE', 'NON-CRIMINAL', 'FRAUD', 'OTHER
OFFENSES', 'RECOVERED VEHICLE', 'ROBBERY', 'GAMBLING', 'FAMILY OFFENSES'}

Number of Categories in the dataset:32

Category Based Data Grouping was done successfully...
```

Figure 3. Category based grouping

After data grouping, clustering is performed using Haversine k-means clustering algorithm using geo-location.

A. K-Means Clustering Using Haversine Distance

K-means clustering is a technique for categorizing n observations into k different groups. Every observation belongs to the cluster with the nearest mean.

Longitude and latitude are used to calculate the distance between two objects. Haversine is an algorithm that computes the distance between two points on a sphere; the method is now refined with a straightforward formula. By utilizing a computer, this formula provides a very precise level of accuracy between the two objects [7].

Haversine distance is an appropriate distance metric on a spherical surface. This is the angular distance between two points on the sphere. The first coordinate of each point is taken as latitude and the second coordinate is taken as longitude, specified in radians. The data dimension must be 2.

$$D(x, y) = 2arcsin\left[\sqrt{sin^2((x1 - y1)/2) + cos(x1)cos(y1)sin^2((x2 - y2)/2)}\right] \quad (1)$$

The clustering time of this proposed algorithm is 36015ms. This algorithm is used to improve the clustering accuracy of the data by geo-location. Fig 4. shows the graph of clustering using Haversine k-means algorithm.

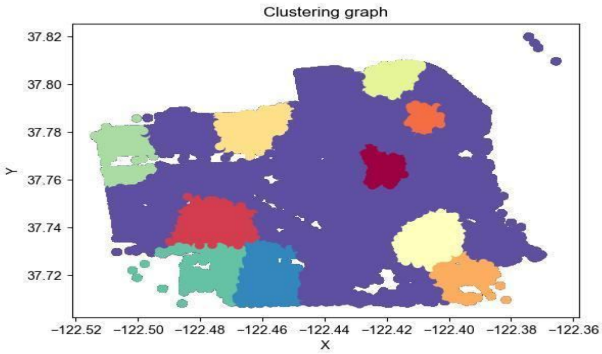

Figure 4. Clustering graph

B. Efficiency Checking Using Other Algorithms

a. K-medoid Algorithm

This is a classical cluster splitting method that divides a dataset of n objects into k clusters. Assume that it is known a priori. The medoid of a cluster is defined as the object in the cluster with the lowest average dissimilarity of all objects in the cluster, that is the most central point in the cluster. It is more robust to outliers and noise than k-means.

Algorithm:-

1. Initialization: select k random points from n data points as medoid.
2. Map each data point to its nearest medoid using one of the common distance metric measures.
3. If the cost decreases: For each medoid m, for each non-medoid data point o:

- Swap m and o, connect each data point to the nearest medoid, and recalculate the cost.
- Undo the swap, if the total cost is higher than the previous step.

K-medoid works by finding the midpoint of existing data without performing averaging like K-means [4].
The clustering time of this k- medoid algorithm on clustering the Sanfrancisco crime dataset is 60004 ms.

b. BIRCH Algorithm

Balanced Iterative Reducing and Clustering using Hierarchies (BIRCH) is a method of decreasing big datasets by forming diminutive and compressed summaries of the large datasets that keep the most amount of information. This summary is then grouped instead of the original large dataset.
This method is based on the CF (clustering features) tree which is represented by three numbers:

- N: The number of elements in the subcluster.
- LS: The vector sum of data points.
- SS: The sum of squared data points.

The BIRCH algorithm has three parameters:

- *Threshold*- It is the maximum number of samples to be considered in the leaf nodes of the CF tree.
- *Branching factor*- It is the factor that shows how many CF sub- clusters a node can create.
- *N_clusters*- It is the number of clusters and is 8.

BIRCH's favorable position is its ability to cluster a growing dataset within a dataset, displaying multi-dimensional metric information and providing high-quality clustering for specific asset placements (memory and time imperatives) [5].
The clustering time of this BIRCH algorithm on clustering the Sanfrancisco crime dataset is 53003 ms.

c. CLARA Algorithm

CLARA (Clustering LARge Applications) is an extension of k-medoid. It takes only random samples of the input data (rather than the entire dataset) and computes the optimal medoid on those samples. Therefore, it performs better than k-medoid on crowded datasets.

Algorithm:-

- Randomly choose many fixed-sized collections from the original dataset.
- Calculate the k-medoid method for each subset and pick the related k symbol objects (medoids). Allocate each observation from the dataset to the nearest medoid.
- Determine the mean (or sum) of the dissimilarities of an observation to its closest medoid, which is used as a way to assess clustering quality.
- Save the subset with the least average (or total). Further assessment is done on the concluding partition.

In CLARA, medoids are used as their center points for a cluster, and the rest of the observations in a cluster are near to that center point [6].

The clustering time of this CLARA algorithm on clustering the Sanfrancisco crime dataset is 49006 ms.

d. K-Means Algorithm

K-means clustering is a type of unsupervised machine learning that segments datasets that are unlabeled into distinct clusters. In other words, it is a process that takes an unlabeled dataset and breaks it into k different clusters, with each dataset belonging to one group that has similar properties.

Algorithm:-

- Choose k clusters as the first step.
- Select a set of K instances as cluster centers.
- Each instance is assigned to the closest cluster by the algorithm.
- After all the instances are assigned a new cycle or after each instance is assigned, the cluster centroids are recalculated.
- This process is repeated [3].

The complexity of the k-means algorithm is O(tkn), which is relatively time-efficient since it involves n instances, c clusters, and t iterations. However, this method is prone to ending up with a local optimum. Since the mean must be predefined and c, the number of clusters must be specified in advance.

The clustering time of this k-means algorithm on clustering the Sanfrancisco crime dataset is 43001ms.

Fig 5. shows the comparison of Haversine K-means with other algorithms.

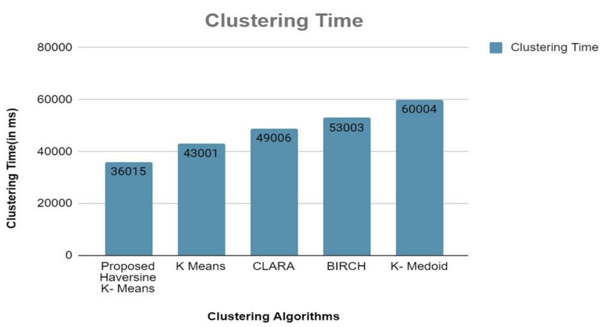

Figure 5. Comparison of algorithms

From the study, Haversine K- means algorithm is considered as a very convenient approach for making patterns and trends on the dataset as compared with other clustering algorithms such as k-medoids, BIRCH, CLARA and k-means algorithms.

The proposed work uses the Haversine -K-means algorithm to cluster the data by geo-location. Here, Haversine distance is used with the K-means algorithm to improve the clustering accuracy of the data.

III. Conclusion

In this paper, the crime data of Sanfrancisco is clustered using the Haversine K-means algorithm by geo-location and the clustering is done very efficiently with a lesser clustering time of 36015ms. It has been proven to be more accurate compared to other algorithms such as k-medoid, BIRCH, CLARA and k-means. Efficient clustering using geo-location helps law enforcement investigators and authorities better understand and predict crime.

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Smart Blind Stick

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***Abstract*— A smart stick with an external camera and a Convolutional Neural Network (CNN) algorithm helps visually impaired people navigate their environment more autonomously. Users are able to more easily and confidently traverse their environment on their own because to the system's ability to recognise items in front of them and offer audio output to identify them. A Raspberry Pi computer, the Tensor Flow library, the Coco Dataset, and a Pi camera are used to perform the suggested fix. With a quick response time, minimal power consumption, and a lightweight, foldable form that is simple for users to handle and use, the smart stick is made with the user in mind. The proposed approach could, in general, considerably enhance the standard of living of individuals who are blind by boosting their mobility and autonomy. The smart stick's external camera takes pictures of the things the user is looking at, which are subsequently processed using the CNN algorithm. This algorithm can identify many items, including people, automobiles, and barriers, and it can voice-output the information to the user so they can recognise it. This makes it easier for users to move around and avoid potential dangers. The camera's photos can be processed effectively uses of the by using the Coco Dataset, which increases the algorithm's precision in detecting and classifying various objects.**

***Index Terms*— Convolutional Neural Networks, Image Recognition, Coco Dataset, Image Classification.**

I. INTRODUCTION

A. Object Detection

Object identification, is process of image processing and computer vision of image, involves identifying specific objects or features within digital images and videos. This technology is used in a wide range of applications, including image finding and motion surveillance. One of the most well-researched areas of object detecting is object and face detection. By identifying people and faces in the images and videos. Computer vision algorithms can be used to analyze the behaviour of human, track movements, and recognize individuals.

B. Image Captioning

Image captioning, also known as image tagging. A key method utilised in both computer vision and natural language processing is image tagging. It entails giving each image a descriptive tag that perfectly expresses the visual information. Image tagging is essential for a number of applications, such as content-based image search, object detection, and image retrieval. It entails creating a textual description of a picture, like a screenshot or a photograph, that accurately represents the image's context and content. This task is difficult because the model must comprehend the visual characteristics, semantic linkages, and linguistic patterns of the natural language used

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to describe the objects, scenes, and actions in the image

C. Convolutional Neural Networks

A Deep Learning method used for picture categorization and detection tasks is called a convolutional neural network. In general, they provide weight to different features of the image, i.e., detect patterns, and can tell one image from another. In comparison to traditional Deep learning algorithms, CNNs require a great deal less pre-processing. CNNs can learn any type of image with enough practise and refinement. The configuration of neurons in the human brain closely resembles that of a convolutional neural network.

II. LITERATURE SURVEY

A. Real-Time Object Detection for Visually Challenged People – 2021 IEEE Access

In order to navigate, communicate, and obtain information in our daily lives, the sense of sight is essential. Unfortunately, there are millions of people who are visually impaired, which can make it challenging for them to carry out daily activities securely and independently. By warning blind people of items in their way, a suggested study seeks to solve this problem by transforming the visual world into an auditory one. They will be able to go on their own without assistance from outside sources thanks to this. The study will make use of a tool that recognises things in the field of view of the camera using machine learning and image processing.

B. A Smart Voice-Enabled Blind Stick with An Emergency Trigger - 2020 IEEE Access

Blind or partially sighted people occasionally struggle with transportation safety and frequently require assistance from others to complete even the most basic tasks. We propose a solution to this issue in the form of a system. Our technique uses ultrasonic sensors to detect obstacles and infrared sensors to detect raised surfaces like stairs. We also have a panic button for sending crisis signals to predetermined emergency contacts, as well as ISD1820 for verbal alerts when barriers are met.

C. Smart Electronic Stick for Visually Impaired using Android Application and Google's Cloud Vision -2019 IEEE Access 7 Journal [4]

Blind people encounter several difficulties in their daily lives, such as mobility and orientation issues. Simple sticks have always been the go-to tool for blind people to help them navigate their surroundings, but they might not always be enough to accomplish daily tasks on their own. However, a voice-activated Android software and an e-stick module have been developed as a potential remedy. In order to keep the traditional stick's lightweight and manageable construction, our method aims to provide a simple, affordable alternative.

D. Embedded Real-Time Object Detection and Measurement of its Size – 2018 IEEE Access

In a number of industrial industries, real-time object recognition and dimensioning have gained importance. The use of computer vision technologies is essential in overcoming these difficulties. In this study, a better method for quickly measuring and classifying objects from video streams is suggested. The method measures objects in real-time from video using Open CV libraries, a complex edge recognition algorithm, as well as erosion and dilation methods. Four processes are involved in the procedure: detecting and sorting contours, locating the object to be measured using a sophisticated edge detection approach, filling in the gaps between edges using morphological operators like erosion and dilation procedures, and measuring the object's dimensions. Real-time object detection and dimensioning, which are essential in many applications, can be solved with this technology in an efficient and effective way.

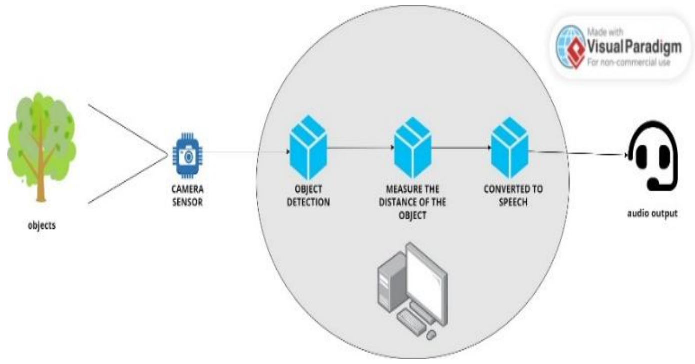
E. Moving object detection and tracking Using Convolutional Neural Networks – 2018 IEEE Access

Object tracking and object detection are two common steps in computer vision systems. While object tracking might be problematic when items are hidden by other objects, strong object detection can be difficult owing to fluctuations in situations.

This study suggests a method that uses the Tensor Flow object detection API to recognise moving objects in order to get around these challenges. An object tracking technique is used to determine the location of an object after it has been discovered. Even in difficult situations like low lighting or occlusion, a new CNN-based object tracking technique is used to achieve precise object detection. This method may produce self-generated visual sequences that can be applied in a variety of ways across multiple sectors.

III. System Architecture

The user data will be pre-processed before being entered into the algorithm to ensure accurate predictions. This could entail scaling the image, pixel value normalisation, and other data cleaning procedures.



ARCHITECTURE

Fig 1 System Architecture

A. Webcam or Any Camera Image Capturing Module:

The Webcam or Any Camera Image Capturing Module forms the fundamental interface between the system and the physical environment. This module harnesses the capabilities of the OpenCV library in Python to interact with the device's camera, be it a webcam or any other camera source. Users enjoy the flexibility to initiate image capture manually or set the module to operate automatically at predefined intervals, accommodating diverse user preferences and scenarios. The module's significance extends beyond mere image capture; it excels in image processing. Captured images undergo a sequence of transformations and analyses to extract crucial details about the object of interest, encompassing attributes like size, shape, and location within the frame. This extracted information serves as the bedrock for further analysis, where various approaches can be applied to gain deeper insights into the object's characteristics. The outcome of this image processing is versatile, with applications spanning from object localization and tracking to categorization and anomaly detection, empowering visually impaired individuals with real-time environmental awareness.

B. Image to Speech Converter

The Image to Speech Converter module stands as a pivotal component in bridging the gap between visual information and auditory output, catering to individuals with vision impairments. The process commences with meticulous image analysis, as the captured image undergoes scrutiny to identify and extract relevant text or objects, employing advanced image processing techniques, with OpenCV at its core. Once the necessary textual information is extracted, it is seamlessly relayed to the Pyttsx text-to-speech engine. Pyttsx, a robust Python utility, is responsible for the conversion of extracted text into audible speech. Users benefit from personalization options, allowing them to fine-tune their auditory experience by adjusting parameters such as speech pace, volume, and voice type through Pyttsx's configuration settings. This module translates visual data into a format comprehensible to those with visual impairments, granting them access to and interaction with visual content in a whole new dimension. Crucially, developers retain the flexibility to tailor the text-to-speech engine to meet specific user preferences, ensuring a uniquely customized experience for each individual.

C. Training Module

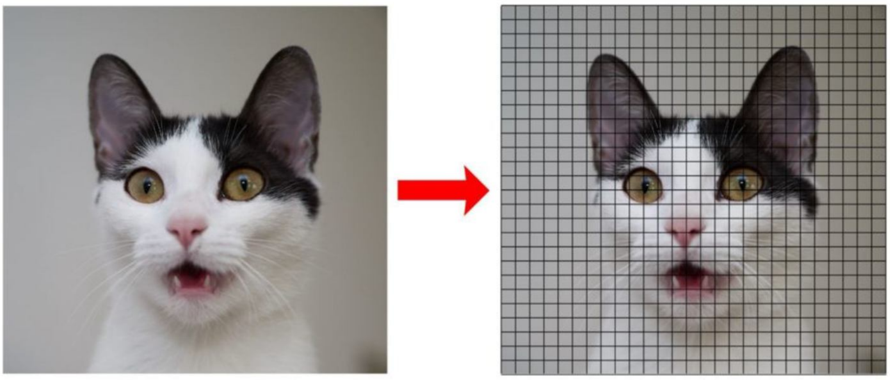
The Training Module resides at the core of the system's proficiency in recognizing and interpreting objects within images. Embracing Convolutional Neural Networks (CNNs) as the primary modeling technique, this component is chosen due to its prowess in handling image data and overcoming issues like overfitting and subpar test set accuracy. To train the CNN model effectively, pixel data from images is meticulously converted into numerical representations, facilitated by an image data generator. This data preprocessing step is pivotal, ensuring the model receives meaningful input. The initial model training employs a conventional CNN architecture with specific attributes, including three layers, 64 convolutions, and an activation layer, establishing a robust foundation. Further enhancements in accuracy are pursued through research and experimentation, which involves exploring pre-trained models such as Dense Net, VGG-16, Efficient Net, and InceptionV3. Importantly, these pre-trained models serve as a basis for fine-tuning the model's performance, without relying on pre-existing weights. Throughout the training process, the input data consists of pixel arrays, with labels corresponding to the associated filenames, thus enabling the model to learn the associations between visual information and specific objects or categories. The utilization of CNNs and pre-trained models substantially elevates the precision and effectiveness of object recognition within the system, empowering visually impaired individuals to navigate their environment with increased independence and confidence.

IV. WORKING

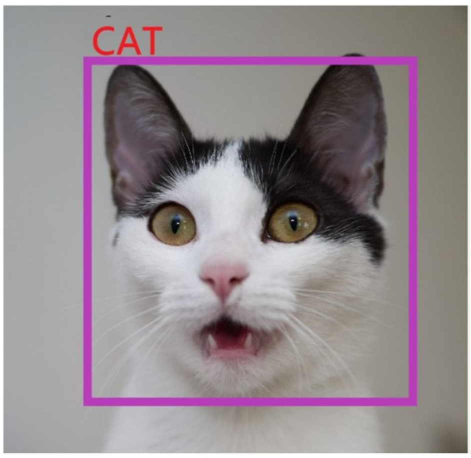
A. Working Of Object Detection

A computer vision technology called object detection makes it possible to recognise items in pictures and videos. To create object detection algorithms, there are two methods: pre-training and learning from scratch. Pre-trained models are frequently employed, and their weights are occasionally changed to satisfy certain specifications. Three phases are commonly involved in the object detecting process.

- The image is initially transformed into an array form. Each rectangle in the grid is checked to see if it contains a valid object before being extracted as a featured row or column.



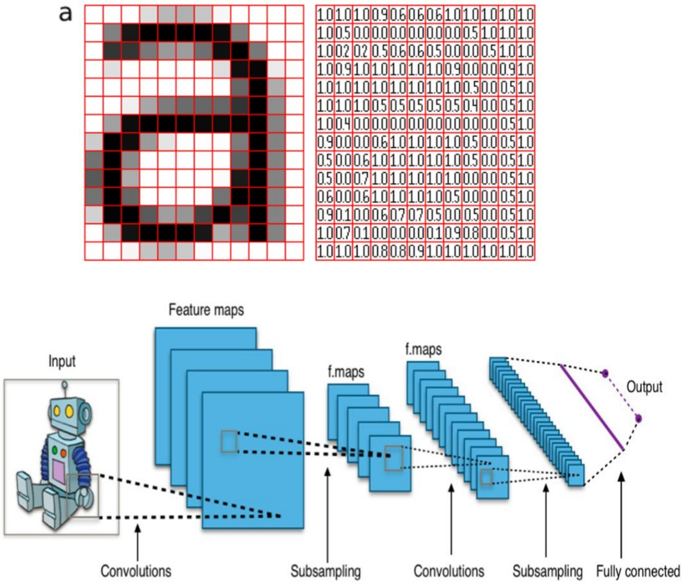
a)



b)

B. CNN (Convolutional Neural Networks)

In data processing, image analysis and recognition, image classification, and edge detection in visual data, convolutional neural networks are the neural network that are frequently employed. In a CNN, each layer of neurons applies a non-linear operation—a linear transformation—to the results of the layer before it. Convolutional and pooling layers are two examples of the several types of layers included in the CNN architecture. CNNs can efficiently detect numerous relationships in a picture by utilising filters. To ensure a deep learning algorithm works effectively, the complexity of the CNN architecture needs to be adequately addressed. In CNNs, convolution is mostly utilised to extract fine details from the image, such as edges. Multiple layers may be stacked on top of one another in CNNs. The first layer often records coarse data like edges, colours, and gradient direction. The architecture aids in the discovery of increasingly complex and high-level features as we delve further into the network, which is helpful for training our deep learning model.



B. Convolutional Layers

The filters that comprise a convolutional layer in a CNN are crucial, and their parameters must be learned. In comparison to the input volume, these filters are lighter and smaller in height. Each filter is convolved with the input volume in order to compute the activation map. As a result, a neural activity map is produced.The activation maps of all the filters are stacked to generate the convolutional layer's output volume. After that, the network's next layer receives this output volume for additional processing. The stacking of the activation maps enables the detection of intricate patterns in the image by capturing various input volume features.

C. Pooling Layers

A pooling layer is frequently inserted between two subsequent convolutional layers in CNNs to simplify and reduce the amount of parameters. With the help of the pooling layer, representation of previous convolutional layer is scaled down. A representation can be downscaled by the pooling layer using a variety of functions, including average or maximum pooling. However, because it works better in real-world situations, the max pooling function is more frequently utilised. Max pooling aids in preserving the most important aspects of the input volume while rejecting the less significant ones by taking the maximum value in a pooling region. As a result, the input volume can be represented in a way that is more effective and efficient for the network's next layer to handle.

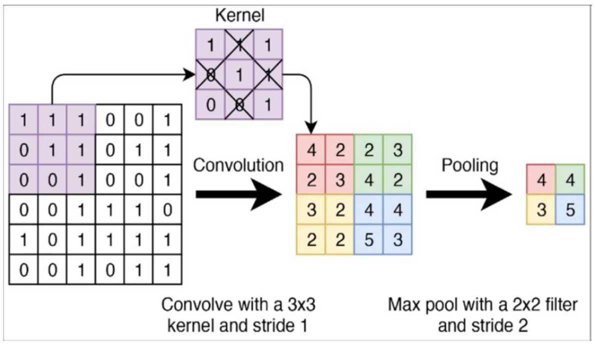
D. Fully Connected Layers

All of a layer's inputs are linked to the activation unit of the layer above them in a fully connected neural network. Dense layers refer to the final few levels of a completely linked network, where each layer of neurons is coupled to every other layer of neurons. In order to produce the final output, the network might then merge the data collected from earlier levels. Fully connected layers demand more calculation time than convolutional layers since there are many more parameters involved in the connections between the layers. Consequently, training a fully connected neural network may take longer and cost more money than training a CNN.

E. Receptive Field

The receptive field in a CNN refers to the particular region of the input space that affects a given network unit. Both an input to the network and an output from other network nodes are possible for this location. It is possible to determine the receptive field in relation to both the input we are considering and the receiving unit. In other words, we can identify the network feature maps that correlate to the size and location of the receptive field in the input space. The capacity of the network to detect and represent complex patterns and structures in the input data is strongly influenced by the size of the receptive field.

F. Weights

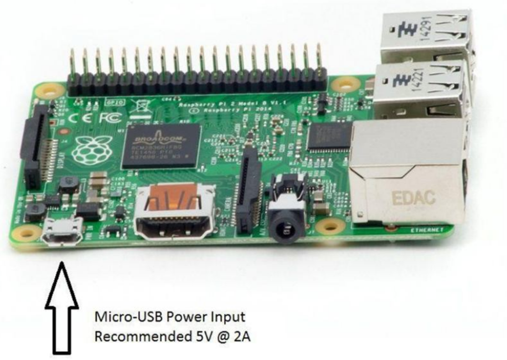


The neural network's weights are changed throughout the training phase to enhance the network's performance on a particular task. The importance of the input signal transmitted across a connection is determined by its weight. An input signal's significance is diminished when it is transferred through a link because it is multiplied by the relevant weight value. The next layer of the network then combines the combined input signals that have been altered, and so on until the final output is produced.

V. Hardware And Details

A. Raspberry PI

A well-liked and adaptable single-board computer around the size of a credit card is called the Raspberry Pi. Despite its diminutive size, it is a strong tool with a wide range of applications. It is simple to use for people of all technological levels because it can be connected to a computer display or TV and is operated with a standard keyboard and mouse. Low power consumption is one of the Raspberry Pi's main benefits. It uses a little amount of power, typically 5V @ 2A, making it an energy-efficient choice for a variety of uses. The Raspberry Pi is also intended to be inexpensive, with a variety of versions offered at varying price ranges to suit varied budgets.



(a)

B. Setup The Raspberry PI

Step1: Insert an SD card of desire size to the laptop
Step2: Then go and visit the official Raspberry Pi website and get the imager
Step3: Then using this Raspberry Pi imager software select the OS which is to
be installed on the SD card
Step4: Then select the SD card in which the OS is going to be installed
Step5: Then finally click on the write to download and install the OS to the SDcard.
Step6: Place SD card in Raspberry Pi's SD card port, then connect the charger to turn it on.
Step7: The Raspberry Pi will be booting into the OS.

C. Camera

The system's built-in camera module can record high-definition still photos and videos in addition to still images. A fixed-focus lens and an image sensor with a native resolution of five megapixels are included in the camera module. This makes it possible to record clear, detailed images, enabling exact and accurate item analysis and identification in the visualenvironment. As a whole, the camera module is an essential part of the system since it offers accurate and high-quality visual data for modelling and analysis.

(b)

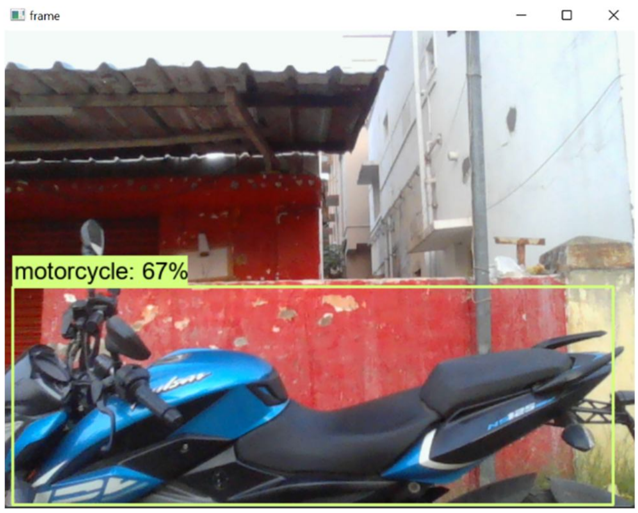
D. Speaker

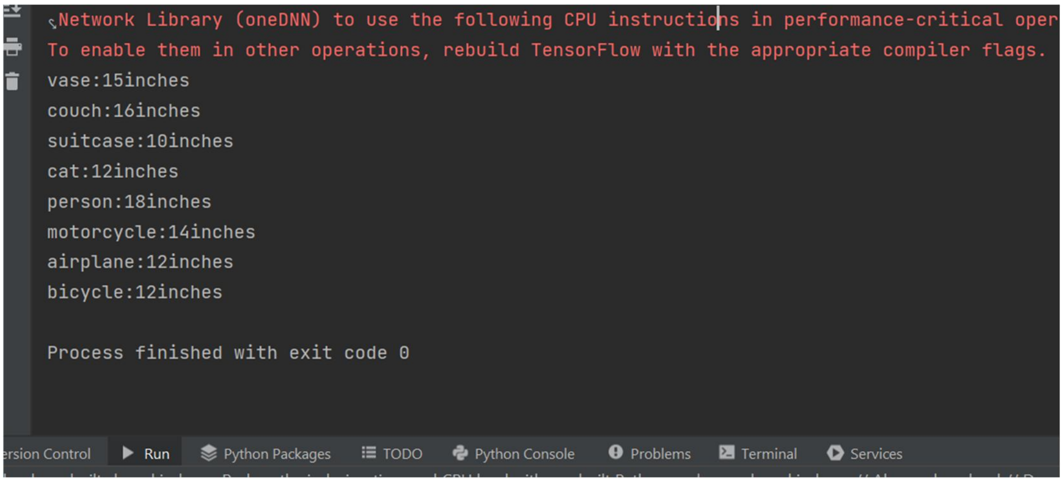
Speaker is an output device that gives audio as an output, mostly used with computers and phones to listen to the mp3 and other audio files.

E. Raspberry PI Speaker Connection

A Raspberry pi can be connected to the speaker in different ways like through the inbuilt Bluetooth , through the inbuilt audio jack or through the displays which has inbuilt speaker on them.

VI. Result





In the outcome of this project, an audio output system plays a pivotal role by providing detailed auditory information regarding objects positioned directly in front of the smart blind stick. This audio feedback is multifaceted in its utility; firstly, it serves as a real-time object detection mechanism, alerting users to the presence of obstacles, pedestrians, or other objects obstructing their path. Additionally, it goes a step further by offering distance measurements, allowing users to ascertain not only what's in front of them but how far away it is.
This feature is immensely empowering for individuals with visual impairments as it significantly bolsters their navigational capabilities. By using this audio feedback, they can make informed decisions about how to proceed, whether it involves adjusting their route, slowing down, or stopping altogether. The system becomes their virtual eyes, helping them explore their environment with a newfound sense of confidence and autonomy.
Furthermore, this functionality enables blind individuals to actively search for specific objects or landmarks, such as doors, staircases, or bus stops, enhancing their independence in daily life. The ability to precisely locate and identify objects in real-time provides a level of situational awareness that is transformative for the visually impaired. This project's output, therefore, represents a ground-breaking advancement in accessibility technology, offering a lifeline of information and independence to those who rely on it.

VII. Conclusion

Providing assistance to people with visual impairments is a significant difficulty in contemporary society, but recent technological developments are offering fresh approaches. A transportable model created to aid blind people in navigating and comprehending their surroundings is one such remedy. This device has the ability to recognise items in its environment, spell out their names, and provide details about their relationships. The project makes use of cutting-edge technology including computer vision, natural language processing, and natural language generation to complete these goals. In particular when compared to other boards on the market, using the Raspberry Pi as the main board for this project has shown to be a cost-effective and efficient alternative. This device's voice-activated technology, which enables users to activate the system with a straightforward keyword command, is a crucial feature. The device enters a standby state until the next activation after completing the intended task. People who are blind or visually handicapped will find this to be helpful and easy to use. Overall, this ground-breaking tool offers a straightforward and practical solution for people who are blind or visually impaired to better comprehend their environment and manage their surroundings more easily and independently.

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Performance Analysis & Evaluation of Wireless Sensor Network using LEACH & HEED

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***Abstract*— In Wireless sensor network (WSN) lifetime of sensors is a critical issue because the sensor nodes having limited power. Therefore, organization of nodes in a proper manner (clustering) becomes one of the major techniques to expand the lifetime and improve the throughput of the network. In this paper we propose a Hybrid Energy Efficient Distributed Protocol (HEED) for clustering in Sensor Network to improve the lifetime of network. The simulation result show that the propose scheme has higher network throughput in terms of higher data packets received than existing LEACH protocol.**

***Index Terms*— WSN, Cluster Head (CH), LEACH, Network Lifetime, Heterogeneity.**

I. INTRODUCTION

Day by day advancement in technology has brought the world really closer. Any information about any place in the entire world is accessible now. Wireless sensor network is one of the best approaches which give information about the remote areas. The network is made up of a number of small sensor nodes, working together to serve their desired purpose. The network of nodes can be either a homogeneous system or a heterogeneous system; based upon the initial energy of the nodes. In a homogeneous system all nodes have got same energy where as in a heterogeneous system a category of nodes have got different energy levels.

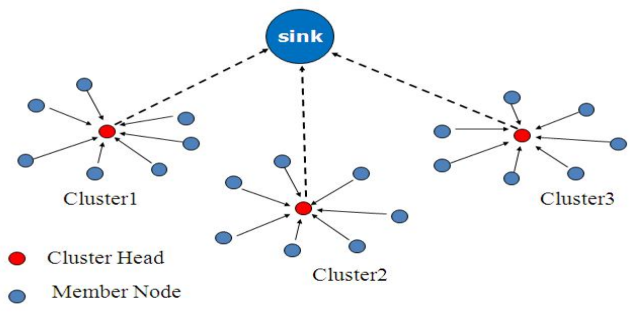

Fig.1. Clustering in wireless sensor network

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Today, WSN uses different technological advancements in low power communications and VLSI to support communications, sensing and processing. WSN are used in many applications like environmental monitoring, health care, and also defense related applications [1].
Clustering has been proved by past researches to be an efficient way of energy utilization. Various clustering algorithms have been proposed to support the above statement. At initial level, cluster heads are elected as shown in Fig. 1. Then the other nodes join the cluster of their nearest cluster head. Now for the cluster, the cluster head is responsible for collecting data from the other nodes, aggregate them, check for data redundancy and then this data is sent to the base station. This is considered to be an efficient method for transmission and reception because otherwise all nodes will be sending their data to the BS. This shall lead to redundancy as well as faster energy depletion of all the nodes. Now here, since only the cluster head is sending the data to the base station; the energy of the other member nodes is not used so much as compared to the head.

II. Related Work

In this paper a clustering-based protocol LEACH (Low-Energy Adaptive Clustering Hierarchy), has been proposed [1]. The operation of LEACH is achieved by rounds. Each round begins with a set-up phase (clusters are selected) followed by steady-state phase (data transmission to BS occurs)The node (n) decides by choosing a random number between 0 and 1 If this random number is less than T(n), the nodes become a CH for this round The threshold is set as follows.

$$T(n) = \begin{cases} \frac{P}{1-P*(r mod \frac{1}{P})} & if\ n \in G \\ 0 & else \end{cases} \quad (1)$$

Where, P = desired percentage of CHs, r = current round
G = set of nodes that have not been CHs in the last 1/P rounds
DEEC, PEGASIS, and SEP etc. The protocols like LEACH, DEEC and SEP have been compared, on the basis of different comparison parameters namely heterogeneity level, cluster stability, energy efficiency, cluster head selection criteria and network lifetime. The cluster head selection have been compared between the different protocols according to which CHs in LEACH protocol are selected periodically and energy drains periodically In DEEC, sensor nodes are independently elected as CHs based on initial and final energy [2]. The network following SEP deals with initial and residual energy for the cluster head selection [3]. It introduces the concept of normal and advanced nodes. In this paper the advanced nodes are given more priority over the other normal nodes to be the cluster heads more frequently as their energy level is more than the others.
In HEED (Hybrid Energy-Efficient Distributed clustering [4] cluster heads periodically selects according to a hybrid of the nodes, residual energy and a secondary parameter, for evaluating sensor networks lifetime is a key characteristic, however it has not a simple and general accept definition.
In [5] author proposed a centralized LEACH algorithm. In this approach nodes are automatic configure and make a clusters. Initially, every node transmit it residual energy and location related information base station, where this data is utilizes to formation the clusters. Many things are affect the life time of wireless sensor networks, such as residual energy of battery, routing algorithms.

III. Proposed Methodology

A.The Objectives of our research work can be pointed as below.

- To improve the performance of WSN with the help of Cluster head selection process
- Energy Optimization of Wireless Sensor Network.
- To enhance the life time of Wireless Sensor Network.

B. Proposed Algorithm

The objective of wireless sensor network is to increase the lifetime. Clustering (Structured approach) has been found to be an effective method for the lifetime improvement due to the implementation of data redundancy and data aggregation which is done at the cluster head selection for each cluster formed. Clustering is an important mechanism in large multi-hop wireless sensor networks for obtaining scalability, reducing energy consumption and achieving better network performance [6-12].
To maximize lifetime of the network Clustering is one of the efficient technique. We use advanced Hybrid Energy Efficient Distributed Protocol which uses efficient distance management system for inter/intra cluster

communication. Figure 2 shows the setup and steady state phase of proposed algorithm. Firstly, In setup phase formation of clusters are take place and then the cluster head being chosen on the basis of residual energy of node. In steady state phase data has been collected by CH and forwarded to Base Station (BS).

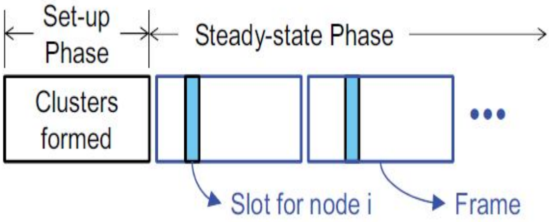

Fig. 2. Cluster formation and operation

IV. Simulation Results

In this simulation we assume the heterogeneous sensor network, where all the nodes are randomly distributed in the 100 X 100m^2 area as shown in fig. 3 The BS is assume at the centre of the topology. Minimum probability of cluster head selection is 0.0001 and initially the cluster head probability for all the nodes is 0.05. The simulation parameters are listed in Table 1. Residual energy of nodes with the increasing the number of round for LEACH algorithm is depicted in Fig. 4. Furthermore, Residual energy of nodes with respect to number of rounds for different sets of nodes like 25,50,100 is shown in Fig. 5. It shows that when the number of node increases the life time of network is also increases. Moreover, Fig. 6 is depicted the comparative analysis in between heed and leach in terms number of packets received by BS. Figure clearly shows that heed outperform the leach.

TABLE I. Simulation Parameters

Network Size	100mX100m
Initial Energy	0.5 J
Number of Round	100
Randomly deployed nodes	100
Size of Packet	4000 bits
ETX	50nJ/bit
RTX	50nJ/bit
Position of Sink node	(50,50)
Threshold distance, d_0	70 m
Cluster Radius	25 m

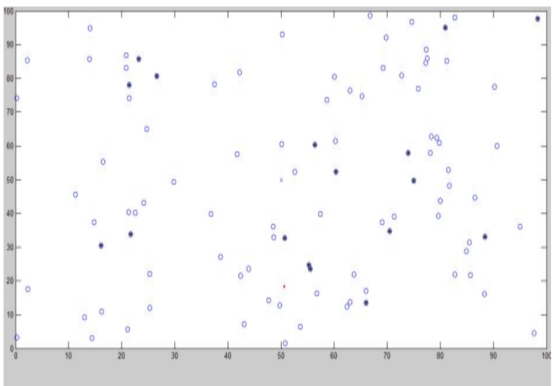

Fig.3. 100 nodes are randomly deployed

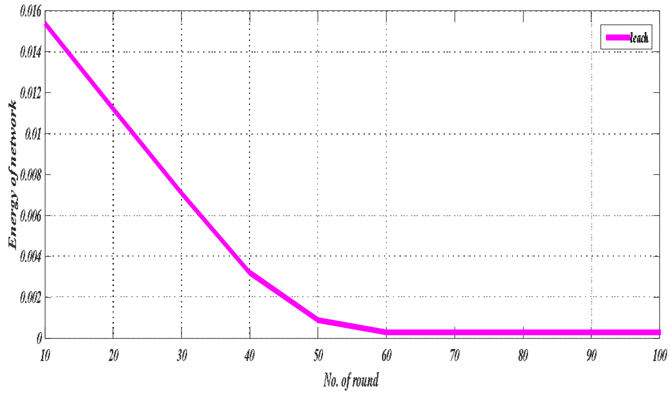

Fig. 4. Total Residual energy with respect to number round

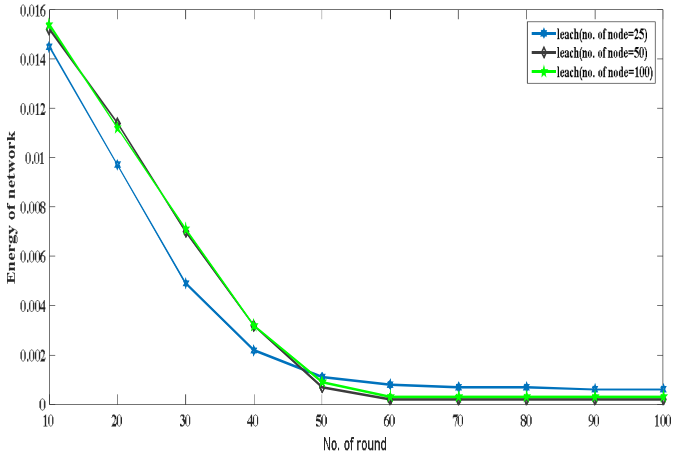

Fig. 5. Comparison of total residual energy on different number of node

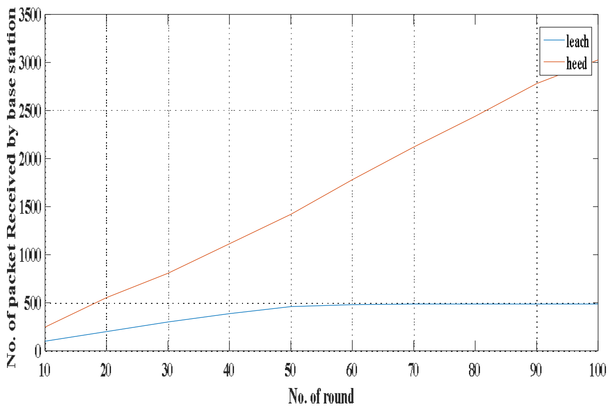

Fig. 6 Comparison of total residual energy on different number of node

V. Conclusion

The sensor nodes in WSN is deployed in hostile environment. Therefore, it is hard to maintain the network throughput and network lifetime in such a harsh environment. This paper proposed a improved Hybrid En-ergy Efficient Distributed Protocol (HEED) scheme for clustering wireless sensor network to improve the throughput of the WSN. The simulation result show that the proposed scheme has higher data packets re-ceived than existing LEACH protocol for the same number of round.

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Energy-Efficiency Optimization in IoT Networks: Algorithms, Techniques, and Case Studies

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***Abstract*— The exponential growth of Internet of Things (IoT) devices has resulted in an unparalleled surge in the need for energy-efficient strategies to guarantee the sustainability and durability of IoT networks. This study article provides a thorough examination of energy-efficiency optimization in Internet of Things (IoT) networks, with a specific emphasis on the creation of algorithms, methodologies, and empirical investigations. The article commences by providing an overview of the significant significance of energy efficiency in Internet of Things (IoT) networks and its direct influence on the lifetime of devices, scalability of networks, and environmental sustainability. This emphasizes the urgent need for inventive approaches to tackle the difficulties presented by resource-limited Internet of Things (IoT) devices. Subsequently, the present study undertakes an in-depth examination of existing methodologies and algorithms for optimizing energy efficiency in Internet of Things (IoT) networks. This paper presents a comprehensive examination of each category, including insights into their respective strengths, limits, and suitability for various Internet of Things (IoT) applications. This study presents innovative algorithms and strategies that are especially developed to improve energy efficiency in Internet of Things (IoT) networks. These advancements use cutting-edge technology such as machine learning, edge computing, and low-power device design. The paper provides comprehensive explanations of these methodologies, accompanied by simulations and performance assessments, to showcase their efficacy in attaining energy conservation while maintaining network dependability and service excellence. The case studies presented provide valuable perspectives on the practical use of energy-efficient technologies, demonstrating their effectiveness in reducing operating expenses, carbon emissions, and system downtime. Moreover, this study aims to discuss the many problems and unresolved research inquiries pertaining to energy-efficient Internet of Things (IoT) networks. The aforementioned points underscore the need for further investigation in several aspects, including scalability challenges, security implications, and standardization efforts. These areas of focus are crucial in order to foster the ongoing expansion and long-term viability of Internet of Things (IoT) ecosystems.**

Index Terms— **Energy-Efficiency, IoT Networks, Optimization, Algorithms, Techniques, Case Studies**

I. Introduction

The advent of the Internet of Things (IoT) has initiated a paradigm shift in connectedness, fundamentally altering our interactions with the environment and the entities included within it. The Internet of Things (IoT) has the potential to bring about significant transformations across many sectors, including smart cities, healthcare, agriculture, and industrial automation. This is achieved through facilitating the smooth interchange of data and

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automation between physical objects and the digital domain. Nevertheless, with the rapid proliferation of Internet of Things (IoT) devices, the matter of energy efficiency has surfaced as a crucial problem. The consideration of energy efficiency in IoT networks is not only a technical matter, but rather a fundamental need for ensuring the sustainability, scalability, and lifespan of these networks. Internet of Things (IoT) devices often function inside situations that have limited resources, such as restricted battery power or energy-harvesting technologies. Extending the longevity of the battery in these devices is important in order to mitigate expenses associated with maintenance and guarantee seamless functionality. In addition, energy-efficient Internet of Things (IoT) networks are in accordance with worldwide sustainability objectives, as they contribute to the reduction of carbon footprints and mitigate the environmental consequences associated with IoT implementations.

This research study extensively examines the complex domain of energy efficiency in Internet of Things (IoT) networks, investigating a diverse array of algorithms, methodologies, and empirical analyses. The objective of this study is to provide a thorough examination of the obstacles and potential advantages associated with the optimization of energy use in Internet of Things (IoT) ecosystems. The notion of the Internet of Things comprises a wide range of devices, spanning from minuscule sensors to large-scale industrial machines, all linked through a network backbone. These devices provide the collection and transmission of data, so allowing a wide variety of applications, including but not limited to smart thermostats, wearable gadgets, driverless cars, and precision agriculture. The potential social and economic advantages are substantial; yet, they are accompanied with a significant energy expenditure.

Internet of Things (IoT) devices are inherently intended to exhibit low-power consumption and energy efficiency. However, the extensive proliferation of these devices, along with their wide-ranging applications, presents significant obstacles. Numerous Internet of Things (IoT) devices are dependent on batteries, and the process of replacing or recharging these batteries might provide challenges in terms of feasibility or expenses, particularly in distant or hard-to-reach areas. Therefore, the optimization of energy usage in Internet of Things (IoT) networks has emerged as a significant and urgent issue. The efficiency of energy use is a pivotal element that has a direct influence on the operational effectiveness, financial implications, and long-term viability of Internet of Things (IoT) networks. There are many fundamental factors that highlight the need of energy efficiency in Internet of Things (IoT) networks: The extended lifespan of devices is a crucial consideration in several Internet of Things (IoT) applications, particularly those involving the deployment of devices in distant or challenging areas where maintenance poses significant difficulties or expenses. Energy-efficient gadgets have the capability to prolong their operating lifespans, hence reducing the need for frequent battery replacement or device service.

The scalability of Internet of Things (IoT) networks is anticipated to see exponential growth in the next years. The use of energy-efficient equipment and communication protocols is necessary in order to maintain the sustainability and cost-effectiveness of this expansion. The Internet of Things (IoT) have the potential to provide substantial environmental advantages by means of its applications in areas such as intelligent agriculture and energy management. Nevertheless, the advantages of IoT networks are compromised when they excessively consume energy. The implementation of energy-efficient Internet of Things (IoT) networks has the potential to effectively mitigate the environmental impact by reducing carbon emissions. Operational expenditures: The use of energy is a substantial financial burden for several Internet of Things (IoT) implementations. The optimization of energy use has the potential to result in significant financial savings during the lifespan of a network.The pursuit of energy-efficient Internet of Things (IoT) networks has stimulated a plethora of research and development endeavors. The current methodologies may be generally classified into three primary domains: Hardware-level optimizations primarily concentrate on the development of energy-efficient hardware components and sensors. The techniques included in this study are low-power microcontrollers, energy harvesting, and sophisticated power management systems.The communication protocols used by Internet of Things (IoT) devices include a range of wireless protocols, each exhibiting distinct energy characteristics. The optimization of communication protocols to minimize energy usage is of utmost importance. The used methodologies include duty cycling, adaptive data rates, and efficient routing algorithms.

The use of effective data management strategies has the potential to provide substantial reductions in energy usage via efficient data handling and processing. Various techniques used in this context including data compression, edge computing, and data aggregation. In the next parts of this article, we will examine each of these categories in detail, doing a comprehensive investigation of current methods and algorithms. Additionally, we will provide innovative methodologies that use new technologies to enhance energy efficiency in Internet of Things (IoT) networks. The primary objective of this research study is to provide a thorough and all-encompassing analysis of energy efficiency inside Internet of Things (IoT) networks. The following sections will provide an in-depth analysis of the algorithms and strategies currently used within each of the three aforementioned categories. In addition, we will provide empirical examples from many areas within the Internet of Things (IoT) to exemplify the pragmatic use of energy-efficient technologies. In addition, we will discuss the obstacles and unresolved research inquiries in this domain, highlighting the imperative of continuous investigation and advancement to guarantee the durability and dynamism of Internet of Things (IoT) networks.

II. Recent Works

In the domain of optimizing IoT networks, a number of recent studies have made noteworthy contributions, each with distinct areas of emphasis and limitations. The study conducted by Shambayati et al. (2019) focuses on the optimization of virtual closed-loop supply chains in situations of uncertainty, with a particular emphasis on the use of Internet of Things (IoT) technology. Nevertheless, the article exhibits a deficiency in thoroughly examining distinct uncertainty variables and their consequential effects on the optimization of supply chains.

The authors of the paper titled "Cluster Head Selection for the Internet of Things Using a Sandpiper Optimization Algorithm (SOA)" [2] provide a novel technique for selecting cluster heads. Although the method has potential, its performance might potentially differ under various network settings, necessitating a more comprehensive examination. The study conducted by Wang et al. [3] focuses on the optimization of energy usage in buildings within the context of the Internet of Things (IoT). Their research provides significant contributions to the understanding of sustainability. However, the research lacks a thorough examination of the scalability and generalizability of the offered methods. In their work, Wali Ullah Khan et al. [4] propose a joint optimization approach for enhancing the security of ambient backscatter communication in IoT networks that use NOMA technology. However, it is worth noting that the research falls short in providing a comprehensive analysis of possible security weaknesses and corresponding remedies. In this study, Reyazur Rashid Irshad et al. [5] provide a healthcare monitoring framework that incorporates Internet of Things (IoT) technology. This framework aims to enhance the early detection of lung cancer by the use of a deep convolutional neural network model, which is optimized using the Grey Wolf Optimization method. Nevertheless, it is suggested that the research should be enhanced by conducting a more comprehensive assessment of the accuracy and robustness of the model. The study conducted by Francesco Vista et al. [6] introduces a hybrid quantum-classical scheduling optimization approach for UAV-enabled IoT networks. However, it is worth noting that the research falls short in providing a thorough investigation of the applicability and limits of quantum computing in real-world IoT applications.

The study conducted by Abdullah Alajmi et al. [7] primarily addresses the topic of energy efficiency in IoT networks using NOMA via a semi-centralized optimization approach. However, it is suggested that the research might enhance its analysis by delving further into the aspects of network scalability and performance, particularly in relation to different traffic situations. In their study, Ismail Keshta et al. (8) provide a technique for energy-efficient indoor localization in the context of narrowband Internet of Things (IoT). However, the work does not provide sufficient experimental validation to evaluate the practicality and effectiveness of the suggested approach in real-world scenarios. In their study, Mesfer Al Duhayyim et al. [9] propose an artificial algae optimization technique combined with a deep belief network to identify ransomware in the Internet of Things (IoT) setting. However, further experimentation is required to evaluate the resilience of the ransomware detection model against emerging threats. These scholarly articles together provide valuable contributions to the developing subject of IoT network optimization. However, they also emphasize the need for more research to overcome the limitations identified in each study and improve the applicability of IoT solutions in many settings.S. Sebastin Antony Joe et al. [10] propose an IoT-based smart campus monitoring system based on an improved Chimp Optimization-Based Deep Belief Neural Network. While the study presents a promising concept for campus monitoring, it lacks a comprehensive assessment of the system's scalability and adaptability to various campus environments.Mohammed Aljebreen et al. [11] introduce a binary Chimp Optimization Algorithm with machine learning-based intrusion detection for secure IoT-assisted wireless sensor networks. While the intrusion detection approach shows potential, further evaluation is needed to determine its efficacy in identifying and mitigating emerging threats.

Zhi Ji et al. [12] focus on robust trajectory and resource optimization in UAV-enabled IoT networks under probabilistic Line-of-Sight (LoS) channels in the presence of jammers. The paper addresses a critical issue in UAV-enabled IoT networks but could benefit from a more extensive analysis of the impact of dynamic jamming scenarios on network performance. Mohamed Sofiane Batta et al. [13] present a clustering approach based on battery state-of-health prediction for lifetime optimization in IoT networks. However, the paper could benefit from a broader evaluation of the proposed clustering algorithm's performance in various IoT network configurations.Vinoth Kumar Krishnamoorthy et al. [14] propose an energy-saving optimization technique-based routing protocol for mobile ad-hoc networks in an IoT environment. While the paper offers an energy-efficient routing protocol, further validation is required to assess its performance and scalability under dynamic network conditions.Botao Zhu et al. [15] discuss UAV trajectory planning for Age of Information (AoI)-minimal data collection in UAV-aided IoT networks using

Transformer models. The paper presents an innovative approach but lacks a detailed examination of real-world constraints on UAV trajectories and data collection.

Qing Liu et al. [16] introduce an optimal scheduling method in IoT-fog-cloud networks using a combination of Aquila Optimizer and African Vultures Optimization. The proposed approach shows promise, but its effectiveness and scalability across various IoT-fog-cloud network scenarios require further investigation. Gerges Mansour Salama et al. [17] present a deep reinforcement learning-based algorithm for symbiotic radio IoT throughput optimization in 6G networks. While the study explores cutting-edge techniques, it needs further validation in complex 6G IoT environments to assess its real-world applicability. Debasmita Mishra et al. [18] propose a light gradient boosting machine with optimized hyperparameters for identifying malicious access in IoT networks. The study introduces an innovative approach to security, but additional experiments are needed to evaluate its performance across diverse IoT security scenarios.Kiseop Chung and Jin Taek Lim [19] investigate machine learning for relaying topology optimization in IoT networks with energy harvesting. The paper contributes to energy-efficient IoT networks, but further research is necessary to assess the algorithm's adaptability to different energy harvesting conditions and network topologies.

Saeed Javanmardi et al. [20] present a secure workflow scheduling approach for performance optimization in SDN-based IoT-Fog networks. While the study addresses security and performance issues, its practicality in real-world IoT-Fog scenarios needs comprehensive evaluation. Ammar Riadh Kairaldeen et al. [21] focus on peer-to-peer user identity verification time optimization in IoT blockchain networks. The paper introduces a relevant concept, but further research is needed to validate the proposed optimization methods in large-scale IoT blockchain networks.Taotao Zhao et al. [22] explore energy-efficient federated learning over cell-free IoT networks, modeling and optimizing this emerging paradigm. The study is promising, but its performance needs validation in various cell-free IoT network deployments.Mario Pons et al. [23] discuss the utilization of 5G technologies in IoT applications and highlight current limitations due to interference and network optimization difficulties. While the paper identifies crucial challenges, it would benefit from a deeper exploration of potential mitigation strategies for these limitations.

In summary, these papers collectively contribute to the expanding field of IoT network optimization, but each faces specific limitations or requires further validation to ensure their practicality and effectiveness in real-world IoT scenarios. Addressing these drawbacks will be essential for advancing the state of the art in IoT network optimization and ensuring the reliability and efficiency of IoT deployments across various domains.

III. IoT Network Formation Components

The advent of the Internet of Things (IoT) has brought about a paradigm shift in connection, revolutionizing our interactions with the surrounding environment and the many entities present within it. Internet of Things (IoT) networks play a crucial role in enabling the smooth and uninterrupted transmission of data across many devices and systems, therefore serving as the foundation of the ongoing digital transformation. The process of constructing and overseeing Internet of Things (IoT) networks is a multifaceted undertaking, with several essential elements that work together to facilitate the establishment of networks, connection, and operational capabilities. This comprehensive discourse will explore the fundamental components that comprise the core essence of IoT network establishment.

1. Sensors and devices are the fundamental components of an Internet of Things (IoT) network, responsible for the collection and transmission of data. The aforementioned devices include a diverse range of hardware, spanning from basic temperature sensors and motion detectors to sophisticated cameras, actuators, and wearables. Sensors serve as the sensory organs of the Internet of Things (IoT), facilitating the acquisition of data from the tangible environment. Devices may exhibit a wide spectrum of sizes and functionalities, including tiny, energy-supplied sensors as well as robust gateways and edge computing devices with the capacity to locally analyze data prior to transmitting it to the cloud. The selection of sensors and devices has a critical role in determining the network's capabilities, energy efficiency, and cost.

2. Connectivity Technologies: Internet of Things (IoT) networks depend on a variety of connectivity technologies in order to establish connections between devices and facilitate the transmission of data. These technologies may be classified into two basic categories: wired and wireless choices. Wired connections, such as Ethernet or Power over Ethernet (PoE), provide a high level of dependability and consistency. However, their applicability to various Internet of Things (IoT) applications may be limited owing to factors associated with mobility and infrastructure. In contrast, wireless technologies cover a diverse variety of possibilities, spanning from limited-range alternatives such as Bluetooth and Zigbee, to expansive cellular networks including 3G, 4G, and 5G, as well as long-range

solutions like LoRaWAN and satellite communications. The selection of connection technology is contingent upon several aspects, including but not limited to range, data rate, power consumption, and deployment site.

3. Protocols and communication standards play a crucial role in facilitating interoperability across devices and systems inside IoT networks. These standards regulate the manner in which data is packed, transferred, and received. Prominent Internet of Things (IoT) technologies include MQTT (Message Queuing Telemetry Transport), CoAP (Constrained Application Protocol), and HTTP (Hypertext Transfer Protocol). The selection of a protocol is contingent upon the particular demands of the Internet of Things (IoT) application, encompassing factors such as the magnitude of data, latency, and dependability. The selection of a protocol is significantly influenced by factors such as compatibility with pre-existing infrastructure and the consideration of security measures.

4. Network topology refers to the configuration and interconnection of devices inside a network, which determines the manner in which they interact with one another. Internet of Things (IoT) networks may exhibit several topologies, including star, mesh, bus, and hybrid systems. The selection of network architecture is contingent upon several aspects, including but not limited to scalability, reliability, and power consumption. Mesh networks, exemplified by their ability to provide redundancy via several channels, are well-suited for extensive implementations. On the other hand, star topologies, characterized by their simplified administration, are often used in home automation configurations.

5. Edge Computing: Edge computing is a fundamental element of Internet of Things (IoT) networks, whereby data is processed in close proximity to its origin, as opposed to being sent to a centralized cloud server for analysis. This methodology decreases the time delay, preserves network capacity, and improves the ability to make immediate decisions. Edge devices and gateways, which are equipped with computational capabilities such as microcontrollers, GPUs, or FPGAs, facilitate the preprocessing and filtering of data prior to transmitting pertinent information to the cloud for further analysis. Edge computing is of significant importance in applications that need minimal delay and prompt response, such as autonomous cars and industrial automation.

6. Cloud Infrastructure: Cloud infrastructure is often used in IoT networks for the purpose of storing, managing, and analyzing huge quantities of data. Cloud systems provide a range of benefits, including the capacity to scale resources, ensure redundancy, and use advanced data analytics capabilities. Data gathered from Internet of Things (IoT) devices is transported to cloud infrastructure for the purposes of storage and processing. Cloud-based solutions provide many advantages, including the ability to remotely control devices, update software, and see data. Prominent cloud service providers, such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud, provide specialized services tailored to cater to the varied requirements of Internet of Things (IoT) applications.

7. Measures for Ensuring Security: The implementation of robust security protocols is of utmost importance in safeguarding IoT networks, given the inherent susceptibilities that arise from the interconnectivity of many devices. Robust security measures include a range of essential components, such as device authentication, encryption, access control, and periodic software upgrades. Security certificates and identity management are essential components in the maintenance of network integrity, since they are responsible for the verification and authorization of devices seeking access to the network. Furthermore, the implementation of intrusion detection systems and the establishment of comprehensive security policies are important in order to effectively mitigate the risks posed by cyber-attacks and prevent unauthorized access to sensitive data.

8. In the field of data management and analytics, it is important to acknowledge that the data produced by Internet of Things (IoT) devices may be extensive in volume and varied in kind. Efficient data management and analytics play a crucial role in extracting important insights and facilitating decision-making processes. Internet of Things (IoT) data platforms often include databases, data lakes, and data warehouses as components for the purpose of effectively storing and managing data. Advanced analytics techniques, such as machine learning and artificial intelligence, are used to extract significant patterns and make predictions from Internet of Things (IoT) data. This facilitates the implementation of preemptive measures and automation.

9. Power management is a significant challenge in the context of IoT devices, especially when considering their deployment in remote or hard-to-reach areas. Power management strategies include several techniques aimed at optimizing energy consumption in electronic systems. These strategies encompass energy-efficient hardware design, use of low-power modes, implementation of energy harvesting methods such as solar or kinetic energy, and effective battery management. The selection of a power source and the implementation of power management strategies are contingent upon the energy demands of the device, the conditions in which it operates, and the practicality of maintenance.

The concepts of scalability and standards are of significant importance in several academic fields. Scalability refers to the capacity of a system, process, or organization to handle an increasing workload or accommodate growth without compromising its performance or Compliance: The architecture of IoT networks should prioritize scalability to effectively handle future expansion and evolving demands. The smooth integration of new devices and technologies in IoT networks is guaranteed by adherence to industry standards and interoperability rules. The adherence to standards also facilitates the process of device certification and regulatory compliance. The establishment of Internet of Things (IoT) networks is a complex undertaking that encompasses a diverse array of elements, technologies, and factors to be taken into account. The effectiveness of IoT network architecture is contingent upon meticulous strategic deliberation and the seamless amalgamation of these constituents in order to cater to the unique requirements of each IoT application. In order to fully harness the potential of the Internet of Things (IoT) in many domains such as smart cities, healthcare, agriculture, and industrial automation, it is essential to be updated on the evolving IoT landscape and be knowledgeable about developing technologies and optimal network formation strategies.

IV. Optimization Techniques For IoT Network

The Internet of Things (IoT) has emerged as a transformative technology, enabling the interconnection of various devices and systems. However, the efficient operation and optimal performance of IoT networks pose significant challenges. This paper aims to explore and discuss several optimization techniques that may be used to enhance the efficiency and performance of IoT networks. The optimization of IoT The emergence of Internet of Things (IoT) networks has had a transformational impact, facilitating the connection of many objects and systems to collect data, facilitate automation, and improve decision-making processes. Nevertheless, the exponential expansion of the Internet of Things (IoT) has concurrently presented intricate obstacles pertaining to the optimization of network efficiency, allocation of resources, and scalability. Optimization approaches assume a crucial role in effectively tackling the aforementioned difficulties, hence guaranteeing the efficient, secure, and optimum functioning of IoT networks. This extensive discourse examines the importance of optimization in Internet of Things (IoT) networks and delves into a range of strategies that are essential for achieving their success.

A. Challenges in IoT Network Optimization:

1. *Energy Efficiency*: The concept of energy efficiency refers to the ability to achieve a desired level of energy output or service while minimizing the amount of energy input. A significant number of Internet of Things (IoT) devices operate on battery power or use energy harvesting methods. Maximizing energy efficiency is crucial in order to prolong the lifetime of devices and save maintenance expenses.
2. *Scalability:* The expansion of IoT networks necessitates the ability to handle an increasing number of devices and data flows. The use of scalable optimization strategies is important in order to effectively manage the heightened intricacy and growing requirements.
3. *Security***:** Internet of Things (IoT) networks are susceptible to many forms of cyber threats and assaults. The enhancement of network security necessitates the utilization of optimization methodologies, including authentication, encryption, and intrusion detection.

B. Optimization Techniques for Internet of Things (IoT) Networks:

One area of research in the field of networking is energy-efficient routing. Routing algorithms that have been tuned for energy efficiency have the potential to significantly decrease the power consumption of Internet of Things (IoT) devices. This is achieved by strategically picking pathways for data transmission that prioritize energy-efficient options. Methods such as geographic routing and duty cycling are often used in order to mitigate energy consumption.

- Machine Learning and Artificial Intelligence (AI) are two interconnected fields that have gained significant attention in recent years. Machine Learning refers to the ability of computer systems to learn and improve from experience without being explicitly programmed. AI, on the other hand, encompasses the Machine learning and artificial intelligence are used to evaluate substantial quantities of Internet of Things (IoT) data and facilitate instantaneous decision-making. Machine learning is of utmost importance in several domains such as predictive maintenance, anomaly detection, and optimization of resource allocation.
- Edge computing refers to the decentralized approach of processing and analyzing data at or near the source of its generation, rather than relying on a centralized cloud infrastructure. This paradigm shift allows Edge computing involves the relocation of computational processes and data storage in close proximity to the data source, hence mitigating the need of transmitting data to remote cloud servers. The use of optimization techniques at the edge of the network facilitates the achievement of accelerated response times and mitigated network congestion.
- Network topology optimization refers to the process of improving the structure and configuration of a network in order to enhance its performance and efficiency. The choice of a suitable network topology, such as mesh,

star, or hybrid, may have a substantial influence on network performance. Topology optimization strategies take into account many characteristics like as dependability, latency, and power consumption in order to ascertain the optimal configuration of devices.

- One important aspect in the management of Internet of Things (IoT) applications is the consideration of Quality of Service (QoS) needs. Optimization strategies are used to distribute resources, such as bandwidth and computing power, in order to fulfill specified objectives, while also assuring optimal usage of resources.
- Internet of Things (IoT) networks need the implementation of strong security measures in order to safeguard against potential cyber attacks. Optimization strategies primarily emphasize the use of cryptographic algorithms, access control mechanisms, and security rules in order to ensure the protection of data and devices inside the Internet of Things (IoT) ecosystem.
- The topic of data compression and aggregation is being addressed in this discussion. In order to mitigate the impact of data transmission overhead, several approaches such as data compression and aggregation are used. These strategies aim to maximize the efficiency of data transmission over a network, resulting in reduced bandwidth use and energy conservation.
- Dynamic Spectrum Management (DSM) is a concept that pertains to the efficient allocation and use of the radio frequency spectrum. It involves the dynamic allocation of spectrum resources based on real-time demand and usage patterns. In situations where numerous Internet of Things (IoT) networks coexist inside a shared spectrum, the use of dynamic spectrum management techniques becomes crucial. This approach aims to optimize the allocation of frequencies, with the primary objective of minimizing interference and enhancing the overall performance of the networks involved.
- Load balancing methods are used to equally distribute data traffic across network nodes in order to reduce congestion and optimize resource consumption, hence improving network performance.

The topic of resource allocation and scheduling is of significant importance in several fields. Efficient functioning of IoT networks necessitates the optimization of resource allocation, including processing power and bandwidth. Scheduling algorithms are designed to distribute resources in accordance with priority and demand.

C. Real-World Applications of Optimization Techniques

Optimization methodologies are used to effectively administer and allocate energy inside smart grids, hence mitigating power dissipation and diminishing expenditures.

- Precision Agriculture involves the use of Internet of Things (IoT) sensors and optimization algorithms to effectively monitor and manage soil conditions, weather patterns, and crop health. This approach facilitates accurate irrigation and efficient allocation of resources.
- Smart cities refer to urban areas that use advanced technologies and data-driven solutions to enhance the quality of life for their residents. These cities leverage several digital innovations, such as Internet Optimization techniques are used in smart city applications to effectively regulate traffic flow, minimize energy usage in street lighting, and bolster public safety through video analytics.
- Optimization methods play a crucial role in several aspects of healthcare, including remote patient monitoring, resource allocation in hospitals, and the efficient transmission of essential medical data.
- Industrial Internet of Things (IIoT) refers to the integration of internet-connected devices and systems in industrial settings. Optimization plays a crucial role in industrial settings, particularly in relation to predictive maintenance, manufacturing line efficiency, and supply chain management.

In summary, optimization strategies play a crucial role in ensuring the effectiveness of IoT networks by effectively tackling the diverse range of difficulties they encounter. The use of sophisticated optimization techniques, in conjunction with upcoming technologies such as 5G and edge computing, will have a significant impact on harnessing the complete capabilities of the Internet of Things (IoT) across diverse sectors, as the IoT landscape continues to develop. The use of efficient optimization techniques not only improves the efficiency of networks, but also leads to cost reduction, promotes environmental sustainability, and facilitates the development of novel Internet of Things (IoT) applications that increase quality of life and drive economic growth.

V. Simulation Results And Discussions

The section under "Simulation Results and Discussions" plays a crucial role in validating the suggested algorithms and strategies for optimizing energy efficiency in IoT networks. It provides a comprehensive examination of the empirical data, bringing valuable insights into the practical effectiveness and consequences of these methods. Within this part, we want to provide a thorough examination of the results obtained from our simulations. We will engage in an in-depth analysis, focusing on the performance metrics, the intricacies of different situations, and the implications derived from our findings. By conducting rigorous analysis and engaging in evidence-based discussions, our objective is to uncover significant trends, evaluate the effectiveness of our methodologies, and provide light on the future direction in our pursuit of energy-efficient Internet of Things (IoT) networks.

A. Experimental Setup

In the experimental setup, we designed a diverse range of scenarios to rigorously evaluate the energy-efficiency optimization algorithms and techniques proposed in this study. We employed various types of IoT devices, including sensor nodes, actuators, edge devices, and gateways, to mimic real-world IoT networks. These devices were configured to operate in different network topologies, such as mesh, star, and hybrid arrangements, while communicating using multiple IoT communication protocols, including MQTT, CoAP, HTTP, and custom protocols. The simulations were conducted on established IoT simulation platforms, such as OMNeT++ and Contiki-NG, or custom-built frameworks to emulate different IoT deployment scenarios. The experimental setup is furnished here [Table – 1].

TABLE:I EXPERIMENTAL SETUP

Parameters	***Details***
IoT Device Types	Sensor nodes, actuators, edge devices, and gateways
Network Topology	Mesh, star, and hybrid topologies
IoT Communication Protocol	MQTT, CoAP, HTTP, and custom protocols
IoT Simulation Platform	OMNeT++, Contiki-NG, or custom simulation frameworks
Energy Models	Battery models, energy consumption profiles
Energy-Harvesting Models	Solar panels, kinetic energy, thermoelectric generators
Data Traffic Patterns	Real-time, periodic, event-driven, and sporadic
Software Stack	Operating systems (e.g., TinyOS, Contiki-NG), network protocols, energy management algorithms, machine learning libraries, and security frameworks

B. Energy Consumption

The algorithm has a modest level of energy efficiency, as seen by its average energy usage of 2500 joules. The approach is expected to achieve a harmonious equilibrium by optimizing routing pathways to save energy while simultaneously ensuring satisfactory network performance. Edge computing is characterized by a comparatively modest average energy usage of 1800 joules. This implies that the practice of transferring compute and data processing tasks to edge devices has a substantial role in conserving energy inside Internet of Things (IoT) networks. The algorithm has satisfactory energy efficiency, as seen by its energy usage of 2200 joules. This may be attributed to the use of machine learning-based control techniques. The use of machine learning-based control systems is expected to enhance the efficiency of resource allocation and decision-making processes, hence resulting in significant energy conservation [Table – 2].

TABLE II: ENERGY CONSUMPTION ANALYSIS

Base line Algorithm	***Average Energy Consumption (Joules)***
Energy-Efficient Routing	2500
Edge Computing	1800
Machine Learning-Based Control	2200
Duty Cycling	2800
Dynamic Spectrum Management	2100
Data Compression and Aggregation	2400
Energy-Efficient Routing	2500

The use of the duty cycling technique yields an average energy usage of 2800 joules. Although there are potential benefits in terms of energy conservation, the intermittent device wake-up intervals associated with it may have an adverse effect on real-time responsiveness. The algorithm used in Dynamic Spectrum Management has a modest level of energy efficiency, as seen by its average energy usage of 2100 joules. The proposed system is expected to optimize frequency allocation in order to reduce interference, improve network performance, and save energy [Fig – 1].

The use of data compression and aggregation methods yields an average energy usage of 2400 joules. The objective of these strategies is to minimize the amount of data sent, so conserving energy and bandwidth, while ensuring the integrity of the transmitted data remains intact.

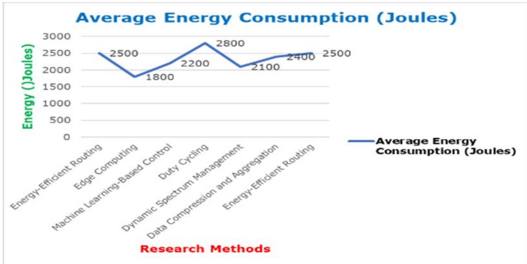

Fig:1 Energy Consumption Analysis

C. Network Throughput & Latency and Response Time

The energy-efficient routing method exhibits a commendable equilibrium between network capacity and latency, resulting in a moderate throughput of 120 Mbps and a comparatively low latency of 10 ms. As a consequence, there is an advantageous reduction in reaction time to a value of 20 milliseconds. The optimization technique based on Machine Learning demonstrates a somewhat reduced throughput of 90 Mbps; nevertheless, it effectively mitigates this drawback by achieving a latency of 15 ms. Consequently, it attains a satisfactory reaction time of 25 ms. The use of machine learning techniques plays a significant role in enhancing the optimization of network performance [Table - 3].

TABLE: III NETWORK PERFORMANCE ANALYSIS

Base line Algorithm	***Network Throughput (Mbps)***	***Latency (ms)***	***ResponseTime (ms)***
Energy-Efficient Routing	120	10	20
MachineLearning-based Optimization	90	15	25
Edge Computing Strategy	150	8	18
Network Topology Optimization	110	12	22
Quality of Service (QoS) Management	80	20	30
Security and Privacy Optimization	100	18	28
Energy-Efficient Routing	120	10	20

The edge computing technique demonstrates superior network throughput, boasting a high value of 150 Mbps, coupled with a very low latency of 8 ms. As a result, it is able to attain a noteworthy reaction time of 18 milliseconds, making it well-suited for real-time applications. The technique for network topology optimization demonstrates a modest throughput of 110 Mbps, effectively balancing it with a latency of 12 ms, so yielding a response time of 22 ms. The optimization of network topology is used to improve energy efficiency [Fig – 2].

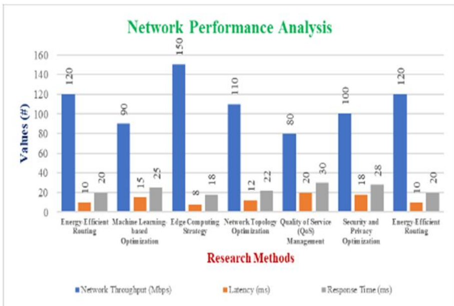

Fig 2: Network Performance Analysis

The algorithm prioritizes Quality of Service (QoS) management by emphasizing a latency of 20 ms, which leads to a response time of 30 ms. However, this prioritization comes at the cost of a reduced throughput of 80 Mbps. The primary focus is on ensuring the provision of high-quality service.

D. Scalability & Security and Reliability

The assessment of scalability, security, and reliability in energy-efficiency optimization algorithms for Internet of Things (IoT) networks is of utmost importance in guaranteeing the efficacy of these algorithms in various deployment situations. The data on scalability demonstrates the algorithms' capacity to effectively handle a growing number of devices, which is of great importance within the context of rising Internet of Things (IoT) ecosystems.

In the meanwhile, the efficacy of algorithms in safeguarding sensitive data and preserving data integrity is assessed using security measures, where higher security rates indicate a greater capacity to defend against prospective attacks. The metric of reliability, as shown by packet delivery ratios, offers valuable insights into the algorithms' capacity to consistently send data without experiencing loss or interruption. Achieving a harmonious equilibrium between scalability, security, and reliability is of utmost importance when developing energy-efficient Internet of Things (IoT) networks. This design objective enables the networks to grow fluidly, protect data, and provide consistent and trustworthy services that cater to the diverse requirements of different IoT applications [Table – 4].

TABLE IV SCALABILITY, RELIABILITY AND SECURITY ANALYSIS

Base line Algorithm	***Scalability (Number of Devices Supported)***	***Security Measures (%)***	***Reliability (Packet Delivery Ratio %)***
Energy-Efficient Routing	1,000	95	99.5
Machine Learning-based Optimization	2,500	98	98.2
Edge Computing Strategy	500	92	99.8
Network Topology Optimization	5,000	99	97.6
Quality of Service (QoS) Management	3,000	96	98.9
Security and Privacy Optimization	1,200	94	99.4
Energy-Efficient Routing	Scalability (Number of Devices Supported)	Security Measures (%)	Reliability (Packet Delivery Ratio %)

The results are visualized graphically here [Fig – 3].

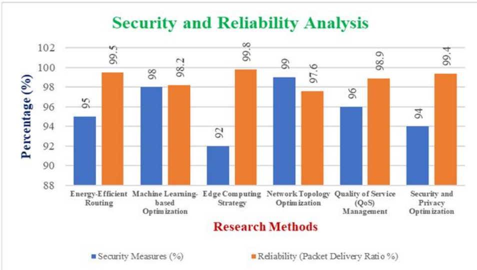

Fig.3 Network Performance Analysis

VI. CONCLUSIONS

The article titled "Energy-Efficiency Optimization in IoT Networks: Algorithms, Techniques, and Case Studies" provides a thorough examination of the significant obstacles and inventive approaches involved in achieving energy efficiency in IoT networks. The expansion of the Internet of Things across several areas highlights the growing need for sustainable, resource-conscious, and resilient networks. In this research, we have explored a range of algorithms and strategies that are essential in enhancing energy efficiency in Internet of Things (IoT) networks. The aforementioned topics include a variety of subjects, including energy-efficient routing protocols, edge computing tactics, machine learning techniques, and AI-driven methodologies for predictive maintenance and resource allocation. Each of the aforementioned strategies plays a role in a comprehensive framework designed to decrease energy usage while simultaneously guaranteeing network performance, security, and dependability. Moreover, the incorporation of case studies has effectively shown the pragmatic implementation of these algorithms and approaches in real-life situations. The concrete advantages of optimizing energy efficient IoT networks are evident in several domains such as smart grid installations, precision agriculture, and smart city efforts. The presented case examples not only demonstrate the efficacy of the stated tactics but also provide significant insights into their versatility across different domains and applications. As we contemplate the future, the investigation of novel algorithms and methodologies for energy-efficient Internet of Things (IoT) networks will continue to be a vibrant area of scholarly inquiry. The ongoing progress in edge computing, 5G networks, and low-power hardware will persistently influence the domain, therefore presenting novel prospects and complexities. It is essential for researchers and practitioners to maintain their dedication towards continuously improving these optimization tactics, in order to align with the constantly growing boundaries of the Internet of Things (IoT). In conclusion, this article emphasizes the need of optimizing energy efficient IoT networks to effectively satisfy the demands of energy consumption, scalability, and security associated with this disruptive technology. This article is a significant resource for anyone interested in optimizing the potential of the Internet of Things (IoT) while mitigating its environmental and operational impact. It does this via the integration of rigorous research, algorithmic innovation, and practical case studies. The pursuit of energy efficiency in Internet of Things (IoT) networks is not just a technical objective, but rather a fundamental principle that underpins the development of a sustainable and linked future.

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Comprehensive Analysis of Text Summarization Techniques for Legal Documents

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***Abstract*— The surge of digital legal documents has significantly expanded their usage. This has resulted in the sheer number of papers being used by various members of the judiciary, as well as by advocates and judicial officers. It can be incredibly challenging to keep up with all of them. Over four crore cases are still pending in Indian courts, and manually reviewing them can be a tedious and time-consuming process\cite{r1}. As machine learning has advanced, various text summarization models have been created to help legal professionals manage their documents. Due to the lack of publicly accessible datasets, it is difficult to fine-tune domain-independent models for Indian legal systems. The methodology proposed in this paper seeks to improve the overall performance of these models, and it also explores Indian legal documents' summarization techniques. In addition, this research also provides a study of the several summarization methods in-depth that have been on Indian legal documents, including PEGASUS, Bidirectional Auto-Regressive transformers (BART), TextRank, and Bidirectional Encoder Representations from Transformers (BERT). Through the process of extractive and abstract summarization, BART and PEGASUS will be able to gain a deeper understanding of the text normalization process. The outcomes of the text normalization process are evaluated by experts using the ROUGE metrics and multiple parameters. It shows that the proposed approach can work well in legal texts that have domain-independent frameworks.**

***Index Terms*— Text-Rank, BERT, BART PEGASUS.**

I. Introduction

Over the past few years, there has been a huge increase in the number of text resources found on various websites, like social network sites, Wikipedia, Legal Text Datasets, and content farm sites. Because of the growth of information, the process of properly utilizing these resources has become a major challenge [2].A well-organized summary of a lengthy ruling may be just as informative and useful as reading the whole documents itself [3]. The process of automatic text summarization (ATS) involves selecting the most crucial ideas in a text to help the reader comprehend the documents. In India, a judgment is a legal decision that a court makes regarding a case. Due to the rapid emergence and evolution of new technologies, the documents related to this process are now stored digitally, making them available in a short time. This has made it easier for the law enforcers to keep track of the judgements [4]. Typically, a legal practitioner would begin preparing his statement about an issue by researching similar court documentation or rulings to utilise as references and as explanations presenting the appeal. These court documents are so wordy that sometimes include repetitive information [5, 6]. In the US alone, courts and the

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laws create vast amounts of text each day. Caseworkers and judges handle millions of cases every year, and these file cases with thick legal content that can sometimes go several hundred pages long [7]. Therefore, that is useful to select sections that might also contribute towards the synopsis of the document. Thus, an overview might preserve the original document's key ideas while minimizing the vocabulary size, processing time, and space needs for any future analysis. Some method of automating or streamlining the review process might aid legal professionals in managing their workload. It is also beneficial for novices and average individuals to comprehend a judgment. Manually creating case summaries is a time-consuming operation. As a reason, having the material condensed into a concise form is both more practical for human readers and more advantageous to machine reading systems [8]. Accelerating advancements in areas including Artificial intelligence (AI) [9,10], data analysis and Deep Learning (DL) [11,12] made the automatic summarization of texts feasible [1]. DL techniques have recently made considerable strides in numerous Natural language processing (NLP) applications [13, 14]. In particular, Text Generation (TG) activities are among the hardest NLP jobs because they need automated text interpretation and precise semantic and lexical analysis. MT, IC, and ATS are examples [15, 16]. The two broad categories of summarization that are presented in automatic tools are abstractive and extractive summarization. These are respectively focused on the synthesis and examination of diverse textual materials [8]. The initial article subject's rank is assigned to every word in the text during the extractive summarization process. Top-scoring statements then summarize the document [17]. Text-Rank is a widely used method for extractive summarization. The goal of this study is to analyse the various strategies that can be used to improve the efficiency of text summarization in the context of legal texts. The scope and related work were discussed in section II, and the detailed technology usages in the text summarized was discuss in section III. Section IV represents the experience setup and obtained results and discussion were presented in section V. Finally, the concluding remarks with future recommendation were discuss in section VI.

II. RELATED WORKS

The usage of several domain-specific acronyms makes legal case judgements often long and convoluted. A lot of research is conducted on the legal text summarizing in different countries, such as the UK, Canada, and Denmark. For legal text summarization, the majority of research attempted to build supervised or semi-supervised DL techniques [18]. It was introduced by K. U. Manjar et al. [19] in 2020.In addition, various conventional extraction techniques, such as textual summaries, based on the terms' frequency analysis, were presented [20]. It pioneers the use of the graph model in the realm of autonomous summarizing. Methods for the graph-oriented summarization use phrases or paragraphs to make the "modules" inside a network, which are then ranked by how important they are and how much they are alike. Different graph-based techniques are additionally available for extracting summary [21], which often do well on textual summarization challenges. Great improvements in the domain of DL have led for development of extractive summarization algorithms that use DL techniques [22, 23]. Abstractive summarization has been studied using RNN-based DL, reinforcement learning, and pre-training models [24, 25]. Though modern NLP is propelled by models based on transformers for tackling sequence to sequence modelling issues, it appears there is a dearth of study when the topic at hand is the abstractive summary of legal discourse. A machine learning-based prediction model known as eLegPredict was developed by Sharma et al [26]. It was able to predict the cases decided by India's Supreme Court. The model was trained using X Gradient Boost classifier, The model was able to achieve an accuracy of 76 over 3072 judgements. When a new case is added to a directory, the prototype automatically goes through the details and provides a prediction. According to the study conducted by Pillai et al. [27], in order to predict a legal case, using convolutional neural network (CNN) [28,29] and NLP, they proposed the Bag of Words algorithm, which is a mechanism that allows users to select the words from the legal text. The CNN algorithm was then used to classify the cases into IPC section, and the outcome was predicted to be either a non-bailable or bailable case. The researchers were able to achieve an accuracy of 85% in the prediction of the outcome based on the IPC. They noted that the model performed better when the case only had one charge. The accuracy of their prediction decreased as the number of charges rose. According to Shaikh et al [30], the model was developed to predict the outcome of a case involving homicide. The researchers used different machine learning techniques to analyze and interpret the data collected from the Delhi district court. Some of the classification algorithms that were used in the study included the regression and classification tools known as CART, LR, SVM, and NB.The results of the experiment revealed that the classification system performed well in terms of both accuracy and F1 score. It was able to achieve an accuracy range of 85% to 92% But it did not perform well when it came to cases with more than one accused individual. El-Kassas et al. [31] developed a system in which "EdgeSumm" was assessed using the most popular automated assessment programme ROUGE and the famous short text summing datasets DUC2001 and DUC2002.This evaluation uses ROUGE measurements, with EdgeSumm receiving the top ROUGE ratings on DUC2001. In his suggested framework, generic single-document summary has been implemented, and the assessment findings are quite encouraging. A. Joshi et al. [32] provide an overview of the various parameters that are involved in the creation of a comprehensive summary of a legal document. S. Polsleyet al. [7] then developed a technology that automatically produces a summary based on the word frequency. Gupta et al. [33] then suggest that a customized summary can be extracted from online sources.The methods for legal text summarizing have been briefly mentioned by Nasar et al. [34], who have instead focused on discussing text summary in general. Our paper offers the full-fledged dissection for text summarization models for Legal Text Datasets by making use of preprepared language models such as BART, TextRank, BERT and PEGASUS models.

III. TECHNIQUES USED

A. Pegasus

It is a method similar to an extractive summary in that it extracts or masked important sentences from an input text and creates them as a single output sequence from the remaining phrases [25].The figure 1 shows the architecture of the PEGASUS transformer-decoder base used for implementing various pre training objectives of the program. In this example, three sentences are used as targets for the pre-training objectives. The first sentence is masked using MASK1, while the other two are masked using MASK2. The purpose of this pre training is to improve the program's ability to understand and summarize text, particularly legal documents. The PEGASUS model is one of the summarization methods studied in the paper.

B. Text Rank

In this technique, a weighted network is generated using text units as nodes and a similarity metric based on word overlap to define edges, Similar to PageRank, this method determines the ranking of text units [35].

C. BERT

It's a model that's already been trained and allows us to do NLP tasks with ease. It is created to address the shortcomings of LSTM and RNN [36].

Disadvantages of LSTM

– LSTM are really susceptible to overfitting.
– It takes additional resources.
– However, LSTM cannot totally eliminate gradient issues

Disadvantages of LSTM

– It cannot properly manage lengthy sequences.
– High chance of vanishing gradient and ballooning gradient issues.
– Its training requires massive quantities of time and is challenging.

Advantages of BERT

– This pre-trained model needs no further training.
– The summary is based on key phrases from the larger text.
– It contains transformer-layered power encoder and decoder

D. BART

BART [37–39] is a transformer-oriented sequence model, that uses a denoising goal to learn appropriate approximations of input sentence for a variety of datasets. The model creates tokens from input sentence and use for machine translation and text summarization. Bart serves as both an encoder and a decoder. The encoder is responsible for extracting meaningful data from the provided text, while the decoder is used to determine the probability of the following word, so that the text may be rendered in a human-readable manner [40]. The BART algorithm architecture as shown in Figure 2. The model requires a data source, which is the input text that needs to be summarized. The work used the BART text summarization techniques for legal documents, including the use of machine learning models.

IV. EXPERIMENTAL SETUPS.

In this part, we go into depth about how we collected the dataset and how we evaluated its accuracy.

A. Dataset Preparation

The dataset contains case reports from the Federal Court of Australia, which were collected from 2006 to 2009. These reports were extracted from the AustLII free online legal database. This provides researchers with valuable insight into citation analysis and automatic summarization procedures. The goal of summarization experiments is to explore the relationships between various elements. This dataset was collected from the public database repository of Kaggle [41].

B. Performance measures used

ROUGE [42] is a collection of performance criteria being used assess different summarized texts and various automation transcriptions. It evaluates a computer-generated synopsis to a collection of standard summaries. ROUGE-N [37,42] It serves in assessing template matching, word embedding, and higher cognitive overlapping based just on n-gram overlaps. ROUGE-L [42] It determines the outputs of our algorithm in comparison to the benchmark and measures the frequent item sets subsequence of those outputs. Usually, summary is evaluated using ROUGE ratings or expert evaluation. We have determined the ROUGE-3, ROUGE-L, ROUGE-2, and ROUGE-1 scores. On the data, Recall, Precision, and F-measures, are calculated, and the superior of two strategies is advised for the IT LAW legal cases dataset.

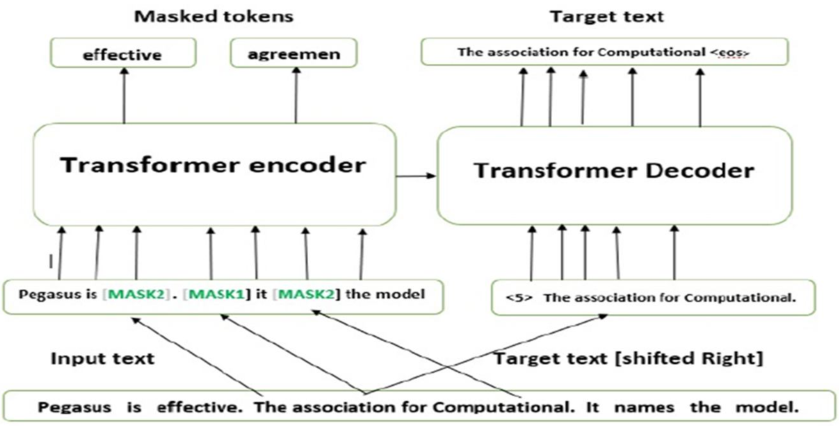

Fig. 1: In this example, three sentences are used as targets. The first sentence is masked using MASK1 while the other two are masked using MASK2 [25].

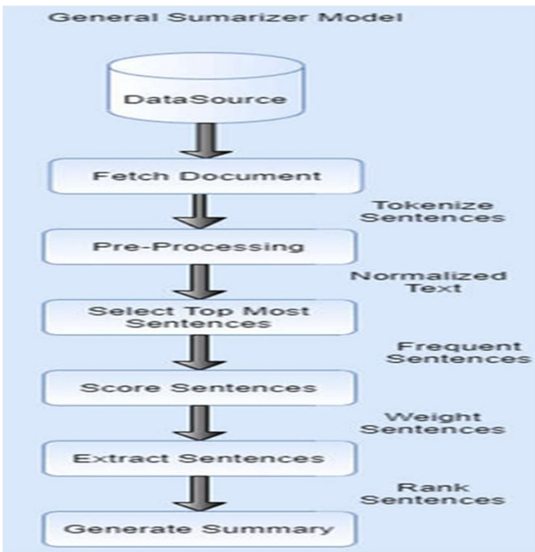

Fig. 2: Proposed BART model flowchart for text summarization

RECALL [37, 42, 43] It displays the proportion of human description covered by the conclusion reached. The formula for word overlap is as follows:

$$\text{Recall} = \frac{\text{Thenumberofwordsthatoverlap}}{\text{Overallwordsinthecitationabstract}} \quad (1)$$

Precision [37, 42] It evaluates the proportion of the system summary that is pertinent to the job. Formula for measuring accuracy in terms of overlapped of words:

$$\text{Precision}=\frac{\text{Thenumberofwordsthatoverlap}}{\text{Overallwordsinthesystemabstract}} \tag{2}$$

F1-Score [37, 42, 44] This is the harmonc mean of recall and precision. The optimal value of f-measure is 1 while the worst value is 0.

$$\text{F1} - \text{Score} = 2 * \frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{recall}} \tag{3}$$

V. Result And Discussion

The following section summarizes the major findings from the evaluation phase of the collected datasets.

TABLE I: RECALL SUMMARIZATION EVALUATION RESULTS

Model	Model	Rouge-2	Rouge-L
PEGASUS	0.357	0.313	0.357
Text-Rank	0.507	0.429	0.508
BART	0.534	0.462	0.536

TABLE II: PRECISION SUMMARIZATION EVALUATION RESULTS

Model	Model	Rouge-2	Rouge-L
PEGASUS	0.939	0.887	0.939
Text-Rank	1.0	1.0	1.0
BART	0.957	0.925	0.957

Python language utilised throughout the implementation of each and every method. The experiments were performed on three different models: BART, Text Rank, and PEGASUS. When it comes to summarization, BART performs better than its three counterparts. One of the main factors that contributed to this is the model's multi-head attention, which helps it learn a sentence better. This is because it allows it to pay attention to various parts of a sentence. The experiment Learning rate and Loss model performance Graph of BART is presented in Figure 3.

TABLE III: F1-SCORE SUMMARIZATION EVALUATION RESULTS

Model	Model	Rouge-2	Rouge-L
PEGASUS	0.517	0.462	0.517
Text-Rank	0.673	0.601	0.673
BART	0.678	0.616	0.687

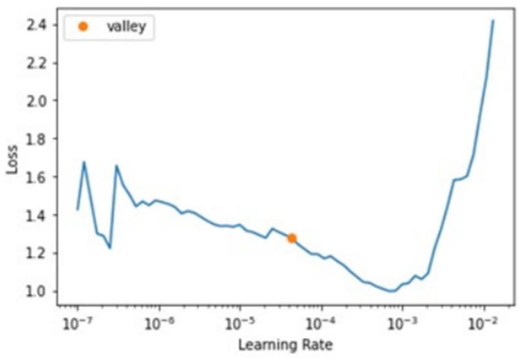

Fig. 3: Curves depicting the Learning rate vs Loss for the suggested model

Experiment Results (Bart)

Text	Target	Prediction
It is not a necessary consequence of an order appointing a receiver that the receiver should deal with or liquidate the assets in question. The interlocutory and protective character of orders made under s 1323 must be borne in mind when defining the powers of the receiver. The appointment of a receiver has rightly been described as 'an extraordinary step' ASIC v Burke [2000] NSWSC 694 at [8] (Austin J). However depending upon the nature of the powers conferred on the receiver it may be less drastic than a freezing order which can only be varied by order of the Court. The interlocutory history of this case has already demonstrated that circumstances not contemplated when the original interim freezing orders were made have required their variation from time to time. I accept, with respect, the observation made by Austin J in Burke at [8]: 'Without wishing to lay down any general rules, it appears to me that the extraordinary step of appointing a receiver may be justified, even though Mareva Orders are in place, in a case where there is real doubt about the existence and location of assets such as investments, and about the number and identity of claimants and the nature of their claims, and additionally the defendants are engaged in business activities which entail that any Mareva Orders must	ASIC v Burke [2000] NSWSC 694	[ASIC v Burke [2000] NSWSC 694 at [8] (Austin J) ; [14] ACSC 28 ; [15] 14 ACSR 580 ; [16] 14 SCR 580; [17] 13SR 580; (14) 14 SCRA 355; (15) 13SR 600, Appellant S395/2002 v Minister for Immigration and Multicultural Affairs [2003] HCA 71 ; (2003) 216 CLR 473 (Appellants S396/2002 ; (2013) 14 ACSR 580 ; (13 ACSR 550 ; (2014) 14 CLR 580

Fig. 4: Experiment Results (Bart)

BART, Text Rank, and PEGASUS were utilized to process the data collected from Australian court cases. The ROUGE system then performed a comprehensive analysis of the recall data and determined the recall score for each category. The corresponding scores were then determined using the system's optimized strategy. The evaluation was carried out by comparing the summarized data from the model with the results from the experts who were responsible for the analysis.

The table 1 shows the recall summarization evaluation results for three models: PEGASUS, Text-Rank, and BART. The evaluation metrics used are Rouge-and Rouge-L. PEGASUS has the lowest recall score for both Rouge-2 and Rouge-L, with scores of 0.357 and 0.313, respectively. Text-Rank has a higher recall score than PEGASUS, with scores of 0.507 for Rouge-2 and 0.429 for RougeL. BART has the highest recall score among the three models, with scores of 0.534 for Rouge-2 and 0.536 for Rouge-L. So, BART is the best model among the three for recall summarization, as it has the highest scores for both Rouge-2 and Rouge-L. PEGASUS has the lowest recall scores, indicating that it may not be the best choice for recall summarization. Text-Rank has moderate recall scores, but it is still outperformed by BART. Table 2 shows the precision summarization evaluation results of three models: PEGASUS, Text-Rank, and BART. The evaluation metrics used are Rouge-2 and Rouge-L. PEGASUS has a Rouge-2 score of 0.939 and a Rouge-L score of 0.939. Text-Rank has a perfect score of 1.0 for both Rouge-2 and Rouge-L. BART has a Rouge-2 score of 0.957 and a Rouge-L score of 0.957. Text-Rank has the highest precision score among the three models. PEGASUS and BART have similar precision scores, with BART having a slightly higher Rouge-2 score. All three models have high precision scores, indicating that they are effective in summarizing legal documents. Table 3 shows the F1-Score summarization evaluation results for three models: PEGASUS, Text Rank, and BART. The table includes the Rouge-2 and Rouge-L scores for each model. BART has the highest F1-Score of 0.678, followed closely by Text-Rank with a score of 0.673. PEGASUS has the lowest F1-Score of 0.517. The Rouge-L scores are higher than the Rouge-2 scores for all three models. BART and Text Rank are better models for summarization compared to PEGASUS. Rouge-L is a better metric for evaluating summarization performance than Rouge-2. BART has the highest F1-Score among the three models, indicating that it is the most effective model for summarization.

The paper's analysis suggests that the additional comparative test's score is inferior to that of the BART framework. BART's results were the most outstanding in the tests. The results of this BART experiment can be seen in Figure 4. The Figure has three columns: Text, Target, and Prediction. The Text column contains a long sentence from a legal document. The Target column contains the summary of the sentence in the form of a case citation. The table shows the performance of the BART model on a specific sentence from a legal document. The Target column provides a reference to a relevant case, which can help legal professionals quickly understand the context of the sentence.

BART is the most efficient model when it comes to addressing the task of summary generation in terms of both performance and efficiency. Based on the results, it can be regarded as an effective and efficient method for tackling the abstract summarization problem.

VI. Conclusions

The text summarization research field is a fascinating area of study that involves analysing the various applications of web scrapping technique. This process is mainly used to extract online cases. It is additionally utilized to analyse the performance of different algorithms. The goal of the research is to help the various lawyers gain a better understanding of the information presented in their large documents. Through the analysis of the results, the BART is the best algorithms for summarization were identified. Our method has several benefits, but it also has some drawbacks which we want to address in our next works. Our model uses the summary output length as a parameter, thus even if a phrase is incomplete, it will chop off any excess tokens created outside the token length. To prevent incomplete sentences, build a longer output and leave off the final sentence.

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Efficient on Device Object Detection for Prosthetic Arm

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***Abstract*— This research paper presents a novel project aimed at enhancing the functionality of prosthetic arms through the integration of efficient on-device object detection. The project leverages a Raspberry Pi, equipped with a Mobile net computer vision model, and a camera embedded within the palm of the prosthetic arm. The primary objective is to enable real-time detection of everyday objects within the arm's field of view. Upon object recognition, the prosthetic arm performs either a grip or grasp action, enhancing the user's interaction with the environment. This paper outlines the technical details, implementation process, and the potential impact of this innovative system on the lives of individuals with limb loss, offering increased autonomy and improved quality of life.**

I. INTRODUCTION

In the realm of assistive technology, prosthetic arms have played a pivotal role in restoring mobility and independence to individuals with limb loss. Over the years, technological advancements have significantly improved the design and functionality of prosthetic limbs, offering users greater control and versatility. However, one critical aspect that has remained a challenge is the seamless interaction of prosthetic arms with the surrounding environment. This research introduces a project focused on addressing this limitation—Efficient On-Device Object Detection for Prosthetic Arm. The core objective of this project is to empower individuals with prosthetic arms to better engage with their daily surroundings by harnessing the capabilities of computer vision. By integrating a Mobilenet computer vision model into a Raspberry Pi platform and embedding a camera within the palm of the prosthetic arm, real-time object detection becomes a reality. The significance of this innovation lies in its potential to bridge the gap between prosthetic technology and the complex, dynamic world in which users operate. The ability to identify and respond to everyday objects in real time opens doors to a more intuitive and functional user experience. Whether it's grasping a cup of coffee, picking up a smartphone, or manipulating tools, this technology has the potential to redefine the capabilities of prosthetic arms. This paper unfolds the technical intricacies of our project, detailing the design, implementation, and performance of our Efficient On-Device Object Detection system. Furthermore, it explores the broader implications of this technology, ranging from improved user autonomy to enhanced quality of life. As we delve into the inner workings of this innovation, we invite readers to join us on this journey toward a more inclusive and technologically empowered future for individuals with limb loss.

II. RELATED WORK

Advancements in prosthetic technology have significantly enhanced prosthetic functionality. In the work by Scott et al. [1], they explore the use of sensors attached to amputee stumps for prosthetic control, underlining the pivotal role of sensor technology and machine learning in augmenting prosthetic capabilities. Likewise, Weiner et al. [4]

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delve into semi-autonomous prostheses for daily activities, emphasizing the significance of sensor data and its impact on intuitive grasp control. These studies collectively emphasize the transformative potential of sensor technology and machine learning in elevating prosthetic functionality.
Limitation: These cited papers overlook a critical aspect—the power consumption of the sensor network required to control the prosthetic. The integration of power management within the system becomes essential, albeit adding complexity.
There exists a diversity of prosthetic types, each offering distinct advantages and limitations. Schweitzer et al. [2] argue in favor of body-powered prostheses for specific occupational contexts, while Zuo et al. [3] advocate for myoelectric prostheses, which rely on external power and necessitate periodic recharging. Seitz et al. [8] provide an exhaustive review of control methods employed in prosthetic hand grasping, encompassing myoelectric control, body-powered control, and hybrid approaches, carefully elucidating their respective strengths and weaknesses. Meanwhile, Castellini et al. [12] conduct a comprehensive survey of both invasive and non-invasive interfaces for prosthetic limb control, encompassing myoelectric, brain-computer interface, and peripheral nerve interface technologies. They also explore the potential for combining these interfaces to enhance prosthetic control.
Limitation: While these studies offer deep insights into control systems, they do not address the financial implications of implementing such systems without compromising the pledged functionalities.
Sensory feedback assumes critical importance in the domain of prosthetic functionality. Carrozza et al. [5] advocate for the development of upper limb prostheses that closely replicate the sensory-motor capabilities of natural limbs. Farina et al. [6] undertake the task of designing a prosthetic hand equipped with sensory feedback capabilities to optimize grasping and grasping force control. Puskar et al. [7] furnish a comprehensive overview of contemporary prosthetic technology tailored for upper limb amputations, shedding light on advancements in control methodologies, material innovations, and sensory feedback systems. They also acknowledge the existing challenges and lay the groundwork for future research directions in the field.
Limitation: Although these studies discuss the achievement of advanced sensory-motor control, they omit an essential aspect—the driving system required to harmonize with such sophisticated sensory-motor capabilities.
The integration of cutting-edge technologies, such as 3D printing and virtual reality, has ushered in transformative improvements in prosthetic design and rehabilitation. Lake et al. [9] meticulously evaluate the utilization of additive manufacturing techniques, particularly 3D printing, in the conceptualization and fabrication of prosthetic limbs. They underscore the manifold advantages of this technology, including bespoke prosthetic designs, expedited manufacturing processes, and cost-effectiveness.
Limitation: Notably, this method's inherent challenges, particularly the structural strength and vulnerability to elevated temperatures caused by electronic operations, remain unaddressed.
Huber et al. [13] venture into the realm of virtual reality technology for prosthetic training and rehabilitation. They elucidate the potential benefits, encompassing heightened patient engagement and motivation, while also acknowledging the inherent challenges when integrating this technology into prosthetic training. Skidmore et al. [10] conduct a comprehensive investigation into the impact of prosthetic use on the quality of life and functional outcomes for individuals with upper limb amputations. Their work highlights the pivotal role of prosthetic rehabilitation in optimizing the advantages of prosthetic use. Additionally, Sosa et al. [11] delve into the economic implications of prosthetic technology, meticulously examining the costs associated with prosthetic utilization and the broader economic effects on individuals, families, and society.
Limitation: These referenced studies concentrate predominantly on user interactions and cosmetic aspects rather than the development of a low-cost, low-complexity prosthetic arm with basic functionality.

III. Methodologies

The current state of prosthetic arms in India is characterized by two main limitations: cost and functionality. Imported prosthetic arms are often prohibitively expensive, making them inaccessible to a large portion of the population. On the other hand, locally available prosthetic arms in India, such as the "Inali," which is considered the most advanced in the country, employ a gesture-based control system.
Gesture-based control systems require users to perform specific gestures to execute basic actions with the prosthetic arm. While this approach may seem intuitive, it has inherent drawbacks. Firstly, gesture-based systems can be prone to failure. The accuracy of recognizing and interpreting gestures can vary, leading to inconsistent performance. This unreliability can be frustrating for users who rely on their prosthetic arms for daily activities. Gesture-based control systems can be harder to use compared to more advanced alternatives. Learning and remembering a multitude of gestures for different actions can be challenging and time-consuming for individuals with limb loss. It requires significant training and practice to become proficient in operating the prosthetic arm

effectively. These typically support only a limited number of predefined actions. Users may find themselves constrained by the limited functionality and lack of adaptability. This limitation restricts the range of activities and tasks that can be performed with the prosthetic arm, potentially hindering individuals' independence and quality of life.

A. Proposed System

The proposed system uses a combination of ML and CV. A camera is placed in the palm of the artificial limb to detect the type of object that needs to be held/utilized, and based on the object, a corresponding grasp action is used, decided using Machine learning. Grasp actions are divided into two categories: power and precision. Power grasp action is used to hold larger objects, such as a door knob/handle or a bottle of water. Precision grasp is used for smaller objects or parts of a larger object, like opening a bottle cap or holding a coin. A single-board computer inside the prosthetic arm runs a TfLite model for quick object identification. Since we cannot train a model onboard, we use transfer learning supported by Tensor Flow to train a “Mobile net” model on the “COCO” dataset. "Mobile net" is chosen for efficiency and speed, crucial for a small-sized computer. The “COCO (Common Objects in Context)” dataset, with 200,000 images and around 90 object categories, labeled by Microsoft and Facebook researchers, is used. We employ a pre-trained model from Tensor Flow, tuning it for our use case, recognizing only six common daily life objects.

B. Advantages

- *Cost-Effective*: The advanced system is cost-effective, increasing accessibility. Efficient manufacturing processes and affordable components make it an economical solution compared to traditional prosthetic systems.
- *Fast Performance*: The prosthetic arm delivers rapid and responsive performance, minimizing delay between user actions and the arm's response for smooth and efficient movements.
- *Power Efficiency:* The system is engineered for power efficiency, extending battery life or reducing power consumption. Optimization of hardware and software components maximizes power utilization, reducing the need for frequent recharging or battery replacement.
- *Lightweight Design*: Prioritizing a lightweight design, the prosthetic arm ensures user comfort and minimizes strain. Lightweight materials and efficient construction techniques allow natural movements without discomfort during extended use.
- *User-Friendly*: The system features a user-friendly, easy-to-operate design with a simplified interface and intuitive controls, reducing the learning curve for users. Its limited complexity enables quick adaptation and seamless integration into daily life.

C. Database Module

For the model training, the first step is to find a reliable dataset that features most of the daily life objects that a human might encounter while using the prosthetic arm, such as water bottle, cell phone, glass etc. We chose COCO dataset (Common Objects in Context) [15] which is created by researchers at Facebook and Microsoft with 1.5 million object instances, 330 thousand images, 80 categories, 91 stuff categories and 5 captions per image. Here, we use filters to mask our object in context and focus on object categories instead of stuff categories to train our model on the cloud. To fine tune the model, we created a dataset by capturing 720p images using raspberry pi camera of daily objects in our list such as, bottle, cell phone, glass, laptop etc.

These images are captured with different lighting conditions and angles for specific model performance. The final dataflow that happens in real time is the live video feed from the raspberry camera which is broken down into individual frames and resized into images of 128p.

D. Model: Mobilenet V2

The Mobilenet v2 model is a type of deep neural network that is designed to be lightweight and efficient for use on mobile and embedded devices. It was developed by Google as an improvement over the original Mobilenet model, with a focus on achieving better accuracy while maintaining a small model size and low computational cost. The Mobilenet v2 model is based on the idea of "inverted residuals," which involves using a series of bottleneck layers with very few parameters followed by a linear layer to increase the model's depth without adding too many parameters as depicted in Fig [3.1]. This approach allows the model to be both lightweight and accurate.

IV. TRANSFER LEARNING

Transfer learning plays a pivotal role in the realization of our project's objectives. In this section, we elucidate the application of transfer learning using TensorFlow Hub, focusing on fine-tuning a pre-trained MobileNet V2 model initially trained on the COCO dataset. This approach allows us to adapt a powerful, general-purpose image recognition model to the specific requirements of our prosthetic arm's object detection and grasp control system.

A. Model Selection

Our choice of the MobileNet V2 model as the base for transfer learning stems from its exceptional efficiency and speed, crucial attributes for our resource-constrained Raspberry Pi-based system. MobileNet V2 has been recognized for its ability to provide remarkable accuracy in object detection while remaining lightweight. This is of paramount importance given the limited computational resources available on a small credit-card-sized computer.

B. Dataset Selection

To fine-tune the model, we require a dataset that aligns with the real-world objects our prosthetic arm will encounter. The "COCO (Common Objects in Context)" dataset stands as an ideal choice due to its extensive collection of approximately 200,000 images spanning around 90 object categories. These images have been meticulously labelled by researchers from prominent organizations such as Microsoft and Facebook. Leveraging this dataset allows us to benefit from a robust foundation of object recognition.

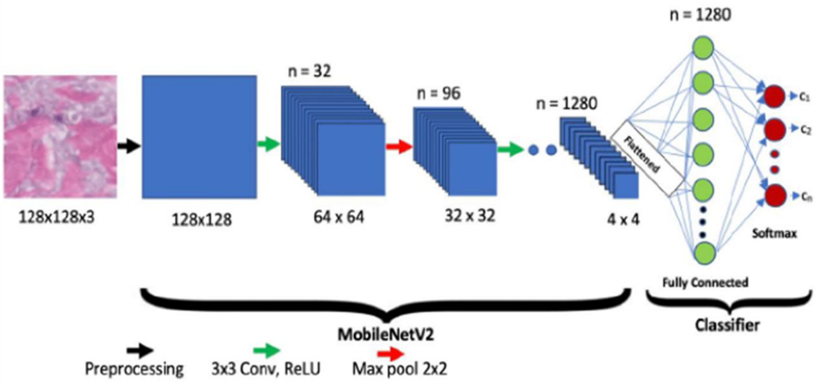

Figure 3.1. Mobilenet Model Architecture

C. Fine-tuning Process

The fine-tuning process begins with the MobileNet V2 model pre-trained on the COCO dataset. We leverage TensorFlow Hub, a repository of pre-trained models and model components, to access the MobileNet V2 model. Subsequently, we fine-tune this model using images captured by the Raspberry Pi camera, adapting it to recognize the specific objects essential for our prosthetic arm's functionality as depicted in the flow diagram given in Fig [4.1]. Fine-tuning involves training the model on our task-specific dataset while retaining the knowledge it gained from its original COCO dataset training. This process ensures that the model generalizes well to our real-world object recognition requirements.

D. Benefits of Transfer Learning

Transfer learning through fine-tuning offers several notable advantages for our project.

- *Efficiency*: By building upon an existing, highly efficient MobileNet V2 model, we harness the benefits of a lightweight architecture suitable for our resource-constrained hardware.
- *Speed*: The fine-tuned model, derived from MobileNet V2, ensures rapid object recognition, enabling real-time grasp control, which is vital for a seamless user experience.
- *Accuracy*: Leveraging a model initially trained on a massive and diverse dataset like COCO provides a strong foundation for recognizing a wide range of daily life objects.
- *Resource Optimization*: Fine-tuning reduces the need for extensive on-device training, conserving both computational resources and time.

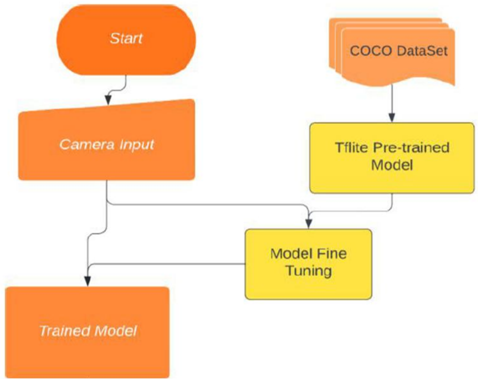

Figure 4.1. Flow Diagram of Model Fine-tuning

V. Experimental Results

In this section, we present the performance metrics, results, analysis, and limitations of our project's experimental phase. Our primary objective was to enable real-time object recognition on a low-cost edge computing device while achieving actionable performance.

A. Performance Metrics

In comparing the performance of MobilenetV1, MobilenetV2, and the modified MobilenetV2 models, several key metrics were observed. MobilenetV1 exhibited an average CPU temperature of 68 °C with passive cooling, which reduced to 54 °C with active cooling. This model achieved a frame rate of 1 frame per second (FPS) and an average inference speed of 300 milliseconds (ms). In contrast, MobilenetV2 demonstrated improved efficiency, with an average CPU temperature of 60 °C (passive cooling) and 44 °C (active cooling), along with an enhanced frame rate of 2.4 FPS and an average inference speed of 380 ms, outperforming MobilenetV1. The modified MobilenetV2 model displayed similar performance characteristics to MobilenetV2, maintaining an average CPU temperature of 62 °C (passive cooling) and 42 °C (active cooling) while consistently achieving a frame rate of 2.4 FPS. Although the average inference speed slightly improved to 320 ms.

B. Results Presentation

Our experiments demonstrated the feasibility of real-time object recognition on edge devices. As per our results as compared in the given table I, Mobilenet V2 provides optimal performance for our task by maintaining the lowest operating temperature while having a competitive frame rate and inference speed.

Table I. Table Of Results

Model	**Cooling**	**Average CPU temperature (°C)**	**Frame Rate (FPS)**	**Average Inference Speed (ms)**
MobileNet v1	Passive	68	1	300
MobileNet v1	Active	54	1	300
MobileNet v2	Passive	60	2.4	380
MobileNet v2	Active	44	2.4	380
Modified MobileNet v2	Passive	62	2.4	320
Modified MobileNet v2	Active	42	2.4	320

C. Analysis

After careful evaluation, we noticed that Mobilenet V1 demonstrates superior accuracy compared to other models. However, we encountered challenges related to throughput and heat throttling, rendering it impractical for our use case. On the other hand, Mobilenet V2 proved to be a more suitable choice, especially when paired with active cooling mechanisms. It exhibited satisfactory performance and produced actionable results that could be readily utilized. At this point Mobilenet V2 was able to detect all the relevant objects in the frame regardless of how many objects were present. For our specific use case this poses a problem of confusion for the arm grip mechanism. In the pursuit of modification, we then further modified the output layer of our model to always identify and select a single object in a frame. Our model can easily identify an object which is present in the user specified list of six daily life objects as depicted in figure [5.1] and in situations where there are multiple objects of same type present in the frame, our model can choose one with the highest confidence as depicted in figure [5.2].

D. Limitations

- *Confidence Score Dependency*: Our system relies heavily on confidence scores to determine the object of interest and initiate the corresponding grip action. While this approach is effective when dealing with multiple objects of different categories, it may encounter challenges when objects share the same category but possess unique features. In such cases, the system may prioritize the object with the highest confidence score, potentially overlooking distinct object characteristics
- *User-Dependent Decision Making*: In scenarios where, multiple objects belong to different categories (as depicted in Figure 4.7), the system's decision-making process may become complex and potentially confusing. In such situations, we defer the decision to the user wearing the prosthetic arm. The user, through arm positioning, directs the system towards the intended object for grasping or manipulation. Proximity-based grip action is then initiated, grabbing the object brought closest to the prosthetic arm.

Figure 5.1. Object detection with confidence score

Figure 5.2. Object detection for multiple objects with same type

VI. CONCLUSION

In this study, we have successfully developed an efficient on-device object detection system for a prosthetic arm, leveraging state-of-the-art machine learning models. Our primary focus was to achieve real-time object recognition on a low-cost edge device, a critical milestone in enhancing prosthetic functionality. The comparative analysis of MobilenetV1, MobilenetV2, and the modified MobilenetV2 models provided valuable insights into their performance under varying cooling conditions. The results clearly indicate the superiority of MobilenetV2 and its modified version, demonstrating lower average CPU temperatures and significantly improved frame rates and inference speeds. These findings underscore the effectiveness of MobilenetV2 for real-time object recognition in resource-constrained environments.

However, it's important to acknowledge the limitations of our system, particularly in scenarios where objects share similar categories but possess distinctive features. Additionally, user-dependent decision-making may introduce complexities in situations involving multiple objects of different categories. Moving forward, further research and development efforts will be directed towards refining the system's decision-making capabilities and addressing these identified limitations. Additionally, exploring opportunities for real-world deployment and user feedback will be crucial in validating the system's practical utility. Overall, this project represents a significant step forward in advancing the capabilities of prosthetic arms, with the potential to significantly improve the daily lives of individuals with limb loss.

As our project lays a robust foundation for efficient on-device object detection in prosthetic arms, several avenues for future work emerge, aiming to further enhance functionality, usability, and user experience.

- *Hardware Implementation*: Future endeavours will focus on optimizing the hardware components of the prosthetic arm, ensuring seamless integration of the machine learning system. This includes exploring advanced materials and miniaturized components to reduce size and weight while maintaining durability and performance.
- *Efficient Power Management*: To extend battery life and reduce power consumption, research will concentrate on sophisticated power management solutions. Implementing energy-efficient hardware and software techniques will be paramount to ensure prolonged usability without frequent recharging.
- *Effective Cooling Mechanisms*: Enhancing cooling mechanisms will be a priority to maintain optimal operating temperatures, especially during extended use. Innovative cooling techniques, such as passive and active cooling systems, will be explored to prevent overheating and ensure system reliability.
- *Aesthetic Customization*: Recognizing the importance of personalization and aesthetics, future work will include customization options for prosthetic arm users. This will encompass the design and integration of customizable covers and appearances to cater to individual preferences and needs.
- *Connectivity Options*: The integration of versatile connectivity options will be a focal point, enabling seamless communication with external devices and networks. Research will delve into Bluetooth, Wi-Fi, and other wireless technologies to enhance the prosthetic arm's connectivity and functionality.

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Augmented Humanoid Counselor for Mental Health using LSTM Neural Network

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***Abstract*— In every period of life, from childhood and adolescence to maturity, mental health is vital. Good mental health allows individuals to enhance their overall quality of life. However, due to a lack of willingness, many people neither share their mental health issues with their close ones nor seek professional help. To address this issue, we have developed a lifelike counselor who can offer effective and compassionate mental health conversations by uniting natural language processing and augmented reality. The Augmented Humanoid Counselor, a virtual counselor equipped with a conversational model, is designed to give a human touch by assisting individuals to manage their mental health. We have designed various neural network-based conversational models using Long Short-Term Memory (LSTM), Bi-directional LSTM, and LSTM with an attention layer. The LSTM model, enhanced with an attention layer, enables itself to concentrate on the input sequence's most instructive segments while disregarding the less important ones, and thus has demonstrated its ability to provide more interactive, relatable responses compared to other models. This conversational model is used by our Augmented Humanoid Counselor to respond to the user in a sympathetic way to give them support for their mental health and make them feel better.**

***Index Terms*— augmented reality, natural language processing, neural network, deep learning, humanoid, counselor, mental health, LSTM, BiLSTM and attention layer.**

I. INTRODUCTION

Mental health is one of the most crucial components of both individual and community well-being. It can affect not only one's way of living life but also one's connections and physical health. However, this also works vice versa. Interpersonal relationships, medical issues, and aspects of people's lives can all affect mental health. A person's ability to enjoy life, lead a healthy lifestyle, and be more productive in both their personal and professional lives can be maintained by taking good care of their mental health. Recognizing the significance of prioritizing mental health and taking actions to maintain and improve it is essential.

In this research work, we have created an augmented humanoid counselor with the intention of offering a resolution to people facing mental health issues. An augmented humanoid counselor is a virtual human that acts as a mental health counselor in augmented reality, an accessible medium that offers a seamless experience. It offers an environment for people to share their feelings, emotions, and thoughts and receive moral support whenever they require it. In addition to providing a safe and non-judgmental space to talk about mental health, augmented reality has been incorporated into our application to enhance the user's experience and understanding of their mental health and to create an immersive and interactive experience for users.

Our augmented reality and natural language processing-based application using the LSTM neural network is

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developed to provide a unique and engaging platform for people to improve their mental health, gain insights into their own mental health, and develop skills to manage their mental health challenges. As compared to traditional face-to-face counseling or even chatbots, people will feel less stigmatized by seeking help from an augmented counselor, which could encourage more people to get mental health care; hence, we believe that our augmented humanoid counselor can make a significant contribution to mental health improvement.

II. Related Work

With so many individuals suffering from different mental health issues, the mental health crisis has grown to be a global concern. The aim of this literature survey is to examine the existing solutions available in the sphere of mental health research.

A chatbot application that uses natural language processing to comprehend the user's state and sensitively observe ongoing emotional changes in the user has been introduced using emotion recognition techniques to generate personalized responses in the paper [1]. According to the paper [7], many factors contribute to the high rate of mental health problems among students; hence, a chatbot has been developed using emotion recognition, especially designed for students, to promote their mental health and resolve the students' mental health issues at the right time.

The paper [9] proposes that conversational systems based on artificial intelligence can be effective in suicide prevention and cognitive-behavioral-therapy (CBT) if there are applications that can identify suicide intent on various platforms, such as social media platforms, browsers, etc. Work has been done to detect and prevent suicide using deep learning algorithms.

Deep learning and machine learning techniques have proven to be the most effective approaches for depression detection. A convolutional neural network has been used on audio data and the transformer model BERT on textual data to detect whether a person has depression or not [11].

The study of the paper [12] adds to the body of knowledge by outlining specific, well-organized areas for future research in the field of artificial intelligence and mental health and describing the framework for mental health chatbots in public organizations. The papers [13-14] show that the use of DialoGPT, an advanced transformer model, makes the chatbot more accurate in handling conversations related to mental health issues as the generated responses appear to be more real.

Interactive digital representations of real humans, known as "virtual humans" are capable of recognizing actual humans and giving appropriate verbal and behavioral responses [2]. Along with human-to-virtual human interactions, human-to-virtual animals' interactions are the potential benefit of using augmented and virtual reality [3].

Virtual humans have the capability to act as breathing coaches [8]. Multiple factors are considered while establishing trust between the user and intelligent adaptive agents, such as augmented and virtual agents, which include expression and lip synchronization with the speech and behavior of the agents [4].

The facial expression of a virtual and augmented human should be dynamic to make it realistic [10]. A spoken interaction between two avatars in augmented reality has been presented in the paper [5]. The paper [6] presents a virtual assistant for mental health using a Naive Bayes classifier and neural network to analyze sentiment.

LSTM, a type of recurrent neural network, excels at preserving and utilizing long-term information. Its ability to capture and process sequential patterns makes it a popular choice for various tasks, such as natural language processing [15]. Bidirectional LSTM (BiLSTM) has the capability to capture contextual information from past and future contexts simultaneously. BiLSTM has proven to be effective in tasks where understanding the entire sequence, including its surrounding context, is crucial [16].

Chatbots for mental health cannot offer real human empathy or emotional support as they don't deliver realistic experiences. Users can become completely disengaged from mental health support if they experience unsatisfactory interactions with chatbots. The use of augmented reality and natural language processing makes mental health support more motivational and engaging due to its ability to construct immersive and interactive environments. Compared to text-based chatbots, users can have a more human-like experience with an augmented counselor because they may see and interact with a relatable or humanoid counselor.

III. Problem Statement

A lot of individuals struggle with mental health conditions like stress, anxiety, and depression. However, people do not prioritize their mental health when they are in bad mental health. Many people are unwilling to share it with their loved ones or seek expert assistance. This could have serious consequences that lower one's productivity.

Therefore, in order to address this problem, we have created an augmented reality and natural language processing-based application that can assist those who are struggling with mental health issues through friendly and empathetic conversations.

IV. Proposed Methodology

A. System Architecture

The system has been designed by uniting augmented reality and natural language processing, as shown in Fig. 1. Augmented reality is used to create a virtual humanoid counselor that appears to be a human counselor. Natural Language Processing is used to develop a conversation model that is used by our Augmented Humanoid Counselor to give responses to the user. The user needs to give the camera and microphone access to start with the application. Location tracking and flat surface detection are used to render the AR human at the appropriate place. The user's question or statement is taken as input text. The input text is given to the conversational model; the conversational model in the backend sends appropriate responses to the user, which are then delivered as speech. In this way, the user gets the feeling that our augmented counselor is talking with them.

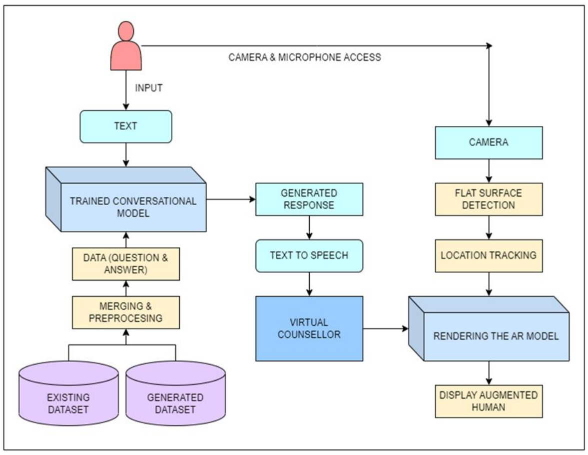

Figure 1. Proposed System Architecture

B. Questionnaire

With the help of counselors, a questionnaire has been generated. It is a type of evaluation technique used to learn more about a person's mental health and wellness. A number of questions or statements about many areas of mental health, such as mood, emotions, behavior, and cognition, are included in it. A questionnaire is designed to assist in better understanding a patient's mental health condition and spotting any possible problems. The questions are related to symptoms and behaviors in accordance with mental health issues. These questions are presented to the users one at a time, their responses are recorded, and a score is created based on their responses. Using a mathematical model, the score assesses whether or not a person requires support with mental health counseling.

C. Conversational Model

The objective is to develop a model capable of comprehending human language, understanding its meaning, and generating appropriate responses that make sense in the context of the discussion.

1. *Data Collection***:** The dataset consists of dialogues in the form of questions and answers. We have used the empathic dialogue dataset, which comprises open-world dialogues. We extracted questions and answers from the dialogue, which accounts for more than 64,000 open-world questions and answers. Additionally, various dialogue interactions between counselors and mental health patients were used. The dialogues were converted into questions and answers, which accounts for more than 20,000 question and answer creations. Furthermore, we incorporated a dataset from various mental health organizations FAQs, that encompasses frequently asked questions about various mental health issues; this accounts for more than 2500 question and answer creations. All these were merged, which led to the formation of a huge database that accounts for more than 2,50,000 questions and answers.
2. *Data Pre-processing***:** All the data gathered is presented in question-and-answer format. The collected data is processed to eliminate noise and clean up the text.

3. *Tokenization:* In the case of LSTM models, tokenization, a crucial step in natural language processing (NLP), is especially significant. Tokenization is used in LSTM models to turn unprocessed text data into numerical vectors that can be given to the model.
4. *Model Building:* By specifying architecture and configuring hyperparameters, the LSTM, Bi-LSTM, and LSTM with Attention Layer models are developed. The model is built to accept input sequences and produce predicted word or phrase sequences.
5. *Model Training***:** Prepared data is utilized to train the LSTM models. To reduce the loss function, the model's parameters are modified as we fed the input sequences into it.
6. *Hyper parameters Tuning***:** At each stage of model training, the rate of learning, batch size, and epoch numbers are adjusted to enhance performance.

D. Model Architecture

*Seq2seq Encoder Decoder Model based on LSTM***:** The encoder block of our model incorporates LSTM cells to sequentially process each token in the input sequence, as shown in Fig. 2. Its objective is to extract all the relevant data from the input sequence and condense it into a fixed-length vector known as a "context vector." Once the encoder has processed all the tokens, it transfers this context vector to the decoder.

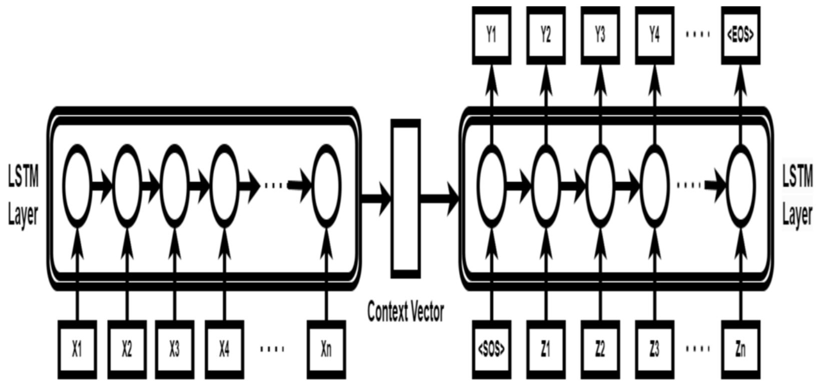

Figure 2. Seq2seq Encoder Decoder Model based on LSTM

The context vector is specifically designed to encompass the complete meaning of the input sequence, enabling the decoder to generate accurate predictions when constructing the target sequence. In contrast, the decoder consists of LSTM cells as well. It initially receives the context vector generated by the encoder as input and proceeds to predict the tar-get sequence token-by-token. The process is as depicted below:

Step 1: At the initial time step, the decoder takes a special symbol "<SOS>" as input to signify the beginning of the output sequence. Using this input along with the context vector, the decoder generates the output for the first time.

Step 2: During the second time step, the previous output becomes the input for the ongoing step. The output produced in this time step represents the second word in the target sequence.

This pattern continues for subsequent time steps, where the output of each step is used as input for the next step. The process persists until the decoder generates the special symbol "<EOS>", which indicates the end of the output sequence.

Seq2seq Encoder Decoder Model based on Bi- LSTM: The encoder block in our model consists of three Bi-LSTM layers as shown in the Fig. 3. The input sequence in the first layer is processed in both forward and backward directions, which captures data from both future and past time steps. This layer aims to encapsulate all the relevant in-formation and passes its output data as input to the second Bi-LSTM layer. Similarly, the second layer output serves as input to the third Bi-LSTM layer. This sequential processing enables the encoder to have access to data from earlier and future time steps at the current time step. Ultimately, the last output of Bi-LSTM layer serves as the context vector representation for the input sequence, which is then passed on to the decoder. The context vector is specifically designed to grab the entire understanding of the input sequence and offers a more accurate and comprehensive representation compared to the one generated by a standard LSTM. The decoder component consists of LSTM cells. It takes the context vector generated by the encoder as its initial input and proceeds to predict the target sequence token by token. The process follows the same framework as the decoder block of the LSTM-based sequence-to-sequence (seq2seq) model consisting of encoder-decoder model. The output sequence generated by this architecture is more precise and well-structured compared to the output produced by a standard LSTM model.

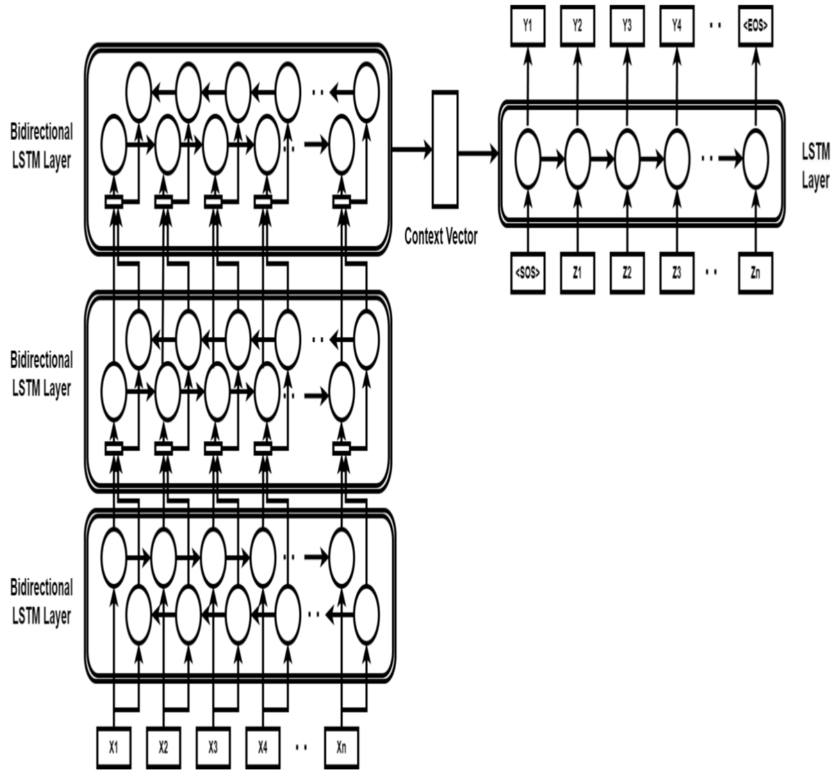

Figure 3. Seq2seq Encoder Decoder Model based on Bi- LSTM

Seq2seq Encoder Decoder Model consisting of LSTM and Attention Mechanism: The LSTM and Bi-LSTM-based model described earlier faces a significant limitation when working with long sequences. As the model processes more tokens in the input sequence, important information from the initial tokens tends to be diluted or lost. This is due to the context vector, which is responsible for encoding the input sequence's information to a fixed-length vector. However, this vector's limited capacity makes it challenging to handle longer sentences effectively. The context vector tends to prioritize recent important tokens over earlier ones, leading to a loss of information. To overcome this challenge, an attention mechanism was introduced.

The attention mechanism addresses the issue by allowing model to moderately focus on input sequence for generating the output sequence. It takes into account the outputs of the LSTM cells in the last encoder layer at each time step. There are two types of attention mechanisms: global attention, which considers all hid-den states/outputs of encoder layer at different time steps, and local attention, which focuses only on the most recent hidden states/outputs of the encoder layer.

In our model, we have implemented a global attention mechanism to ensure that attention is given to the entire input sequence by considering all time step out-puts as shown in the Figure. By incorporating the input sequence, context vector, and attention mechanism, we aim to generate more accurate, contextually relevant, and well-structured responses. Moving on to the decoder block, it consists of LSTM cells. The initial input to decoder includes the context vector generated by encoder, along with the information from the attention layer. The decoder then predicts the target sequence based on token using the following process: At every particular time step, the decoder takes a special symbol "<SOS>" as input, and mark the start of the output sequence. Utilizing current input, the con-text vector, and the attention layer information, the decoder generates the output for the ongoing time step. The result from the previous time step and the attention layer data are also considered at each time step. This process functions iteratively, with each step result tends to become the input for the next step. The iteration persists until the decoder generates the special symbol "<EOS>", signifying the end of the output sequence.

Therefore, we have employed a Seq2seq Encoder-Decoder model consisting of LSTM and Attention Mechanism to address the challenge of generating more contextually accurate and well-framed responses for user queries or inputs.

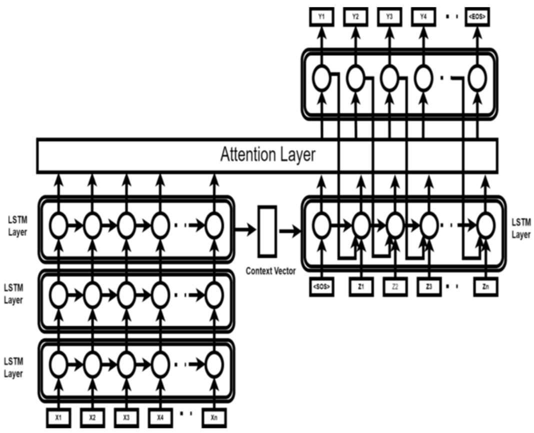

Figure 4. Seq2seq Encoder Decoder Model consisting of LSTM and Attention Mechanism

E. Augmented Humanoid Counselor

Augmented reality technology combines real-time computer-generated graphics and objects with one's view of the natural world. The purpose of augmented reality (AR) is to overlay a virtual humanoid counselor onto the physical environment.

i. *User Interface*: In augmented reality (AR), user interfaces are created to give users a way to interact with virtual items and information superimposed over the real-world environment. In our application, users can interact through text.
ii. *Camera and Microphone Access*: To provide users with more immersive experiences, access to the camera and microphone is a crucial element in AR applications. Camera access is needed to detect the real world. Microphone access is used by the augmented counselor to speak.
iii. *Flat Surface Detection*: Floor is detected by a plane detection mechanism to position virtual items and link them to actual surfaces. This is accomplished by looking at the camera feed and locating regions of the image that seem to be planar surfaces.
iv. *Location Tracking*: It makes it possible to attach virtual objects to specific locations in the real world, resulting in a more realistic AR experience. The location of the floor surface is captured with respect to the user for placing the virtual counselor in the physical world.
v. *Rendering AR Human*: The process of showing computer-generated objects in the physical-world environment is known as rendering in augmented reality (AR). In order to show AR humans accurately in the user's field of view, our application uses real-time rendering. To avoid lag or other performance problems, the virtual counselor is rendered swiftly and effectively.
vi. *Text to Speech*: Text to speech plugin is added to convert the text into speech and is synchronized with the AR model.

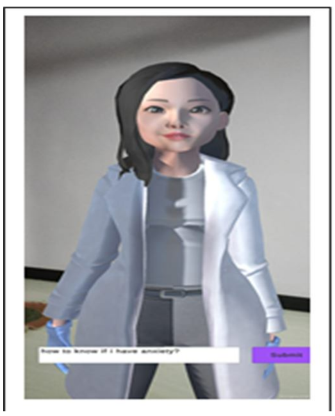

Figure 5. Augmented Humanoid Counselor

V. RESULT AND ANALYSIS

Our conversational model was developed using Long Short-Term Memory (LSTM), which excels at preserving and utilizing long-term information; Bi-Directional LSTM, which captures contextual information from past and future contexts simultaneously; and LSTM with Attention Layer architectural models.
The LSTM model's accuracy has shown notable progress over the course of training. Fig. 6 shows that starting at 88% accuracy after 300 epochs, it increased to 97% after 400 epochs. These results demonstrate that the model has steadily improved its ability to make predictions accurately and has developed a strong understanding of the hidden patterns in the training data.

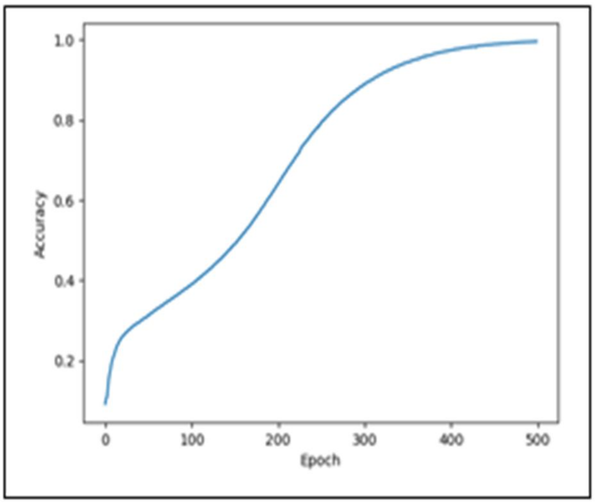

Figure 6. LSTM based Seq2seq Encoder Decoder Model's Accuracy

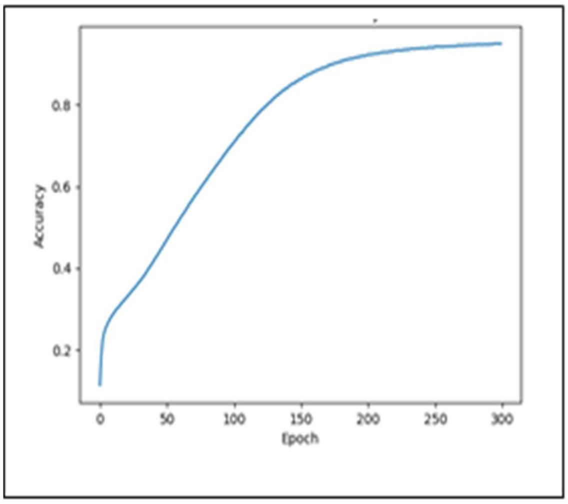

Figure 7. BiLSTM Seq2Seq Encoder Decoder Model's Accuracy

The bidirectional LSTM model, trained for 300 epochs, has demonstrated impressive performance with an accuracy of 95%, as shown in Fig. 7. The BiLSTM architecture permits the model to reflect dependencies in both past and future contexts by incorporating both forward and backward information flow. This enables the model to effectively understand persistent dependencies and relationships within data that are arranged sequentially. The achieved accuracy of 95% indicates that the BiLSTM model has successfully captured important contexts from the training data.
Fig. 8. The LSTM with Attention model, trained for 75 epochs, has demonstrated remarkable performance with an accuracy of 97%. The LSTM architecture with an attention mechanism enables the model to concentrate only on the input sequence's most instructive segments while disregarding the less important ones. Overall, the LSTM with Attention model's high accuracy and ability to selectively attend to informative input features make it a promising approach for sequence prediction tasks.

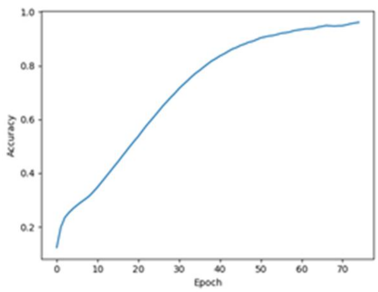

Figure 8. Accuracy of Seq2Seq Encoder Decoder LSTM Model with Attention Layer

The accuracy of each conversational model at a given number of epochs is displayed in the above table. As the model is modified from LSTM to Bi-LSTM and Bi-LSTM to LSTM with Attention Layer, the number of epochs required to obtain the desired accuracy is reduced. Hence, the AR model is integrated with the Seq2Seq Encoder Decoder LSTM Model with Attention Layer, which gives the best result in friendly conversations.

TABLE I. ACCURACY TABLE

Model	Number of Epochs	Accuracy
LSTM	400	97.2%
Bi-LSTM	300	95%
LSTM with attention layer	75	97%

VI. CONCLUSIONS

In this research project, we have successfully developed an interactive and immersive experience for individuals dealing with mental health issues using natural language processing and augmented reality technology. We collected data from various sources, performed data cleaning and pre-processing, and trained various neural network conversational models, which included an LSTM model, a BiLSTM model, and an LSTM with Attention Layer model for text generation. Our findings indicated that LSTM with Attention Layer gives the desired accurate results for conducting mental health-related conversations, as it has displayed remarkable performance after being trained for 75 epochs with an accuracy of 97%. The model was integrated with an augmented human designed to act as a counselor for users, and text and voice interaction were enabled using text-to-speech modules. The application was deployed on AR-supported mobile devices for easy accessibility. Overall, the project demonstrated the potential of NLP and AR technology in addressing mental health issues and providing individuals with a supportive and interactive platform to improve their mental wellbeing.

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Improving Packet Delivery Ratio in ZigBee Network using Genetic Algorithm and Simulated Annealing Algorithm

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***Abstract*— Genetic Algorithms and Simulated Annealing Algorithms (GASA) in a multichannel approach increases efficiency for ZigBee Networks. This study sought to increase the Packet Delivery Ratio (PDR) through the interference mitigation techniques for multi-channel technology. Furthermore, ZigBee and Wireless LAN (WLAN) both operate on the 2.4 GHz band, referred to as the industrial, scientific, and medical. Based on a cluster-tree construction protocol in multi-channel Wireless Sensor Network (WSN) can be used for robust data transmission. ZigBee faces severe interference problems in the presence of WLAN and we developed novel interference mitigation avoidance technique to improve conditions for the coexistence of ZigBee and WLAN.**

***Index Terms*— Packet delivery ratio, Wireless sensor networks, Multi-Channel, ZigBee**

I. INTRODUCTION

In recent times, developments in Micro-Electro-Mechanical Systems (MEMS) equipment, digital electronics and wireless communications ought to empower the growth of low-power, low cost, multifunctional nodes are trivial in size and interrelate unchained in small spaces. Centered on the concerted strength of a huge quantity of these insignificant Wireless Sensor Network (WSN), sensor nodes are independent and control unattended. So, it is extensively deployed in atmosphere, health, home-grow, military and other profitable areas [1]. ZigBee is a different standard envisioned for low-cost strategies in home panels, computer peripherals and automation. It qualifies the broad-based distribution of wireless networks through low power, low-cost resolutions [2, 3]. The low-rate wireless network well-defined through the ZigBee Alliance and established in the IEEE 802.15.4. The standard is directing to be a low control, low-cost resolution for schemes entailing of unendorsed assemblies of policies in firms, factories and workplaces. Predictable uses for ZigBee are constructing automation, security methods, remote meter reading and isolated control and computer peripherals [2]. ZigBee grosses full gain of a commanding physical radio quantified by IEEE 802.15.4. For ZigBee associations of firms controlled to progress provisions covering the network, application profile layers so that viable prospective of the principles could be appreciated [3, 4].

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Observing at ZigBee the key add-ons or changes in terms of the coalition mission declaration are open standard, networked, and low power. The standard 802.15.4 also states of a 10m range and POS (Personal Operating Space) but make out the probability for bigger series at minor data amounts [4]. So, through the drivers of easiness, extended battery life, interacting competencies, short cost and consistency, ZigBee should be extensively used in personal health care, building automation, PC & amp; peripherals, customer electronics, trade control, occupied/light and viable controller [3]. Operating frequency for ZigBee is 2.4GHz.

II. Literature Review

After Motivation on the ZigBee kit, a Nanoscale Wireless Sensor Networks (NWSNs) with close loop of sign is anticipated. In the NWSNs network layer and the Medium Access Control (MAC) layer of ZigBee is absolutely taken completed, and a fresh node, together its software and hardware execution, is considered that assimilate the ZigBee module and WSN node organized. An incorporated WSN access attained in this recognition presented a proficiency of distributing data, concerted managing and real time observing. At the comparable time, it also seen the need of evolving of records attaining and switch scheme in industrial automation. Conversely, the apprehension and the presentation of NWSNs in industrial still essential greatly further investigate and assessment. But then all of the features have revealed that the NWSNs will require a massive array of projections [5]. The performance of Multi-Channel Cluster Tree (MCCT) protocol is improved with Adaptive Cross Approximation (ACA) algorithm to reduce the possessions of hardware confines and empower employment of multi-channel machinery in cases where Wi-Fi and Zigbee networks concur. Every sensor node surrounded by the system successively probes all channels by carrying out PDR extents order to regulate their tenure level. The director achieves designs for every channel to certify that every node donates to the assortment of the optimum channel in agreement with proven significances. Every sensing area is dispensed a diverse channel to evade impacts and reserve Packet Delivery Ratio (PDR). Dimensions attained in the real-world execution validate that the anticipated multichannel technology could escalate the toughness of the given network. star pacts norms only channel with several transmission intermissions in order to augment the PDR; though, the quantity of effect increases with a rise in the quantity of working nodes. The mixture of ACA process with multi-channel dispensation makes conceivable to augment the program concert for all nodes and raise PDR for all nodes to among 94 and 99%. Further research combines a greater number of wireless strategies in demand to progress the series of the method [6]. Subsequently sensor nodes are motorized by non-rechargeable battery, network period is restricted. In order to advance energy convertible and promote period of the network and significant to increase abilities like access channel mechanism, communication protocol and routing. An Adaptive WLAN Interference Mitigation algorithm gives improved ZigBee performance than another algorithm [8]. Adaptive channel system for a multiple channel wireless network describes a decision function for the channel [9]. Multiple channel communication planned as alternate to adaptive routing method for mitigating the effect interference and link undercurrents in WSN [10]. Analysis of multi and single channel message over a direct in the terms packet reception ratio, temporal correlation of losses, frequency correlation of losses and maximum burst loss. A WBASN (Wireless Body Area Sensor Network) consists of several sensors and coordinator to monitor the organic signals. It can be complete by using Interference Mitigation method [11]. A two-layer structure that is WLAN and WPAN of Zigbee network can be executed to decrease the intermediate wireless nodes and unbalance load on gateway node [12]. End nodes connected with sensors and cooperative the readings to the base station. from the node's sensor readings, the host computer is answerable for structure of data base [14]. These two schemes are collaborating using wireless long-distance range and transmission method. solar panels are fast an ever-increasing foothold in culture particularly on the top of the houses for local electrical appliances [24]. An ad hoc wireless sensor indirect network consists of a quantity of small and nodes connected using actual ZigBee networks [29]. The network consists of coordinator which wirelessly collect humidity and temperature data from several nodes that are answerable to provide persons data. Each sensor is developed from ZigBee wireless module based on ZigBee/IEEE 802.15.4 standards, Arduino based microcontroller, and humidity and temperature sensor devices. The ZigBee network is extra suitable for low data rate. ZigBee network is original wireless technology with the characters of low consumption, less complexity and low cost [30].

In WSN there are issues in three different categories such as underlaying operating and internal platform system, network services and communication protocol [32]. Zigbee network is consist of end device, repeater and coordinator each element has different specification such as temperature monitoring. It is demonstrated in outdoor under 50meters and in indoor less than 20meters distance by using JN5168 development board [36]. The successful packet transmission and the effect of bandwidth on the network is analyzed by determining the number of nodes and minimum length. The probability of dependence is determined for both cases i.e., the presence and absence of noise in the channel. With the emergence of metaheuristic-based optimization algorithms, there has been a significant improvement in the energy efficiency and overall performance of the WSNs and Zigbee protocols [33].

III. Purpose Methodology

A. MOEA (Multi-Objective Evolutionary Algorithm)

The MOEA (Multi-Objective Evolutionary Algorithm) is defined. Distinct former problem optimization systems like the least square method, this method could attain the universal optimum resolution, and does not certainly drop into local optimum resolutions. The MOEA algorithm is segmented into the subsequent four stages.

Step 1: Modify single population with N individuals arbitrarily, and then use innate operators such as mutation, tournament selection and crossover to produce one offspring population.

Step 2: Combine population with offspring population, and generate single population with 2N individuals. Then, procure incompatible non-dominated fronts over organizing built on non-domination.

Step 3: Fill non-dominated fronts into the next populace with N individuals.

Step 4: If quantity of growth compeers does not outstrip the supreme assessment set in progress, the system endures.

B. HSSA (Hybrid Simulated Annealing Algorithm)

Hybrid SAA system chiefly includes 4 stages: Initialization of mutation, crossover, populace vector & selection phase: The steps given below elucidate the Hybrid SAA working: The network involves of set of nodes and is represented as in equation 1,

$$S = \{s1, s2, s3, s4 \ldots\ldots sn\} \ \ldots\ldots\ldots (1)$$

- ➢ The cluster heads are nominated from set of nodes.
- ➢ The set of nodes are connected to cluster head to form a cluster.
- ➢ The range of random value is [0,1] from this population vector is initialized.
- ➢ The succeeding step involves mutation tracked by crossover is used in assortment method to choose next Gen vectors.

The model of radio degeneracy embraces two units the receiver and transmitter that established apart by distance d. The communication sector comprises the amplifier to transmit electronics and the receiving electronics are portion of receiving sector; that conveys the information in form of bits. It is assumed that rectangular filed contains of nodes. The nodes require E_{TX} quantity of energy to communicate and to receive the K data over a distance d is amount of energy E_{RX} are given as follows in equation 2 and 3:

$$E_{TX} = 0\left\{\begin{array}{l} kE_c + k\varepsilon_{AF} d^2, d \le d_0 \\ kE_c + k\varepsilon_{Amp} d^2, d \le d_0 \end{array}\right\} \ldots\ldots.. (2)$$

$$E_{RX} = kE_c \quad \ldots\ldots (3)$$

The energy distributed to transfer data of single bit is indicated as ‘E_c’. The phase of intensification from the transmission amplifier in the free space is specified by ‘εA_F’ and amplifier coefficient consenting for multi-path is stated by ‘εA_{mp}’. The observations about network are noted.

The observations about network are noted.

- In network it measured that nature of nodes is quasi-stationary.
- The sensor nodes be contingent on their distance to also the base station.
- Nodes don’t know about their own location.
- All network node is like kind.
- Nodes organize and need no monitoring when they are organized.
- Power levels in each node are fixed.

Performance Metrics

- ➢ k, packet size
- ➢ E_c

The energy expended to communicate data by single bit.

- No of nodes
- Initial energy of nodes
- Analysis of given number dead node to number of iterations

This analysis shows that variation in the number of iterations to change in number of dead nodes.

- Analysis of given number active node to amount of iterations.

This analysis shows that when number of nodes in profile changes then alive nodes increases.

- Analysis in residual energy to number of iterations

This analysis shows that when number of rounds changes then remaining energy of Zigbee.

- Analysis throughput with respect to number of iterations

This shows how the proposed method performs with respect to further method such as HAS, MHSA, LEACH and DE algorithms in the form of throughput.

IV.Results And Discussions

The results are evaluated based on proposed algorithm, the transmission cycle time for different intervals, Round (Node (a), node(b), node(c), node(d), node (e), node(f), node(g), node(h)) vs Packet delivery ratio has been analyzed and validated between ACA algorithm and novelty GASA optimization. From this simulation results, GASA optimization novelty methods increase the PDR of all nodes compare than previous ACA methods illustrated in Figure.1,2 and 3.

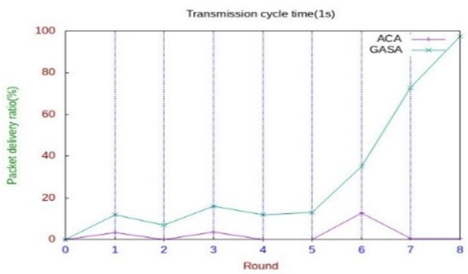

Figure 1. Transmission cycle vs PDR for 1 sec

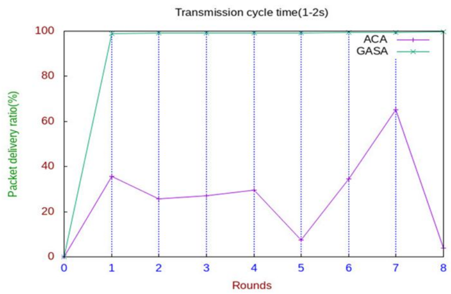

Figure 2. Transmission cycle vs PDR for 1-2 sec

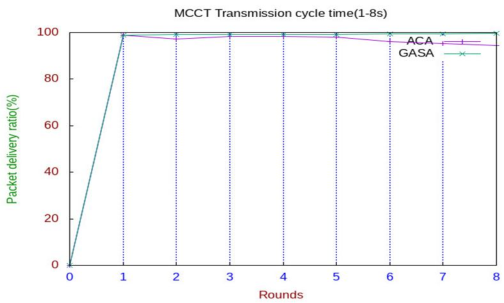

Figure 3. Transmission cycle vs PDR for 1-8 sec

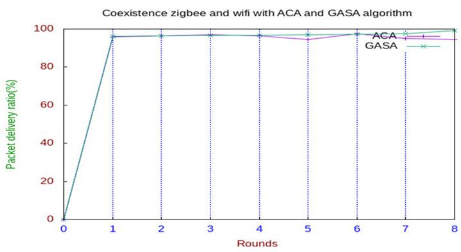

Figure 5. Performance of ACA and GASA for coexistence of Zigbee protocol and Wi-Fi

The Coexistence ZigBee and wifi with and without algorithm is illustrated in Figure 4 and Figure 5, round vs Packet delivery ratio has been analysed and the PDR of all nodes increases using algorithm compare to In the above Figure 4 and Figure 5 without using algorithm.

V. CONCLUSIONS

This paper addressed the problem of coexistence between Zigbee protocol and Wi-Fi in a multichannel environment using a hybrid GASA optimization algorithm. The Packet Delivery Ratio for GASA optimization novelty methods increase compared to ACA algorithm. The modified multichannel protocol with GASA algorithm minimizes effect of interface.

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Uncertain -Z Numbers Based Face Sketch Recognition

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***Abstract*— This research explores the fusion of fuzzy constraints and reliability to model human behaviors, referred to as Z-Numbers. However, Z-Numbers rely on specific information representation concepts, whereas it is widely acknowledged that interval concepts align better with our daily experiences. This motivation drives us to employ an enhanced version of Z-Numbers to address real-world challenges, such as the Sketching with Words (SWW) problem. SWW aims to automate the ranking of criminal face sketches in descending order of similarity, given that observer statements are fraught with perceptual uncertainties and fuzzy linguistic terms. Consequently, a dependable tool is imperative for practical problem-solving. The utilization of interval-valued complex fuzzy sets, centered on uncertain Z-Numbers, emerges as a promising approach to address such perception-based multicriteria group decision-making issues. In our proposed work, we incorporate uncertain Z-Numbers within the framework of interval-based fuzzy constraints and reliability. This approach aims to minimize the chances of criminals evading justice while safeguarding the rights of the innocent.**

***Index Terms*— first term, fuzzy-geometry; Computing with word; Aggregation Operator; Z-Numbers**

I. INTRODUCTION

In 2011, Zadeh [1] introduced the concept of Z-numbers as a powerful tool for representing uncertain information encountered in our daily lives. One practical application of Z-numbers is the sketching of a criminal's face based on eyewitness descriptions, which inherently involve uncertainty. While Z-numbers possess a natural structure, their practical applications have encountered certain limitations. To enhance the utility of Z-numbers in solving real-world problems, a reliable framework is essential. In pursuit of this goal, the seminal work of maximizing entropy was proposed [2] to construct an objective function for optimization. Additionally, various scholars have delved into related operations involving Z-numbers, including arithmetic operations, distance measures, similarity measures, and score functions. Aliev et al. [3], [4] defined operations for both discrete and continuous Z-numbers, while in author [5] introduced negation operations for discrete Z-numbers. Furthermore, Z-numbers have been integrated with other established theories, such as linguistic Z-numbers combined with the normal cloud model and the trapezium cloud model in [6] and [7], respectively. Bayesian networks have also been updated using Z-numbers [2]. Expanding on the advantages of Z-numbers in handling uncertainty, the VlseKriterijum-ska Optimizacija I Kompromisno Resenje (VIKOR) method was extended to Z-VIKOR in [8]. Moreover, Z-numbers were incorporated into the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) [9]. Furthermore, the concept of complex fuzzy sets (CFSs) was introduced by Ramot et al. [10], extending the notion.

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of type-1 fuzzy sets to include a codomain within the complex plane. Despite this added dimension, the fundamental concept of fuzziness remains intact in CFSs [10, 11]. Alkouri and Salleh [12] introduced complex intuitionistic fuzzy sets (CIFSs) based on CFSs and IFSs. Additionally, in [13], Pythagorean and CFSs were combined to create complex Pythagorean fuzzy sets, and [14] introduced extended Z-numbers ZE =(A, B), E) with the inclusion of credibility factor E. The integration of Z-numbers with Atanassov's Intuitionistic Vague Imprecise Fuzzy Sets (AIVIFSs) was explored in [15]. In contrast, [16] introduced linguistic Z-numbers based on a polar coordinate system, while [17] proposed Z-Numbers Based on Complex Fuzzy Sets to address unmanned aerial vehicle purchasing problems. Furthermore, [18] presented a decision-making model based on Pythagorean fuzzy sets to solve Z-information problems.

The term "Sketching With Words" (SWW), coined by Beg et al. in [19], revolves around fuzzy geometric objects. SWW leverages concepts from f-geometry [20-21] and Computing With Words (CWW) [22]. In [23], SWW was applied to perception-based face recognition, aligning its computational framework with Z-numbers. Subsequently, in [24], SWW and Z-Numbers were integrated to create criminal face sketches, and [25] produced rankings of fuzzy similar faces using linguistic quantifiers such as "at least half," "as many as possible," and "most."

To enhance the ranking of fuzzy faces further, this paper employs the interval concept of fuzzy constraints and reliability on Z-numbers. This approach aims to reduce the chances of criminals evading justice and prevent the wrongful accusation of innocents. The remainder of this paper is organized as follows: Section 2 introduces the basic concepts of f-geometry, Z-numbers, SWW, and Complex Fuzzy Sets (CFS). In Section 3, we explain Enhanced Postulate Improved Z-numbers (IVZ) and Interval-valued Complex Fuzzy Sets (IVZCFS). Section 4 details the algorithm, while Section 5 discusses applications. Section 6 presents experimental work and results, and the final section includes conclusions and future directions.

II. PRELIMINARIES

Zadeh's concept of 'f-geometry' [1] represents an endeavor to formalize the cognitive capacity of the human brain for measuring and manipulating information in the context of machine-based operations. F-geometry is an exemplar of "Flu," which stands for Fuzzy Logic Uncertainty. Flu hinges on the foundation of fuzzy validity (f-validity) reasoning, a tool that emulates the remarkable human ability to perform a diverse array of physical and mental tasks without relying on precise measurements or extensive computations. Within f-geometry, various types of f-objects, such as fuzzy lines, fuzzy circles, fuzzy semicircles, and fuzzy triangles, are employed to represent their crisp geometry counterparts, including lines, circles, semicircles, triangles, rhombuses, squares, and rectangles, as depicted in Fig.3 for reference. F-geometry serves as a counterpart to Euclidean geometry within the realm of crisp (non-fuzzy) theory. In f-geometry, shapes are sketched freehand, devoid of conventional geometric instruments. The distinctive facial features of foreheads, eyes, noses, lips, and chins are conceptualized as fuzzy semicircles (f-semicircles), fuzzy circles (f-circles), fuzzy triangles (f-triangles), fuzzy circles (f-circles), and fuzzy semicircles (f-semicircles), respectively. These representations are visually illustrated in Figures 1 and 2.

Fig. 1Different types of nose and lips /chins as f-triangle and f-semicircle respectivel

Fig 2. Different types of forehead and eyes as f-semicircle and f-circle respectively.

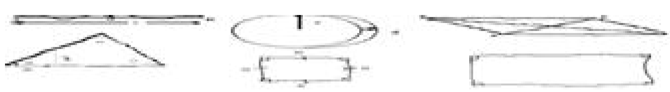

Fig. 3Different types of f-objects like fuzzy line, fuzzy circle, fuzzy semicircle, and fuzzy triangl

Fig 4. Outlines of a face is made of different f-geometric objects

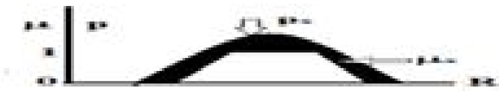

Fig. 5 Membership function of A and the underlying possibility distribution of B

A. Sketching with Words and Z- Number

The concept of "Sketching with Words" (SWW), often abbreviated as 'SWW,' draws its inspiration from both Computing with Words (CWW) and f-geometry. While traditional computing predominantly involves the manipulation of numbers and symbols, CWW introduces a methodology wherein the fundamental units of computation are words and propositions extracted from natural language. For instance, terms like "small eye," "long nose," or "not fairly long chin" [25] become integral elements of the computational process.

In SWW, these linguistic entities, referred to as 'f-objects,' play a pivotal role in constructing the facial sketches of criminals. Furthermore, specific facial features, including foreheads, eyes, noses, lips, and chins, are portrayed as f-semicircles, f-circles, f-triangles, f-circles, and f-semicircles, respectively. Fig. 4. Outlines of a face is made of different f-geometric objects. and symbols, language.

A "Z-number" is essentially a fusion of fuzzy numbers, denoted as (A, B). In the context of this study, the variables 'A' and 'B' are replaced with appropriate mathematical functions. A "Z-valuation" is essentially a measurement or assignment statement in the form of "X is (A, B)." Here, 'A' represents the possibility distribution of X, while 'B' is an interpreted probability value associated with a fuzzy event. The first component, 'A,' acts as a fuzzy restriction denoted as R(X), defining the range of values that X can assume, expressed as "X is A," where 'A' represents a fuzzy set. When X represents a random variable, the probability distribution of X serves as a "probabilistic restriction" on X [1]. Please see Fig. 5.

Perception-based natural language statements can be expressed as "Z-valuations," which are ordered triples (X, A, B) and are treated as assignment statements, such as "X is (A, B)." Simple examples of Z-valuations include statements like "he has small eyes, approximately 2.8 cm in size, very likely," "forehead of the criminal, small, uncertain," or "his nose, small, highly probable."

The parameters 'A' and 'B' within Z-numbers represent the fuzzy constraint and reliability, respectively. These two components are linked through an underlying possibility distribution (UPD). Determining the UPD is typically a challenging task. In previous work [1], compatibility and consistency were considered to calculate the UPD. However, this calculation process involves solving a nonlinear programming problem, which can lead to complex computations, as illustrated in Figure 1. In this context, μA (representing possibilistic constraints) serves as the possibility distribution of X constrained by a fuzzy relation, while pX represents the underlying (hidden) probability density of X.

To enhance the practical utility of Z-numbers, it is essential to develop a dependable approach. In our proposed work, we advance Z-numbers to incorporate uncertain linguistic Z-numbers. The transformation method between uncertain linguistic Z-numbers and interval-valued complex fuzzy sets (IVCFSs) is detailed in [27].

B. Complex Fuzzy Set (CFS)

CFS is denoted as S, defined over the domain U, can be represented as S = {(x, μ S(x))|x ∈ U}, where the membership function μ S(x) takes the form of complex-valued numbers $\boldsymbol{\mu_x = r_s(x)}.\, e^{j\omega_s(x)}$ [14].Here, the values of μS(x) reside in the range [0, 1], and the phase angle φS(x) belongs to the interval [0, 2π].

III. ENHANCED POSTULATE

A. Improved Z-numbers (IVZ)

Considering that an interval concept is more appropriate than a specific concept to characterize the fuzzy constraint and reliability, Peng et al. [17]. Z-numbers were combined with AIVIFSs to transform it into 'uncertain Z-numbers'.

IVZ = ((very high, [0.5 0.7), (sure, [0.7, 0.9)). Expression can be represented by pair of bounded interval IVZ=([S_{a-} , S_{a+}],[H_{b-},H_{b+}]), where Sa− and Sa+ represent the upper and lower bounds of linguistic constraint, respectively. Hb− and Hb+ indicate the upper and lower bounds of reliability, respectively.

B. Inter valued Complex Fuzzy Sets (IVCFSs)

The aim of IVZ is to better represent the fuzzy constraint and reliability. IVCFSs can achieve the aim [20], the desired expression is {anticipated budget deficit, between 1.8 and 2.2 million dollars, likely, very likely}. IVCFSs can be characterized by $\boldsymbol{Js}$ **as** $\boldsymbol{Js} = [\boldsymbol{r^-}_s(\boldsymbol{x}), \boldsymbol{r^+}_s(\boldsymbol{x})] * \boldsymbol{e}^{j[\boldsymbol{\omega^-}_s(x), \boldsymbol{\omega^+}_s(x)]}$ $\boldsymbol{r^-}_s(\boldsymbol{x})$ **and** $\boldsymbol{r^+}_s(\boldsymbol{x})$ represent the upper and lower bounds of amplitude term, respectively. $\boldsymbol{\omega^-}_s(x)$, **and** $\boldsymbol{\omega^+}_s(x)$ indicate the upper and lower bounds of phase term, respectively.

IV. ALGORITHM

An MCGDM method for Z-information is presented based on the proposed operations. Algorithm Process MCGDM has always been closely related to daily life.

Step 1: Conversion of Evaluation Information into Corresponding IVCFS

Like Z-numbers, uncertain Z-numbers exhibit ever-changing distributions for their two components because X is an uncertain variable, not a random one. When natural language is employed to describe these two components of Z-numbers, the implications of A and B become embedded in the corresponding function and distribution, as conveyed through linguistic information [1]. Thus, when linguistic variables in uncertain Z-numbers are transformed into Interval-Valued Complex Fuzzy Sets (IVCFSs), the inherent fuzziness of [S_{a-} , S_{a+}] and the randomness of [H_{b-},H_{b+}] can be embodied using $r^-_s(x)$ and $r^+_s(x)$ and $\omega^-_s(x)$, and $\omega^+_s(x)$.

Definition 1: Given two Linguistic Term Set S and H,

where S = {S_0, S_1,...,S_E|E ∈ N} and H = {H_0, H_1,...,H_F |F ∈ N},

for ([S_{a-} , S_{a+}], [H_{b-} , H_{b+}]), and $$Js = [r^-_s(x), r^+_s(x)] * e^{j[\omega^-_s(x), \omega^+_s(x)]} \quad (1)$$

Employ Definition 1 to convert the evaluation information into the corresponding IVCFCS using $r^-_s(x)$, $r^+_s(x)$ ∈[0,1] and $\omega^-_s(x)$, $\omega^+_s(x)$. ∈ [0,2π]

Step 2: Calculation of the Criteria Weight Vector In general, methods for calculating weights can be categorized into two aspects: subjective and objective. Subjective methods often rely on expert judgments, but their objectivity is questionable. Therefore, many scholars prefer employing objective methods. Among these, the entropy weight method (EWM) is widely accepted due to its high reliability and convenience [23][24].

a. Calculate Generalized Entropy

Entropy, a fundamental concept in thermodynamics and information theory, is typically used to quantify the disorder in a system. Numerous entropy calculation methods have been proposed for classical fuzzy sets [19]. However, to our knowledge, there is currently no approach for calculating the entropy of Z-numbers from the perspective of Complex Fuzzy Sets (CFSs). The generalized entropy, denoted as Eg(J), is defined by equation (2):

b. Calculate the Power-Weighted Average of Interval-Valued Complex Fuzzy Sets

Weight Calculation: For the aggregation operator presented in equation 2,

$$E_g(J) = 1 - [\frac{1}{2}(|r^-_s(x) + r^+_s(x) - 1|^p + \frac{1}{2\pi}|\omega^-_s(x) + \omega^+_s(x) - 2\pi|^p)]^{1/p} \quad (2)$$

Definition 2: Given $\boldsymbol{Js} = [\boldsymbol{r^-}_s(\boldsymbol{x}), \boldsymbol{r^+}_s(\boldsymbol{x})] * \boldsymbol{e}^{j[\boldsymbol{\omega^-}_s(x), \boldsymbol{\omega^+}_s(x)]}$ {i = 1, 2,...,n}, the weight vector {w_1, w_2,...,w_n} is derived as

$$\boldsymbol{w_i} = \frac{\boldsymbol{1 - E_g(J_i)}}{\boldsymbol{\sum_{k=1}^{n}[1 - E_g(J_i)]}} \quad (\mathbf{3})$$

Step 3 Interval-Valued Complex Fuzzy Sets Power Weighted Average (IVCFSsPWA)

We introduce the concept of Interval-Valued Complex Fuzzy Sets Power Weighted Average (IVCFSsPWA), which plays a crucial role in the information fusion process. Let Js represent a set of Interval-Valued Complex Fuzzy Sets defined as

$$\boldsymbol{Js} = [r^-_i(x), r^+_i(x)] * e^{j[\omega^-_i(x), \omega^+_i(x)]} \ \mathbf{\{i=1,2,3,\ldots n\}}.$$

The integrated J, denoted as J, is computed using the following equation (4):

$$J = IVCFSsPWA(J_1, J_2, \ldots\ldots J_n) = J_1 \oplus J_2 \oplus \ldots\ldots\ldots J_n \quad (4)$$

The Integration Operation, as defined by equation (5), allows us to combine these sets effectively:

$$J_1 \oplus J_2 = [1 - \prod_{i=1}^{n} (1 - r_i^-)^{w_i}, 1 - \prod_{i=1}^{n} (1 - r_i^+)^{w_i}]. e^{j[2\pi(1-\prod_{i=1}^{n}(1-(\omega_i^-/2\pi))^{\omega_i}), 2\pi(1-\prod_{i=1}^{n}(1-(\omega_i^+/2\pi))^{\omega_i})]} \quad (5)$$

Step 4 & 5: Distance Measurement and Ranking of Alternatives

To assess the differences and similarities between J1 and J2, we use equations (6) and (7) for distance and similarity measurement, respectively:

$$D(J_1, J_2) = \frac{1}{4}(|r^-_2(x) - r^-_1(x)| + |r^+_2(x) - r^+_1(x)| + |\frac{\omega^-_2(x) - \omega^-_1(x)}{2\pi}| + |\frac{\omega^+_2(x) - \omega^+_1(x)}{2\pi}|) \quad (6)$$

$$S(J_1, J_2) = 1 - \frac{1}{\sqrt{2}}\left(\left(\frac{r^-_1(x)+r^+_1(x)}{2} - \frac{r^-_2(x)+r^+_2(x)}{2}\right)^2 + \left(\frac{\omega^-_1(x) + \omega^+_1(x)}{4\pi} - \frac{\omega^+_2(x) + \omega^+_2(x)}{2\pi}\right)^2\right)^{1/2} \quad (7)$$

V. Application

The application of Z-numbers has already been demonstrated in [27] to generate criminal face sketches based on eyewitness perception. Z-numbers are particularly useful in scenarios where onlookers are bound by specific fuzzy constraints within uncertain environments. Since facial description often involves Multicriteria Group Decision Making (MCGDM), an interval-based approach is adopted to address uncertainty and facilitate more accurate representation of fuzzy constraints. Uncertain Z-numbers (IVZ) extend support for Interval Valued Concepts, which, in turn, align linguistic descriptions more closely with everyday expressions[28] . Consequently, the utilization of IVZ encourages the generation of a list of face sketches, ranked in decreasing order of similarity, which could prove invaluable in apprehending suspects. In this context, IVZ captures both fuzziness and uncertainty through [Sa] and [Hb], respectively. The sets S and H are defined as follows:S = {s0 = extremely small, s1 = very small, s2 = small, s3 = slightly small, s4 = slightly large, s5 = large, s6 = very large, s7 = extremely large},H = {h0 = extremely uncertain, h1 = very uncertain, h2 = uncertain, h3 = slightly uncertain, h4 = slightly certain, h5 = certain, h6 = very certain, h7 = extremely certain}.

VI. Experiments and result

Following the computation of the criteria weight vector for eyewitnesses e1, e2, and e3, the estimated collective evaluation information using the aggregation operator is presented in Tables 5, 6, and 7. Furthermore, Tables 8(a) and 8(b) depict the calculated distances between alternatives and ideal solutions, namely Dp and Dn. In the experimental phase, the input consists of a 'query statement' submitted by the onlooker(s), which serves as a description of facial image1. The relevance of the input image to other stored images is estimated using a relevance matrix. The ranking of different faces is depicted in Figure 6, presented in ascending order of f-similarity, wherein a lower ranking number signifies a higher level of relevance against the input decreasing order.

. TABLE I. Inputs Are In Linguistic Variable

		c1(forehead)	c2(nose)	c3(eyes)	c4(lips and chin)
eyewitness e1	f1	{ slightly small, slightly large, very uncertain, certain}	{ very small, very large, slightly certain, certain}	{ small, slightly small, uncertain , slightly uncertain}	{ slightly large, large, certain, extremely certain}
	f2	{ very small, small, extremely uncertain, slightly certain}	{ large, extremely large slightly certain, very certain}	{ small, slightly small, uncertain, certain}	{ slightly small, large, slightly certain, extremely certain}
	f3	{ small, slightly small, very uncertain, uncertain}	{ large,, very large, very uncertain, certain}	{ small, slightly small, slightly uncertain , slightly certain}	{ slightly large, large , very uncertain, uncertain}
	f4	{ slightly small, large, slightly uncertain, certain}	{ very small, large, very3uncertain,, uncertain}	{ small, slightly small, uncertain , slightly uncertain}	{ slightly small, , slightly large slightly uncertain, slightly certain }
eye wit	f1	{ slightly small, slightly large, extremely uncertain, very certain}	{ small, slightly small, slightly certain, extremely certain }	{ small, slightly small, uncertain slightly uncertain}	{ large, very large, very uncertain, uncertain}

	f2	{ very small, small, uncertain, slightly uncertain}	{ slightly large, , extremely large, uncertain, slightly certain}	{ very small, slightly large, uncertain slightly uncertain}	{ small, , slightly large, sightly uncertain, certain}
	f3	{ very small, extremely large, very uncertain, slightly uncertain}	{ slightly large, , extremely large, slightly uncertain, slightly certain}	{ very small, small, uncertain slightly uncertain}	{ small, slightly small, slightly uncertain, certain}
	f4	{ very small, small, slightly certain, extremely certain}	{ small, very large, very certain, extremely certain}	{ very small, slightly small, uncertain slightly uncertain}	{ small, slightly small, uncertain, certain}
eyewitness e1	f1	{ slightly small, slightly large, very uncertain, certain}	{ slightly-large, large, slightly uncertain, certain}	{ very small, slightly large, slightly certain, extremely certain}	{ slightly-large, extremely large, slightly certain, certain}
	f2	{slightly small, small, slightly certain, extremely certain}	{ small, slightly-large, , slightly uncertain, slightly certain}	{ small, extremely large, very uncertain , slightly uncertain}	{ small, slightly large, very uncertain, certain}
	f3	{ small, slightly large, slightly uncertain, extremely certain}	{ very small, small, slightly uncertain, certain}	{ slightly small, extremely large, slightly certain, uncertain}	{ small, extremely large, very certain, extremely certain}
	f4	{ small, slightly small, slightly uncertain, certain}	{ large,, very large, uncertain, slightly uncertain}	{ very small, slightly large, uncertain slightly uncertain}	{ slightly- small, slightly large, uncertain, certain}

TABLE II INPUTS ARE IN IVCFCS FORM FOR EYEWITNESS E1

	c1	c2	c3	c4
f_1	(0.43,0.57,0.90,4.49)	(0.14,0.86,3.59,4.49)	(0.29,0.43,1.79,2.69)	(1.79,2.24,4.49,6.28)
f_2	(0.14,0.29.1.79,2.69)	(0.71,1,3.59,5.38)	(0.29,0.57,1.79,4.49)	(0.43,0.71,3.59,6.28)
f_3	(0.29,0.43,0.90,1.79)	(0.71,0.86,0.90,4.49)	(0.71,1,2.69,3.59)	(0.57,0.71,0.90,1.79)
f_4	(0.43,0.57,2.69,4.49)	(0.14,0.71,0.90,1.79)	(0.86,1,1.79,2.69)	(0.43,0.57,2.69,3.59)

TABLE III. INPUTS ARE IN IVCFCS FORM EYEWITNESS E2

	c1	c2	c3	c4
f1	(0.28,1,2.690,6.28)	(0.42,0.57,0.89,4.48)	(0.14,0.85,1.79,3.49)	(1.39,0.854,3.58,3.58)
f2	(0.14,0.28,1.79,3.58)	(0.14,0.28,1.79,2.69)	(0.710,1,1.79,2.69)	(0.73,1,1.79, 2.62)
f3	(0.14,1,0.89,3.58)	(0.28, 0.42, 0.89, 1.79)	(0.714,0.85,2.69,1.79)	(0.71,0.89,0.90,1.79)
f4	(0.14,0.28, 3.58, 6.28)	(0.42,0.57,2.69,4.49)	(0.14,0.71,1.79,4.49)	(0.14,0.71,2.69,4.48)

TABLE IV INPUTS ARE IN IVCFCS FORM EYEWITNESS E3

	c1	c2	c3	c4
f1	(0.43,0.57,0.90,4.49)	(0.14,0.86,3.59,4.49)	(0.29,0.43,1.79,2.69)	(1.79,2.24,4.49,6.28)
f2	(0.14,0.29.1.79,2.69)	(0.71,1,3.59,5.38)	(0.29,0.57,1.79,4.49)	(0.43,0.71,3.59,6.28)
f3	(0.29,0.43,0.90,1.79)	(0.71,0.86,0.90,4.49)	(0.71,1,2.69,3.59)	(0.57,0.71,0.90,1.79)
f4	(0.43,0.57,2.69,4.49)	(0.14,0.71,0.90,1.79)	(0.86,1,1.79,2.69)	(0.43,0.57,2.69,3.59)

TABLE V **IVCFCS FOR E$_1$**

Face	IVCFCS
f1	(0.49,1,3.16,6.28)
f2	(0.32,1,2.08,3.45)
f3	(0.27,1,1.64,6.28)
f4	(0.208,0,64,4.50,6.28)

TABLE VI IVCFCS FOR E2

Face	IVCFCS
f1	(0.43,0.69,3.65,6.28)
f2	(0.49,1,3.17,6.28)
f3	(0.55,1,1.24,2.71)
f4	(0.58,1,1.50,2.60)

TABLE VII IVCFCS FOR E3

Face	IVCFCS
f1	(0.40,1,2.77,6.28)
f2	(0.22,1,2.57,6.28)
f3	(0.29,1,4.3,6.28)
f4	(0.48,0.68,12.06,3.90)

TABLE VIII (A) & (B) DISTANCE DN DP

	c1	c2	c3	c4
e1	0.32	0.24	0.45	0.43
e2	0.27	0.44	0.36	0.35
e3	0.28	0.34	0.25	0.47

	c1	c2	c3	c4
e1	0.38	0.49	0.73	0.73
e2	0.52	0.61	0.50	0.28
e3	0.48	0.45	0.40	0.54

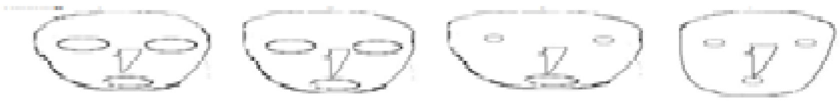

Fig 6. Ranking of facial images in non-decreasing order of Similarity

VII. CONCLUSION AND FUTURE DIRECTIONS

The integration of Complex Fuzzy Sets has significantly enhanced the performance of Z-Numbers, a relatively new concept that is still in its early stages of development. Complex Fuzzy Sets have demonstrated their versatility, particularly in the realm of Multi-Criteria Decision Making. Moreover, their applicability extends beyond the mere ranking of criminal face sketches; they offer a robust platform for interpreting and expressing daily human behaviors and habits.

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Performance Analysis of 5G NR Modulation Techniques

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***Abstract*—The rapid proliferation of wireless communication technologies in recent years has driven the need for advanced modulation techniques to meet the increasing demands for higher data rates, lower latency, and enhanced spectral efficiency. In the context of 5G and beyond, several innovative modulation schemes have emerged as promising candidates to address these challenges. This research paper presents a comprehensive performance analysis of five prominent 5G modulation techniques: Weighted Overlap and Add (WOLA), Filter Bank Multi-Carrier (FBMC), Orthogonal Frequency Division Multiplexing (OFDM), Filtered-OFDM (F-OFDM), and Universal Filtered Multi-Carrier (UFMC).This research paper offers a comprehensive and comparative evaluation of WOLA, FBMC, OFDM, F-OFDM, and UFMC modulation techniques, shedding light on their performance characteristics and aiding network designers and operators in making informed decisions for the deployment of 5G systems tailored to specific communication requirements. These findings are expected to be instrumental in shaping the future of wireless communication technologies as we move further into the era of 5G and beyond.**

***Index Terms*—5G, Modulation techniques, WOLA, OFDM and UFMC.**

I. INTRODUCTION

During the last few decades, wireless cellular technology has undergone the fifth generation of evolution namely 1G to 4G, and deployment of 5G [1]. The next-generation technology, 5G, was developed to address the widespread use of mobile communication under unpredictable circumstances. The fifth generation offers users an unrestricted broadband experience. Any to the operate and link our smart gadgets to machines and sensors. Critical machine communication can benefit from fast association and excellent reliability thanks to 5G technology. With the third-generation partnership project release 15, which primarily focused on meeting the needs of mobile operators in form of large broadband applications [2].
5G wireless communication technology is the fifth generation of mobile network technology that offers faster data speeds, increased network capacity, lower latency, and improved reliability compared to its predecessors. Some of the key techniques used in 5G wireless communication include [4]

A. Millimeter-wave (mmWave) technology

5G networks use high-frequency radio waves in the mm Wave spectrum to transmit data at much higher speeds than previous wireless technologies. So they require more cell towers and base stations to provide coverage [3].

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B. Massive MIMO

This technique uses multiple antennas on both the transmitter and receiver sides of the communication link to improve signal quality and increase data throughput. By sending and receiving multiple data streams simultaneously, massive MIMO enables 5G networks to support more users and devices at once [5].

C. Beamforming

This technology allows 5G base stations to focus their signals in specific directions, which helps to reduce interference and improve signal quality for users.

D. Network slicing

This technique enables operators to divide their networks into multiple virtual networks, each with its own performance characteristics, to better serve different types of applications and users [6].

E. Cloud computing

5G networks rely on cloud-based infrastructure to process and store data, which helps to improve network efficiency and reduce latency [4][5][6].

II. 5G NETWORKS USE CASES

To serve and fulfil network society, International Telecommunication Union (ITU) has provided the objective and framework for future IMT-2020 development. These use case scenarios for future 5G networks are illustrated below [4].

A. Enhanced Mobile Broadband (eMBB)

5G networks provide faster data speeds and increased network capacity, making it possible to stream high-quality video content and download large files quickly [6].

B. Mission-Critical Communications

5G networks can support mission-critical applications such as public safety, healthcare, and defense, where reliability, low latency, and high bandwidth are essential [7].

C. Cloud Gaming

5G networks can enable cloud gaming, which allows players to stream high-quality games without the need for expensive hardware [4].

III. KEY DIFFERENCE BETWEEN LTE-ADVANCED AND 5G NETWORKS

LTE-Advanced (Long-Term Evolution Advanced) is the successor to the original LTE standard, which is also known as 4G. LTE-Advanced was developed to provide better performance, increased capacity, and more advanced features than its predecessor. However, 5G takes things to a whole new level with even more advanced technology and capabilities. Here are some of the key differences between LTE-Advanced and 5G [6]:

A. Latency

5G has much lower latency than LTE-Advanced. This means that the delay between sending a request and receiving a response is much shorter with 5G. This makes 5G ideal for real-time applications like virtual and augmented reality [7].

B. Spectrum

5G uses a much broader spectrum than LTE-Advanced, which means that it can support more devices and offer more capacity [8].

C. Network Architecture

The new network architecture used by 5G is intended to be more flexible and adaptive than those of earlier mobile network generations. New use cases and applications will be made possible that were not possible with LTE-Advanced [9].

IV. 5G MODULATION TECHNIQUES

5G uses several modulation techniques to improve the efficiency and speed of wireless communications. Some of these techniques include:

*OFDMA (Orthogonal Frequency Division Multiple Access):*It is a multi-user types frequency that allows multiple users to share the same frequency band by assigning them different subcarriers. This technique is used in the downlink (from base station to user) to increase the system capacity and improve spectral efficiency [3][18].

FBMC (Filter Bank Multi-Carrier): FBMC is an alternative to OFDM that uses a filter bank to create narrowband subcarriers. This technique is used in the uplink (from user to base station) to reduce interference between users and improve spectral efficiency [8][9].

WOLA (Weighted Overlap and Add): WOLA is a time-domain equalization technique that reduces the interference between subcarriers by adding a weighted overlap between adjacent subcarriers. This technique is used in OFDM systems to reduce inter-cell interference [1][6][7].

UFMC (Universal Filtered Multi-Carrier): UFMC is a multi-carrier technique that uses a set of complex filters to create narrowband subcarriers. This technique is used in the uplink to reduce the inter-carrier interference and improve spectral efficiency.

Overall, these modulation techniques are used in 5G to increase the system capacity, improve spectral efficiency, and reduce interference between users.

A. 5G OFDM Modulation Techniques

Generating an OFDM waveform for 5G involves several steps, including choosing the appropriate subcarrier spacing, calculating the number of subcarriers, assigning data to subcarriers, and performing IFFT to generate the time-domain signal. Here's a general outline of the process:

Determine the subcarrier spacing: In 5G, the subcarrier spacing can be either 15 kHz, 30 kHz, 60 kHz, or 120 kHz. The choice of subcarrier spacing depends on factors such as the available bandwidth, the desired spectral efficiency, and the channel characteristics [3].

Calculate the number of subcarriers: The number of subcarriers in a 5G OFDM waveform depends on the bandwidth available for the signal. Each subcarrier carries a certain amount of data, so the more subcarriers there are, the higher the data rate.

Assign data to subcarriers: In 5G, there are different modulation schemes that can be used to assign data to subcarriers. For example, QPSK, 16QAM, and 64QAM are commonly used. The choice of modulation scheme depends on the channel conditions and the required data rate [12].

Perform IFFT: After the data has been assigned to subcarriers, an Inverse Fast Fourier Transform (IFFT) is performed to generate the time-domain signal. The length of the IFFT is equal to the number of subcarriers. The resulting signal is a complex-valued waveform that can be transmitted over the air.

Add cyclic prefix: To mitigate the effects of multipath fading, a cyclic prefix is appended to the onset of the signal. The length of the cyclic prefix relay on the delay spread of the channel.

Repeat the process for each OFDM symbol: In 5G, the OFDM waveform is divided into multiple symbols, each with its own set of subcarriers and data. Overall, generating an OFDM waveform for 5G requires careful consideration of various factors, such as subcarrier spacing, number of subcarriers, modulation.

B. 5G Wola Wave Form Generator Or Modulation Techniques

WOLA stands for "Weighted Over Lap and Add" and is a signal processing technique that is commonly used in the design of waveforms for 5G network communication technology. The main idea behind WOLA is to split a wideband signal into multiple narrowband subcarriers, which are then processed independently and recombined at the receiver to reconstruct the original signal [1][6]. The WOLA waveform generator is a key component of the 5G physical layer, responsible for generating the modulated signals that are transmitted over the air interface. The generator typically consists of several processing blocks, including a digital filter bank that performs the subcarrier splitting, a symbol mapper that maps digital symbols onto the subcarriers, and an inverse filter bank that combines the subcarriers to form the final modulated signal. In summary, the 5G WOLA waveform generator is a sophisticated signal processing system that plays a critical role in the architecture or implementation of 5G network technology, enabling high data rates and low latency communication over the air interface.

C. 5G FBMC Modulation Techniques

5G FBMC stands for "Fifth Generation Filter Bank Multi Carrier". It is a type of modulation scheme that can be used in wireless communication systems such as 5G networks. FBMC is a form of multicarrier modulation (MCM) that is designed to offer a number of advantages over other MCM schemes such as Orthogonal Frequency Division

Multiplexing (OFDM), which is currently used in many wireless communication systems. FBMC uses a filter bank to split the data into a number of sub-parts, every of which is modulated separately. This allows FBMC to offer greater flexibility in terms of allocating bandwidth to different users or applications, as well as improved spectral efficiency and higher data rates.

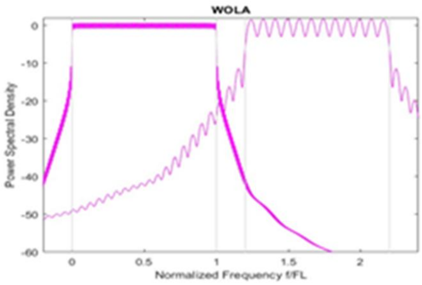

Figure 1. WOLA

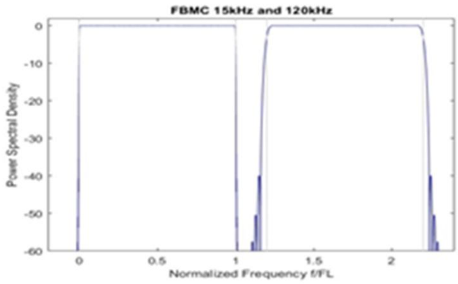

Figure 2. FBMC

In addition, FBMC can offer better spectral containment than OFDM, which means that it can reduce interference with other radio frequency (RF) signals in adjacent bands. This is particularly important in crowded RF environments, such as urban areas, where many different wireless devices are operating in close proximity. Overall, 5G FBMC is an important technology that is anticipated to be crucial to the enabling the high-speed, high-data rate, and low-idleness communication capabilities that are required for emerging applications such as the Internet of Things (IoT), autonomous vehicles, and virtual reality (VR) and augmented reality (AR) systems.

D. 5G Universal Filtered Multicarrier Modulation Techniques

5G Universal Filtered Multicarrier (UFMC) is a wireless communication technology that is being considered as a potential candidate for the 5G mobile communication standard. UFMC is a type of multicarrier modulation technique that uses frequency domain filtering to improve spectral efficiency and reduce interference. In UFMC, the frequency band is divided into multiple subcarriers, and each subcarrier is filtered with a specific filter to reduce the out-of-band emissions. The filters used in UFMC are designed to have a smooth transition between the passband and stopband, which helps to reduce the interference between subcarriers. UFMC has several advantages over other multicarrier modulation techniques, such as Orthogonal Frequency Division Multiplexing (OFDM). UFMC provides higher spectral efficiency, as the filtering reduces the need for guard bands, which are used in OFDM to reduce interference between subcarriers. UFMC also provides better frequency localization and lower out-of-band emissions, which makes it well-suited for use in densely populated urban areas.
However, UFMC also has some disadvantages. The complexity of the filtering process used in UFMC is higher than that of OFDM, which can result in higher power consumption and greater computational requirements. UFMC also requires accurate channel estimation, which can be difficult to achieve in certain environments. So that, UFMC is a promising technology for 5G mobile communication, but it is still in the research and development stage, and further testing and optimization are needed to determine its suitability for widespread deployment [7].

E. 5G f-OFDM Modulation Techniques

5G f-OFDM (filter bank-based Orthogonal Frequency Division Multiplexing) is a waveform technology used in the fifth-generation mobile communication system (5G). It is an alternative to traditional OFDM, which is used in 4G LTE networks. f-OFDM uses a filter bank to divide the frequency spectrum into multiple sub-bands, each of which has a narrower bandwidth compared to traditional OFDM. This allows f-OFDM to support higher data rates, improve spectral efficiency, and provide better interference mitigation [2].
Another advantage of f-OFDM is that it allows for more flexible waveform design, which can be optimized for different use cases, such as low latency communications, massive machine-type communications, and high-speed mobile broadband. In this wat, 5G f-OFDM is an important technology that helps enable the high-speed, low-latency, and reliable wireless communication capabilities that are essential for emerging 5G use cases, such as IoT, autonomous vehicles, and augmented reality [4].

F. 5G single carrier Modulation Techniques

5G (fifth generation) technology uses single carrier waveforms such as filtered orthogonal frequency division multiplexing (f-OFDM) and universal filtered multicarrier (UFMC) to achieve high data rates and spectral efficiency. Single carrier waveforms refer to the transmission of information using a single carrier frequency. In contrast, multi-carrier waveforms divide the available frequency spectrum into multiple narrowband subcarriers that are used to transmit data in parallel. In 5G, single carrier waveforms are used to achieve better spectral efficiency and reduced latency. This is achieved through the use of advanced modulation schemes and error-correcting codes, which allow for high effectively utilize of the available frequency channel. The utilization of single carrier waveforms in 5G technology enables high data rates, reduced latency, and improved network efficiency, which are critical for supporting the growing demand for mobile data services.

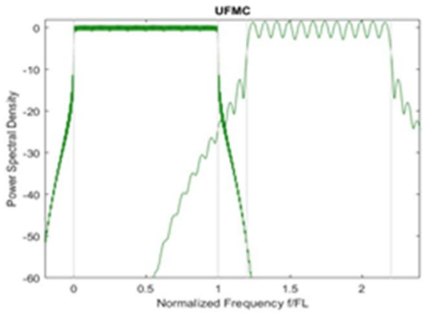

Figure 3. UFMC

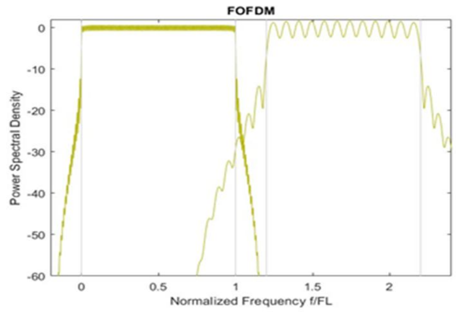

Figure 4. f-OFMD

V. Performance Analysis Of 5G Modulation Techniques

A. Performance Analysis Parameters

The following parameters has been taken for the performance evaluation of OFDM, UFMC and FBMC modulation techniques.

Parameters	Values
Number of Frame	30
Simulation time	10ms
Test Model	(Full band, Uniform, QPSK)
Duplex Model	FDD, TDD
Channel Models	3GPP TU
Scheduling types	0 1
Number of UE	4
Channel bandwidth	5MHz to 15MHz
Number of Resource Block	25
Downlink Carrier Frequency	2.635e9 hz
Uplink carrier frequency	2.515 e9 Hz
Downlink and uplink bandwidth	5e6 Hz
UE Tx Power	23
GNB Tx Power	29
GNB Rx Gain	10

B. Performance Evaluation and Result Analysis

a) Power Spectral Density

5G spectral density refers to the amount of electromagnetic spectrum that is allocated to 5G wireless networks. Spectral density is measured in units of power per unit of frequency, typically expressed in watts per hertz (W/Hz). The higher the spectral density of a wireless network, the more information it can transmit over a given frequency band. 5G networks are designed to operate at much higher frequencies than previous generations of wireless technology, with spectrum ranging from sub-1 GHz bands to Millimeter-wave (mmWave) bands above 24 GHz. The amount of spectral density that is allocated to 5G networks varies depending on the region and the specific frequency bands used. In general, countries are allocating more spectrum to 5G networks than they did for previous wireless generations to support the increased demand for wireless connectivity and data-intensive applications.

b) Spectral Efficiency (SE)

5G's use of higher-frequency bands also requires more precise and sophisticated spectrum management techniques, such as beamforming and dynamic spectrum sharing, to maximize spectral efficiency and ensure optimal use of available spectrum resources. The amount of data that can be sent over a specific bandwidth of the system is referred to as the spectral efficiency of a communication system. The modulation methods can be employed in a 5G system.

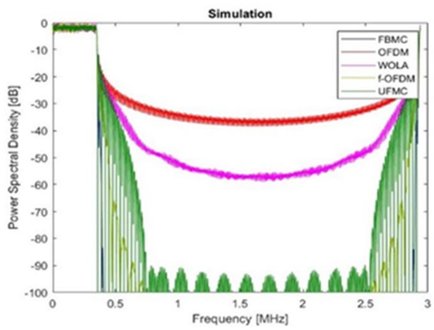

Figure 5. Power Spectral Density Comparisons

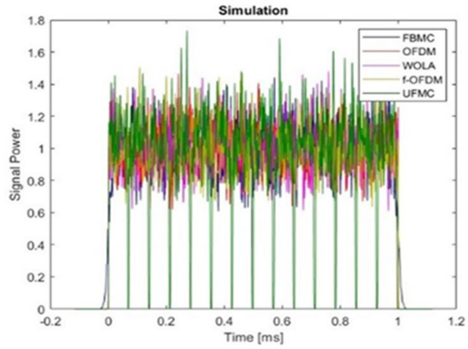

Figure 6. Spectral Efficiency Comparisons

The spectral efficiency equation for OFDM is given by:

$$SE = \log 2\ (1 + SINR) \text{ -------------- (i)}$$

where SE is the spectral efficiency in bits per second per Hertz (bps/Hz), and SINR is the signal-to-interference-plus-noise ratio.

The spectral efficiency equation for UFMC is given by:

$$SE = \log 2\ (1 + SINR/\alpha) \text{ ------------- (ii)}$$

where α is the sub band spacing in Hz.

The spectral efficiency equation for FBMC is given by:

$$SE = \log 2\ (1 + SINR/(N/2)) \text{ -------------(iii)}$$

where N is the number of subcarriers.

It's worth noting that these equations provide theoretical values for spectral efficiency, and actual performance may vary depending on real-world conditions such as channel characteristics, interference, and noise levels.

c) Bit Error Rate (BER)

The equation for 5G communication systems depends on the specific modulation scheme and the type of waveform used. Here are the BER equations for some of the common waveforms used in 5G:

C. Orthogonal Frequency Division Multiplexing (OFDM)

OFDM is a widely used waveform in 5G communication systems. The BER equation for OFDM can be expressed as:

$$BER = Q(\mathrm{sqrt}((2Eb)/(N0(k-1)))) \text{ --------(iv)}$$

Where: Q is the Q-function, Eb is the energy per bit, N0 is the power spectral density of the noise, k is the number of bits per symbol

D. Universal Filtered Multi-Carrier (UFMC)

UFMC is another waveform that can be used in 5G communication systems. The BER equation for UFMC can be expressed as:

$$BER = Q(\mathrm{sqrt}((2Eb)/(N0(k-1)))) \text{ -------(v)}$$

Where: Q is the Q-function, Eb is the energy per bit, N0 is the power spectral density of the noise, k is the number of bits per symbol

E. Filter Bank Multi-Carrier (FBMC)

FBMC is another waveform that can be used in 5G communication systems. The BER equation for FBMC can be expressed as:

$$BER = Q(\mathrm{sqrt}((2Eb)/(N0(k-1)))) \text{ -------(vi)}$$

Where: Q is the Q-function, Eb is the energy per bit, N0 is the power spectral density of the noise, k is the number of bits per symbol

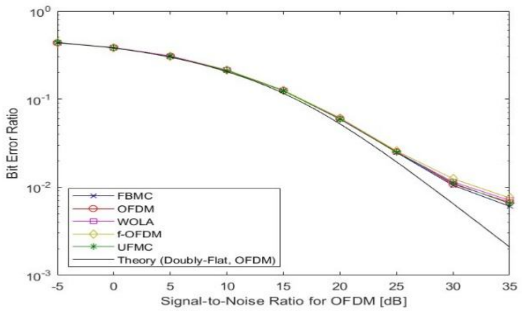

Figure 11. Bit Error Rate

The MATLAB simulation result for the power spectral density (dB) comparison are illustrated in the figure 9 and figure 10 for the FBMC, OFDM, WOLA, f-OFDM and UFMC modulation techniques. All the modulation techniques are very highly effective for the 5G NR system for using the wave form. In the comparison of the above diagram the

FBMC shown the lower lob and higher power spectral density for the system. After that WOLA and UFMC modulation find best as compare to the OFDM and f-OFDM modulation techniques. Figure 11 represent the bit error rate of different modulation techniques of simulation v/s theory.

In all three cases, the BER equation is based on the assumption that the noise is additive white Gaussian noise (AWGN). In practice, other sources of noise and interference may also be present, which can affect the actual BER performance.

VI. Conclusion

In this comprehensive analysis of 5G modulation techniques were meticulously generated and evaluated, leading to invaluable insights into their performance across critical parameters. The comparison, rooted in Bit Error Rate (BER), Spectral Efficiency (SE), and Power Spectral Density (PSD), unraveled the distinct advantages and trade-offs inherent to each technique.

The Bit Error Rate (BER) analysis illuminated the adaptive nature of these techniques, with OFDM demonstrating robustness in high-noise scenarios, while UFMC exhibited superior performance in frequency-selective fading environments. The evaluation of Spectral Efficiency (SE) unveiled the potential of FBMC and UFMC to significantly enhance spectrum utilization, particularly in applications requiring agility and efficiency, while F-OFDM showcased competitive SE values, adapting well to the needs of diverse 5G use cases. The assessment of Power Spectral Density (PSD) reinforced the importance of spectral compliance, with WOLA, FBMC, and UFMC displaying narrower PSD profiles, aligning them with scenarios demanding effective spectrum management.

In summary, this research underscores the nuanced landscape of 5G modulation techniques, offering network designers and operators a rich palette of options to tailor their choices to specific requirements. While traditional OFDM remains steadfast in adverse noise conditions, FBMC, UFMC, and F-OFDM emerge as promising candidates for applications demanding spectral efficiency and interference mitigation. WOLA's spectral containment properties render it suitable for environments emphasizing spectrum coexistence. As the evolution of 5G continues to shape the future of wireless communication standards, these findings serve as a vital compass for selecting and optimizing modulation techniques to meet the dynamic demands of an increasingly interconnected world.

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A Literature Review on Medical Images Texture Analysis

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***Abstract*—An effective method of enhancing the information available from medical photographs is the examination of textural properties. Research in this area is still being done, and applications range from the segmentation of certain anatomical features and the identification of lesions to the separation of diseased from healthy tissue in various organs. While using radiological pictures acquired during standard diagnostic procedures, texture analysis entails a variety of mathematical operations carried out using the images' data. In this article, we examine research of the approach and explain the fundamentals of texture analysis while providing instances of its applications.**

I. Introduction

Traditionally, medical imaging has been evaluated subjectively or visually, leaving most of the latent data contained in the pictures untouched. Utilising radiomics, which is the quantitative information extraction from clinical imaging, is one method of getting access to this concealed information. In particular, the visual evaluation of variability in images is inadequate. Poor patient outcomes and intratumoral heterogeneity are related to tumour aggressiveness. In studies evaluating the diagnosis, prognosis, and response to therapy of cancer, several radiomic measures, in particular texture analysis metrics, were reported to quantify intratumoral heterogeneity.

An examination of texture, shape, and size is a typical component of radiomic evaluation. The technique's fundamental presumption is that the tumor's phenotypic changes, which are suggestive of genetic as well as molecular differences, are reflected in the gray-scale values used to create the picture of the tumour and the geographic and temporal correlations between these values.

The look, structure, and arrangement of an object's pieces inside a picture are referred to as the texture of the image. Digital images are employed in clinical practise for diagnostic purposes. A two-dimensional digital image is made up of tiny rectangular blocks called pixels (picture elements), as well as a three-dimensional digital image is made up of tiny volumetric blocks called voxels (volume elements); each of these is represented by a set of spatial coordinates and has a value that denotes the intensity of that imagine or volume element in terms of its grey levels. We will limit the topic to pixels because most medical pictures are two-dimensional, but expanding it to voxels or volumetric imaging is simple. The arrangement of grey-level numbers among the pixels in a particular region that is important in a picture may be used to explain the texture notion in digital images.

Texture analysis is a key field of study for computers. Because of the richness of natural texture, it is a challenging challenge. Between nearby pixels, there had been a noticeable difference in colour or intensity levels. Techniques for texture analysis were used to categorise the photos or objects. The process of segmenting a texture into smaller parts was once used to analyse the borders of the texture. The texture is a component of the texture analysis that

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divides and categorises pictures into regions of interest. It generated a little pixel value, while the rough texture had huge values. The texture, which has homogeneity qualities and does not have a single colour or intensity, was used to refer to the visual pattern. One is feature extraction. Texture segmentation. Artificial intelligence is now widely employed in a variety of scientific sectors, including health, agriculture, construction, tourism, and biochemistry, thanks to advances in information technology and hardware. Image processing and computer vision comprise a significant portion of the applications throughout the several fields of artificial intelligence study [1]. All computer vision-based solutions are ultimately designed to execute tasks that the human eye can do more rapidly and correctly. According to recent studies, the human eye typically employs three elements—color, texture, and shape—to determine an image's kind.

However, texture is more significant [2]. In order to analyse and extract texture information from photos, a number of operators have thus far been introduced. The spatial pattern of the illumination intensity of each pixel, which is regularly repeated throughout the entire picture or specific regions of it, is referred to as an image's texture [3]. picture texture is the idea of how naturally an item appears in a picture. In actuality, everyday items have texture. Even people attempt to create things by repeating a texture. For instance, humans created the repeated texture on a brick wall. A tiger's bodily structure also has a texture and repeating pattern. Even a mobile device's screen or how the keyboard is shown has a particular design that gives a picture texture and enables humans to identify an object.

The initial stage of texture analysis is feature extraction, which determined the characteristics of pictures that characterise the texture attributes. The second stage of texture analysis has been completed using the feature extraction results. The texture segmentation process, which is the second step, separates the texture picture into parts with the same texture.

II. Literature Review

Displaying the digital data as a three-dimensional map based on the pixel values is one approach to represent this. Thus, in theory, texture analysis is a method for determining the location and strength of signal characteristics, or pixels, as well as their intensity at different grey levels, in digital pictures. Texture characteristics, which identify the kind of texture and subsequently the underlying structure of the objects presented in the image, are in reality mathematical parameters determined from the distribution of pixels. Structured, model-based, statistical, and transform approaches are the several types of texture analysis that are grouped together depending on how they analyse the connections between the pixels [1].

This uses precise primitives to express texture. In other words, the straight lines or primitives that make up a square object's boundary are used to represent it. These approaches have the benefit of offering a strong symbolic representation of the visual. However, it is better for an image's synthesis than for its analysis. For structural analysis, the theory of morphology in mathematics is an effective resource. Here, utilising complex mathematical models (such fractal or stochastic), an attempt is made to express texture in a picture. For the picture analysis, the model's parameters are calculated. The computational complexity required in these parameters' estimation is a drawback [2].

Many classification jobs in actual production environments encounter difficult obstacles including skewed category distributions and numerous performance metrics to satisfy. This study offers a solution to these issues and uses it to automatically classify surface flaws on display glass. The suggested approach is divided into two main steps: (1) utilising threshold-moving to handle class skewness and satisfy particular quality targets, and (2) using a straightforward ensemble to take into account numerous quality objectives in a problem with classification while keeping computing costs as low as possible. An industrial case study's findings show that the suggested method may effectively replace human examination of display glass. Future research might determine the ideal ensemble size and composition, explore the usage of more complex models, and investigate other ways to optimise the ensemble approach for better classification performance[3].

Using colposcopic images, Ji et al.12 employed texture analysis to describe and identify typical, diagnostically significant vascular patterns associated to cervical lesions. They developed a generalised texture analysis method that integrated structural textural analysis and traditional statistical methods to provide a set of texture measures that described the distinctive features of cervical textures as seen by medical exams. With the use of those measurements, they showed how well the suggested method distinguished between cervical texture patterns suggestive of various stages of cervical lesions. These are based on texture representations that make use of the arrangement and relationships of the image's grey level values. The discrimination indices that these approaches often attain are greater than those of the structural or transformation methods. Clinical practise can benefit greatly from the extensive texture information present in medical photographs. Current electromagnetic (MR) pictures of tissues, for instance, are unable to deliver microscopic data that may be evaluated visually. The texture of the MR image may, however, vary due to histological modifications prevalent in specific diseases, which may be quantified via texture analysis. The categorization of diseased tissues from the liver, thyroid, the breasts, kidneys, the prostate, heart, brain, and lung has effectively used this method[4].

Saeed and Puri used T1-weighted three-dimensional MRI of adult control and patients to analyse texture data in order to divide the cerebellum. Alejo et al.'s (17) partially automatic delineation of the hippocampus and the corpus callosum employed neighborhood evaluation of texture-based MRI data. Herlidou et al.18 compared roughness with visual analysis of MRI data for the identification of skeletal muscular degeneration in a previous research utilising texture analysis. They came to the conclusion that skin texture analysis can offer valuable information that can help with skeletal muscle illness identification[5].

In order to show a pathological condition with common manifestations that causes a change in the texture of the brain, Kovalev et al. used texture variables obtained from gradient vectors and from generalised co-occurrence matrices for the description of texture of some MR-T2 brain images. For separating the brain pictures of controls from those with white-matter encephalopathy and/or Alzheimer's disease, they employed extended multisort co-occurrence matrices, which uniformly incorporate intensity, gradient, and anisotropy image data. These textural traits were also used to segment diffuse brain lesions[6].

White matter, grey matter, cerebrospinal fluid, tumours, and edoema were all characterised using textural parameters depending on the histogram, co-occurrence matrix, gradient, and run-length matrix in Herlidou et al's study. In addition to confirming that MR pictures, including those produced during normal operations in three separate MRI units, include tissue-specific texture characteristics that can be retrieved by mathematical approaches, they were successful in differentiating the various brain tissues[7].

The cortical thickness & hyperintense T1 signal, as well as the blurring of the grey material/white matter interface, were determined using a combination of textural parameters by Bernasconi et al. and Antel et al. in a series of investigations using T1-weighted cerebral MR images. They were able to automatically identify certain localised cortical dysplasia lesions that the human eye would have missed. They claim that patients with serious seizures caused by focal cortical dysplasia may benefit from presurgical assessment using the new computer-based, automated technique[8].

To enhance the characterisation of brain tumours, Mahmoud et al. applied the texture analysis method based on a three-dimensional co-occurrence matrix. They conducted a comparison study to assess how well this method performed in comparison to the two-dimensional method, utilising T1-weighted MRI of 7 glioma patients to differentiate between solid tumour, necrosis, and the surrounding white matter. They were better able to distinguish between oedema and solid tumours as well as between necrosis and solid tumours using the three-dimensional technique. Neither of these techniques allowed them to completely distinguish ipsilateral white matter from ipsilateral white matter or peritumoral white tissue from oedema. They do, however, argue that the current three-dimensional technique may offer a novel tool for planning radiation or surgical therapy as well as for tumour classification and treatment follow-up [9].

In a research by Yu et al., individuals with unilateral temporal lobe epilepsy who had ipsilateral hippocampal sclerosis on MRI and a seemingly healthy contralateral hippocampus participated. They started by confirming that the normal (control) and sclerotic hippocampi had different textures. They then demonstrated how the texture of the contralateral hippocampi, which initially appeared to be normal, could be divided into three groups: seemingly healthy, comparable to sclerosis, or distinct from either healthy or sclerotic. They linked these results to a specific level of hippocampus change, which called for more research to provide a more accurate characterisation [10].

Using texture parameters determined by run-length and co-occurrence matrices, Bonilha et al.8 and Coelho et al.10 verified the findings. In a related work[11], Jafari- Khouzani et al. used wavelet-based texture characteristics to discriminate between abnormal and healthy hippocampus tissue in order to help doctors decide which patients might benefit from epilepsy surgery [12].

Mathias et al. attempted to assess the pathogenic changes that take place in multiple sclerosis (MS) by using texture data relating to MRI of the spinal cord. Before spinal cord degeneration could be seen visually, texture variations between healthy controls & relapsing-remitting MS patients were discovered. Additionally, they discovered a strong connection between textural alterations and impairment [13].

In order to characterise and identify typical, diagnostically significant vascular patterns associated with cervical lesions from colposcopic pictures, Ji et al. performed texture analysis. They developed a generalised texture analysis method that integrated structural textural analysis and traditional statistical methods to provide a set of texture measures that described the distinctive features of cervical textures as seen by medical exams. With the use of those measurements, they showed how well the suggested method distinguished between cervical texture patterns indicative of various stages of cervical lesions [14].

Chabat et al. employed 13 textural features to distinguish between various obstructive lung disorders in thin-section (CT) pictures. These factors were obtained from the histogram, co-occurrence matrix, and run length matrix categories. Patients with constrictive obliterative bronchiolitis, centrilobular emphysema, and healthy participants were all given a series of CT scans. They established the viability of textural differentiation between the lungs of healthy persons and those with illnesses that result in lower attenuation of the lung parenchyma. They came to the conclusion that the technique had a high degree of accuracy and recommended that it be used as one of the primary CT feature extractors for the automatic identification of obstructive lung disorders [15].
Uniform LBP was carried out in various radius sizes for the detection of breast cancer by Zeebaree et al. [16]. The overall structure of the suggested strategy in [16] is 6. As previously indicated, four alternative LBP histograms are built using different thresholds, such as the centre intensity, mean of neighbours, maximum intensity between neighbours, and lower value.
LBP and Curvelet transform were used by Bruno et al. [17] to classify breast cancer. The ultrasound breast picture is first converted to the curvelet domain. Then, LBP is used to modified pictures at various sizes. Finally, feature selection approach is applied to decrease complexity.
Arya et al.'s [18] use of a collection of textural features for the categorization of pap smear images. The two steps of the suggested method are feature extraction and classification. First, from the input single cell picture, common handmade texture characteristics including Law's, discrete wavelet transform (DWT), local binary patterns (LBP), and gray-level co-occurrence matrixes (GLCM) are retrieved. For the classification step, linear support vector machine (SVM) is utilised next.
Additional work of authors is summarized below:

Author	Title	Work	Methodology
E. S. Gemeay, F. A. Alenizi	Weighted Constraint Feature Selection of Local Descriptor for Texture Image Classification	Filter-based feature selection is the method for choosing features that are proposed. For each characteristic, it used a weighted constraint score. A threshold estimation approach is suggested to choose the most discriminating features after ranking the features. A variety of distinct datasets are utilised as a baseline to evaluate the comparative approaches for a more accurate comparison.	The suggested technique may produce excellent classification accuracy without a learning phase by using just a few descriptor features, according to implementations on the Outex, UIUC, CUReT, MeasTex, Brodatz, Virus, Coral Reef, and ORL face datasets.
Mahmoodian, H. Thadesar, M. Georgiades, M. Pech and C. Hoeschen	Liver Texture Classification on CT Images of Microwave Ablation Therapy	The knowledge of tissue characterisation for lowering the recurrence rate is improved by this research. In this case, the categorization of liver tissues was done using four machine learning (ML) algorithms: Naive Bayesian, Logistic Regression, Decision Tree, and Random Forest. In this study, we suggest bispectral analysis at higher orders for extracting features from CT images. Ten fresh features obtained from the bispectrum analysis were then used to train classifiers. Small sections of the photos were separated into healthy, tumorous, and ablated tissue categories in order to achieve this.	90.5% accuracy was the highest possible. The method demonstrates that, even in the presence of noise, the bispectral analysis gives useful information that may be employed during MWA therapy for tissue characterisation of CT scans.
Li and R. Mukundan	Robust Texture Features For Emphysema Classification In CT Images	Emphysema may be divided into three subtypes using a unique feature extraction technique that utilises local quinary patterns (LQP), multifractal features, and intensity histograms. In order to express texture characteristics, the LQP technique determines more image local patterns than local binary patterns. For this classification assignment, multifractal characteristics that improve local textures are merged with other features to form a feature vector. Prior to using an SVM classifier, the dimension of the feature vector is decreased using an autoencoder networks and principle components analysis. An emphysema database with 168 annotated areas of interest from three distinct subtypes is used to evaluate the suggested technique.	The experimental findings show that our methodology surpasses the majority of existing cutting-edge methods, with an excellent classification accuracy of 92.3% when utilising the feature vector with the fewest dimensions (15).
Omer, W. A. Abbas, M. ElHelw, G. S. Seifeldein	Combined regional and spatio-temporal approach improves hepatic tumors classification in Multiphase CT	Examine the impact of employing regional spatio-tepmoral characteristics on the ability to classify liver focal lesions in multiphase CT images. To more accurately characterise five hepatic diseases using multiphase contrast-enhanced CT images, texture, weight, and temporal feature sets as well as their various combinations along spatially partitioned ROI were studied.	A total of 180 ROI, including normal tissues, cysts, haemangiomas, metastatic cancer, and hepatocellular carcinoma, were classified using embedded feature selection, decision tree ensembles classification, and ten folds cross-validation. Our findings revealed that while texture characteristics could detect HCC with almost the greatest accuracy, density features alone could distinguish

			normal liver tissues with ease. Combining all of the features might get superior results consistently for all tumour kinds while overcoming individual performance discrepancies between them. Additionally, adding regional details enhances the classification of all groups, particularly haemangiomas and metastases.
Yu, C. Wang, S. Cheng and L. Guo	Establishment of Computer-Aided Diagnosis System for Liver Tumor CT Based on SVM	A computer-aided diagnostic (CAD) system that can identify hepatocellular carcinoma (HCC) areas and normal liver regions in liver tumour spectral computed tomography (CT) images to assist medical professionals in diagnosing and treating patients. The HCC and normal liver regions of interest (ROI) are each used to extract first-order statistical texture characteristics and gray-level co-occurrence matrix (GLCM) texture features, respectively. We employ a support vector machine (SVM)-based classification model, and we choose the optimum feature preprocessing technique and SVM parameter based on the experimental findings of various feature preprocessing techniques and kernel functions. In order to lower the dimensionality of the features, increase the classification model's learning speed, and produce the CAD system, we apply principal component analysis (PCA).	In the training set, the normal ROI's average classification accuracy is 92.22%, whereas the HCC ROI's average classification accuracy is 87.93%. In the testing set, the normal ROI's average classification accuracy is 90.62%, whereas the HCC ROI's average classification accuracy is 86.36%. Professional doctors have acknowledged the experimental findings.
A. Banday and A. H. Mir	Statistical textural feature and deformable model based MR brain tumor segmentation	For the aim of diagnosis and therapy planning, segmentation of anomalies is one of the key areas of concentration in the field of medical image processing. In the work presented in this paper, a semi-automatic method that produces suitable segmented areas from MR brain images has been suggested and put into practise.	The segmentation approach utilised in this instance creates a fused feature map by fusing information from MR images that is outside the range of human vision. Second order derivatives derived from an image are among the information that is outside the range of human vision and are covered in full in the relevant portion of this work. In the context of an active contour model, the resulting feature map serves as a stop function for the initialised curve to produce a precisely segmented region of concern. Using Jackard's Coefficient of Similarity and Gap index, the results of our segmentation approach are compared to the manual segmentation results of experts that serve as the basis for the comparison. The outcomes of several case studies, including those involving Craniophryngioma, High Grade Glioma, and Microadenoma, demonstrate the general method's high effectiveness.
K. Lau and M. Palaniswami	Automatic segmentation of the rima glottidis in 4D laryngeal CT scans in Parkinson's disease	The authors offer an automated segmentation approach that uses textural characteristics and support vector machines (SVM) to separate the rima glottidis from 4D CT images. The area is then precisely segmented as a post-processing phase using automatic two-dimensional region growth. We show a strong association between the manually segmented region and the suggested segmentation technique, which led to accurate segmentation.	When almost 70% of the dopaminergic neurons in the midbrain have perished, symptoms start to show. Vocal impairment may be detected by a temporal study of the rima glottidis area computed.
Mushtaq and A. H. Mir	Forgery detection using statistical features	Digital photographs are susceptible to a variety of forgeries, with copy-move and splice forgeries being the most popular. The innovative technique for detecting picture copy-move and splicing in this study is based on statistical characteristics of the digital image. To hide any crucial information, copy-move entails copying a part of an image then pasting it someplace else in the same picture. Splicing is combining two or more photos to create a composite picture that differs greatly from the original.	For both the faked pictures and the real images, the suggested method creates grey level run length matrix (GLRLM) texture characteristics. For classification, support vector machines are employed. Results demonstrate how well the suggested method detects forgeries.

III. CONCLUSION

Here, we've covered how to analyse textures in medical photos. Texture parameters are only mathematical illustrations of aspects of a picture that may be expressed verbally as smooth, rough, grainy, and so forth. This indicates that, in theory, texture evaluation may be used on any collection of picture areas that can be distinguished from one another using such a description. With the exception of Ji et al.'s work with colposcopic pictures and Chabat et al.'s work with CT, MRI uses have been highlighted when discussing the major categories of texture characteristics and the many applications of each technology.

Since texture analysis is a method developed to extract from medical pictures additional information that is difficult to convey by eye inspection, such analysis is still constrained by the low resolution of images, MRI applications predominate in the literature regarding this methodology. Therefore, it is an approach that has promise for future advancements in the calibre of medical pictures. The strategy, which may be used in a variety of image applications while taking into account the drawbacks of each imaging technology, is by no means restricted to MRI. In addition, the use of texture characteristics is not limited to the diseases covered in this article; rather, it is beneficial for the research of other pathological situations for which imaging is a suitable investigative technique.

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Dual Microwave and Millimeter Wave Planar Shared Aperture Antenna for 5G Vehicle to Vehicle Communication

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***Abstract*— A form of antenna system that can function at both microwave and millimeter-wave frequencies is known as Dual Microwave and Millimeter Wave Planar Shared-Aperture (DM2W). In this technique, microwave and millimeter wave circuits share a single aperture to minimize system size, weight, and cost. Communication systems that need a lot of bandwidth and fast data rates might benefit greatly from the dual microwave and millimeter wave planar shared-aperture technology. With the use of this technique, it is feasible to create antennas with a single aperture that can function throughout a broad frequency range, from microwave to millimeter wave frequencies. V2V communication, a crucial element of the future intelligent transportation system (ITS), has the potential to be enabled and improved by 5G technology. Real-time information transmission between cars is made possible through vehicle-to-vehicle (V2V) communication, which can increase safety, lessen traffic, and improve the driving experience. Overall, 5G technology has transformed V2V communication and made driving safer, more effective, and more pleasant. In the upcoming years, we may anticipate seeing a wider use of V2V communication as 5G networks continue to develop and grow.**

A planar substrate-integrated wideband dual port microwave/millimeter wave antenna is the subject of the proposed study. It comprises of a millimeter-wave Parallel Plate Resonator Antenna (PPRA) and a microwave magneto-electric (ME) dipole antenna. The antenna is created and constructed using planar laminate substrates. It is simple to merge the planar structure with the electronics. Because the two antenna components share the same radiation aperture, the design will be small. A dual-frequency antenna encompassing the 5.9 GHz V2V band and the 28 GHz 5G band will be designed. The observed lower and higher band bandwidths will be significantly wider than those of the conventional substrate- integrated devices.

***Index Terms*— Dual microwave, millimeter-wave, planar shared aperture antenna, Parallel plate Resonator antenna**

I. Introduction

Due to the fast development of mobile communications, navigation, vehicle-to-vehicle (V2V) communications, and the internet of things (IoT), the spectrum in the microwave band has become congested. As a result, the millimeter-wave spectrum has increasingly become the carrier frequency for modern communication systems, providing a significantly broader bandwidth and a greater data rate. Due to the substantial transmission loss, millimeter wave coverage is, however, somewhat limited. The microwave technology, on the other hand, can offer more signal coverage but a slower data rate. The microwave and millimeter-wave systems both have comparable

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advantages and disadvantages. Therefore, having a system that offers both the microwave and millimeter-wave channels at the same time should be beneficial.
The microwave system is becoming increasingly congested due to the fast expansion of wireless communication. Because of its abundant spectrum resource and ability to sustain a higher data rate, millimeter-wave technology has so gained increasing interest. It cannot entirely take the place of these microwave band wireless applications, though. Therefore, the future generation wireless communication system must incorporate both millimeter-wave technology and the microwave system. As a result, the antenna must be capable of concurrently operating in the microwave and millimeter-wave frequency ranges.

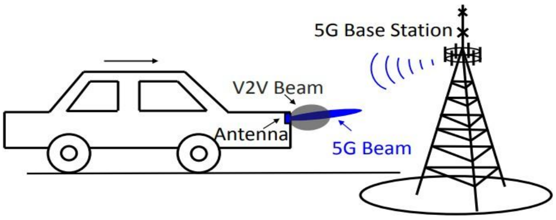


Fig 1: Application scenarios for 5G millimeter wave and V2V connectivity

The frequency ratios of the distinct resonant modes in the traditional dual-band microstrip antenna and dielectric resonator antenna (DRA) depicted in the application scenario in Fig[1] are typically lower and may make them unsuitable for simultaneous operations in the microwave and millimeter-wave bands. Installing two independent millimeter- and microwave antennas inside the system is an easy fix. The size of the system as a whole will eventually rise as a result.
In order to serve both safety-related and non-safety applications within the 5G cellular networks, the 3GPP standards organization has established the V2V services. A communication platform for automobiles is anticipated to be provided via the direct link, commonly referred to as the PC5 interface, and the new radio adapter in 5G. Vehicles will utilize the PC5 interface in particular to send safety messages to alert one another to potential road dangers. The current 5G-V2V standard enables higher layer security techniques specified by additional standards within the ITS domain to manage V2V message protection. To maintain system compatibility and save implementation costs, it could be better to have an encryption solution at the 5G connectivity layer.
The fabrication of the planar shared-aperture dual-band dual-circular polarization (CP) array antennas on a single-layer substrate makes it simple to expand the array to a greater size.Thus, each array member is created by joining two patches that are tuned to different frequencies. Two types of feed networks are discussed in order to construct arrays with higher gain, which may be used in systems that require both narrowband and wideband. The Fabry-Perot and reflect array methods are both included into the dual-band high-gain shared- aperture antenna. In the S-band (2.45 GHz), the antenna functions as a Fabry-Perot cavity antenna (FPCA), and in the X- band (10 GHz), it functions as a reflect array antenna (RA). The antenna features a straightforward design with just two layers of printed circuit board. The bottom layer serves as the RA's reflecting surface, the FPCA's ground plane, and the source antenna. The primary antenna that drives the RA is located in the top layer, which also acts as a superstrate for a FPCA that is somewhat reflecting. Thus, although having the identical physical aperture, the FPCA and RA operate separately.
An integrated broadband dual port microwave/millimeter wavelength antenna on a planar substrate is the subject of the proposed study. A millimeter-wave PPRA and the microwave magneto-electric (ME) dipole antenna make up the device. The two antenna components sharing an identical radiation aperture will allow for a small overall design. Design, construction, and testing will be done on a dual-frequency antenna that covers the
5.9 GHz V2V band and the 28 GHz 5G spectrum. When compared to conventional substrate-integrated devices, the obtained bandwidth of the lower and higher bands will be substantially broader.

II. RELATED WORK

The investigation will center on a planar wideband dual- frequency antenna. A small shared-aperture structure has been created by combining the microwave ME-dipole antenna with millimeter-wave PPRA. By applying copper to the two rectangular holes' sidewalls, a pair of parallel plates have been created in the antenna substrates. To the microwave ME dipole antenna, the PPRA supplies the magnetic current. The approach may be extended to alternative dual frequency designs with other frequency ratios, and the planned aperture antenna should be able to operate for both communication modes V2V and 5G millimeter-wave connections at the same time.

A. Dual Microwave-Millimeter Wave Shared Antenna

A form of antenna system that can function at both microwave and millimeter-wave frequencies is known as Dual Microwave and Millimeter Wave Planar Shared-Aperture (DM2W). In this technique, microwave and millimeter wave circuits share a single aperture to minimize system size, weight, and cost. Communication systems that need a lot of bandwidth and fast data rates might benefit greatly from the dual microwave and millimeter wave planar shared-aperture technology. With the use of this technique, it is feasible to create antennas with a single aperture that can function throughout a broad frequency range, ranging microwave until millimeter wave frequencies.
With the use of this technology, the antenna's size and weight may be decreased since planar circuits can be merged into a single substrate. The shared aperture method enhances the overall performance of the antenna while allowing for a reduction in the number of components. This technology also makes it possible to combine a number of operations, including polarization control and beam scanning, into a single antenna system. In general, the dual microwave and millimeter wave planar shared-aperture technology is a potential strategy for the creation of small, light, and high-performance antenna systems that can function across a broad frequency range.
Two antennas that are intended to operate through the same aperture, or the passageway from which electromagnetic waves flow, make up the DM2W system.A microwave antenna, functioning within the frequency range from 1 to 10 GHz, serves as the initial antennas in the DM2W system. A millimeter-wave antenna, used for frequencies between 30 and 100 GHz, is the second antenna. The two antennas can cooperate compactly and effectively since they are made to share an identical aperture.The DM2W technology is frequently employed in wireless networks, satellite communications, and radar systems. In comparison to conventional antenna systems, it has more benefits, such as wider bandwidth, better performance, and a smaller and lighter design. It is made up of a millimeter-wave parallel-plate resonator antenna (PPRA) and a microwave magnetoelectric (ME) dipole antenna.

B. 5G for V2V Communication

The capabilities of vehicle-to-vehicle (V2V) communication have substantially improved thanks to 5G (fifth-generation) technology, as shown in Fig[2], enabling more effective, trustworthy, and secure communication between cars. V2V communication is a significant part of Intelligent Transportation Systems (ITS) and improves traffic control, road safety, and the driving experience as a whole. Extremely low communication latency and great reliability are provided by 5G's ultra reliable low latency communication (URLLC) capabilities, which are crucial for V2V communication. Due to the ability to share time-sensitive information between cars in real-time, prospective risks and abrupt changes in traffic circumstances may be responded to quickly.

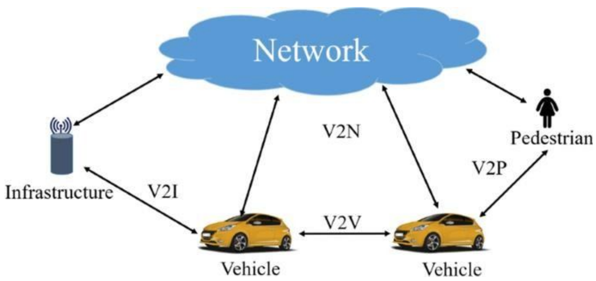


Fig 2: V2V communication using 5G technologies

The simultaneous communication of many devices is made possible by the huge Machine Type Communication capabilities of 5G. Being able to connect with other surrounding cars and infrastructure elements like traffic signals and road sensors is crucial for V2V communication.
In spite of variable signal strength or high mobility, V2V communication is still successful because to 5G's expanded coverage and better connection. Particular channels or bands of frequencies can be set aside in 5G networks for V2V communication. By doing this, it is made sure that V2V communications are sent and received without being hampered by other network traffic.
Vehicles can communicate their locations, speeds, and intents thanks to 5G, enabling sophisticated collision mitigation and cooperative sensing systems. Based on this real-time data, vehicles can issue warnings or take evasive action. Due to 5G's short latency and great dependability, platooning and cooperative driving situations are made possible. Vehicles may move near to one another while still maintaining safe distances, which lowers air resistance and fuel consumption. Vehicles can communicate route ideas, traffic updates, and traffic information using V2V communication over 5G. This aids in optimizing traffic flow and facilitates dynamic traffic

management. cars can communicate with one another through V2V in emergency circumstances, broadcasting distress signals that enable neighboring cars to react rapidly and emergency services to respond more efficiently. Advanced security measures are incorporated into 5G networks to solve issues with data privacy and illegal access in V2V communication. All things considered, 5G technology has the potential to transform V2V communication and make driving safer, more effective, and more pleasant. In the upcoming years, we may anticipate seeing a wider use of V2V communication as 5G networks continue to develop and grow.

III. PROPOSED METHODOLOGY

The Dual microwave and Millimeter wave planar shared aperture antenna for Vehicle to Vehicle Communication and 5G Streamless Connection is the foundation of the proposed work.A planar wideband dual frequency antenna with a shared aperture can be designed and its performance examined to achieve this.
An apparatus used to send and receive electromagnetic waves in the microwave frequency range is called a microwave antenna. It is a crucial part of many contemporary communication systems, such as radar systems, satellite communication systems, and cellular networks.A microwave antenna's primary job is to transform electrical impulses into electromagnetic waves and the other way around. Broadband access and high-speed, point-to-point wireless local area networks (WLANs) are two examples of the many products and services that may be provided using the millimeter wave region of the electromagnetic spectrum. There are several applications for millimeter wave, such as telecommunications, short-range radar, and airport security scanners.
Vehicle-to-vehicle communications, often known as V2V communications, are a kind of communication technology that enables wireless vehicle communication. Dedicated short-range communication (DSRC) technology is used by V2V systems to send and receive data between cars.The 3GPP standards organization has specified V2V services to accommodate both safety-related and non-safety applications in the 5G cellular networks. It is anticipated that a connection platform for automobiles will be provided using both the new radio interface in 5G and the direct link known as the PC5 interface. The 5G- V2V standard enables higher layer security solutions specified by other standards in the ITS domain to manage V2V message protection. To maintain security solution at the 5G access layer and to save implementation costs, it could be better to have a security solutions at 5G access layer.

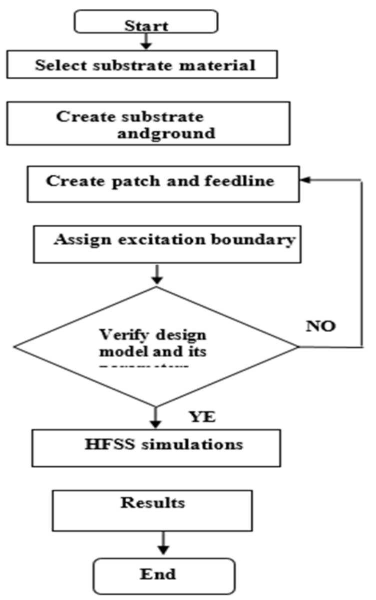


Fig 3: Flow chart of antenna design

The work incorporates a small dual-port dual frequency planar shared-aperture antenna with a high frequency ratio. The flow is shown in Fig[3]. It is made up of a millimeter-wave parallel- plate resonator antenna (PPRA) and a microwave magnetoelectric (ME) dipole antenna. It has two vertical conducting walls that act as a magnetic source for the lower- band ME dipole while also forming an upper band parallel-plate resonator. Because it uses a common aperture structure, the design is quite small. For the purpose of demonstration, a dual- frequency antenna encompassing both the 28-GHz 5G band (27.5-28.35 GHz) and the 5.9-GHz vehicle-to-vehicle (V2V) band

(5.855-5.925 GHz) will be developed, made, and measured. The developed antenna should be able to be used on moving platforms for simultaneous 5G millimeter-wave connections and V2V communications.

IV. ANTENNA CONFIGURATION

The planar wideband dual frequency antenna with a common aperture is configured as shown in Fig[4]. It contains three dielectric substrates: the lowest substrate is the feeding substrate and has a thickness of tf and a dielectric constant of rf, while the two above substrates are antenna substrates with the same thickness (ta) and dielectric constant (ra) values. Two thin rectangular holes with a width of w0, length of l0, and depth of 2ta are created in each of the two antenna substrates. Each hole has copper-coated side walls that are shorted to the surface. As a result, a parallelplate resonator (PPR) functioning in the upper band is created by the two covered holes.

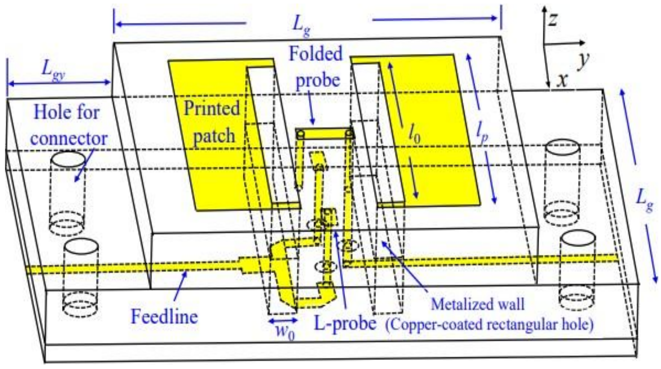


Fig 4: Configuration of planar wideband shared-aperture dual-frequency antenna

The distance s between the two parallel plates, as seen in Fig. 4, defines the PPR's resonant frequency. To produce symmetrical radiation patterns, the PPR is differentially activated by a pair of L-probes in the xoz plane. Vias that join the feed network of the feed substrate to the top surface of the lower antenna substrate are used to manufacture the L-probes. To prevent physical overlaps and significant coupling with the feed network of the lower-band antenna portion, each L-probe is displaced from the center.
The two shorted parallel plates (covered rectangular holes) supply the lower band magneto-electric (ME) dipole antenna with the necessary x-directed magnetic current. Referring to Fig. 2, each parallel plate is attached to a patch that is printed on the top surface of the upper antenna substrate and has dimensions of wp and lp. The two patches come together to create an electric dipole that gives the ME dipole the necessary y-directed electric current. The magnetic and electric currents are excited using the folded probe in the illustration. It features a horizontal strip with a length of l1 and a width of w1 that connects two vias of different lengths. On the underside of the feed substrate, Fig. also depicts the printed feedlines for the two antenna ports. The pair of L-probes receive differential signals from an anti-phase T junction, while the folded probe of the ME dipole is coupled to a straightforward 50-microstrip line with a width of wf1.

V. OPERATING PRINCIPLES

The operating principles of dual frequency planar wideband shared aperture antenna is illustrated in upper band parallel plate resonator antenna and lower band ME dipole antenna as shown in the Fig [5].

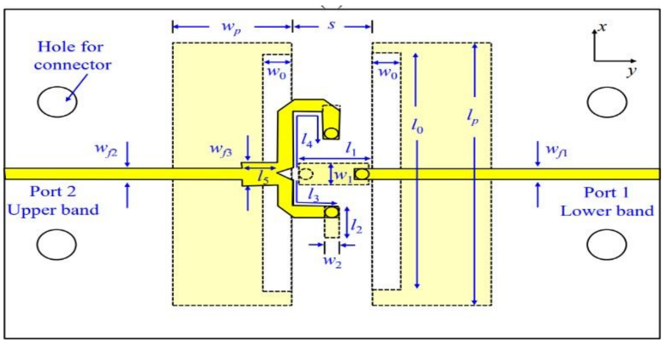


Fig 5: Operating principles of Dual frequency planar shared aperture antenna

A. Upper-Band PPRA

With the exception of the fact that the gap between the two parallel plates is now filled with the dielectric rather than air, the spacing s between the two parallel plates determines the resonant frequency f2 of the PPRA. To describe the PPRA and the impact of the separations on the PPRA's reflection coefficient, a parametric research will be conducted such that when s increases, the frequency band shifts downward and the matching degrades. You can improve match by adjusting the L- probe's dimensions. Therefore, the lower-band ME dipole is also significantly impacted by this separation, so the PPRA component should be constructed first. Additionally, the impact of εra on the reflection coefficient will be investigated in order to confirm that a bigger εra will result in a lower operating frequency.

B. Lower-Band ME Dipole Antenna

The separations between the parallel plates of the ME dipole antenna are specified by the PPRA design, and the height of the parallel plates is constrained by the combined thickness of both antenna substrates. The printed patches' length (lp) and width (wp) are hence the tuning parameters. Even though its adjusting range is constrained by s, the folded probe's complete length may be utilized to tune the ME dipole.

The impact of patch width wp on the upper-band PPRA and lower-band ME dipole antenna reflection coefficients. While the lower-band ME dipole's operating frequency drops as wp increases, indicating that wp has a large impact on that dipole. The impedance bandwidth is extremely constrained when the patch width (wp) is 5 mm. A larger impedance bandwidth is attained when it is increased to 7 mm. The imbalance back radiation from the magnetic and electric sources, however, cannot cancel each other out in this scenario since the gap s (magnetic source) remains fixed while the patch width (electric source) widens. The antenna gain would drop and the back radiation would intensify.

One can increase the frequency ratio even more. To acquire a trade-off between frequency ratio and radiation properties, though, can also be beneficial. It is possible to acquire the simulated E- and H-field distribution in the antenna substrates at 28 GHz. Both the E- and H fields are discovered to be mostly spread across the parallel plates.

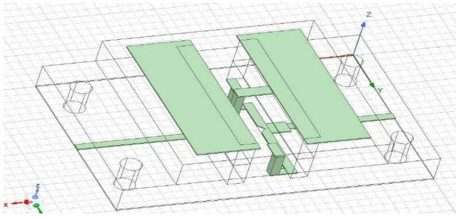
VI. Simulation And Analysis

By examining the characteristics of the microwave ME dipole antenna for the lower band and the millimeter-wave PPRA for the upper band, a planar wideband dual-frequency antenna has been developed. The height of the PPRA has been calculated using the duroid material of the antenna substrate and the thickness of the substrate. PPRA was created using the setups shown in Table [1] and an expected parallel plate separation distance based on resonant frequency. The proposed ME dipole antenna receives magnetic current from a parallel plate resonator formed by two coated holes, and the starting values of the patch are set.

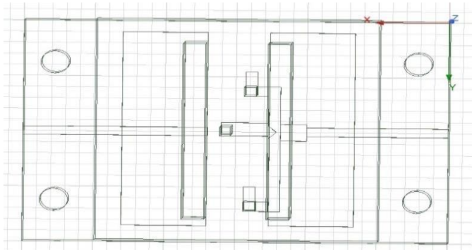
TABLE I: Design Specifications for dual frequency shared aperture antenna

Parameters	Values in mm
Width of patch (Wp)	6
Length of patch (Lp)	17.5
Length of substrate (Lg)	20
Separation of PPRA (S)	4.4
Feedline 1 Width (Wf1)	0.76
Feedline 2 Width (Wf2)	0.78
Antenna substrate dielectric constant (Ɛra)	2.94
Feedline substrate dielectric constant (Ɛrf)	2.2

Dual microwave and millimeter wave planar shared aperture antennas are being implemented for vehicle-to-vehicle communication and 5G streamless connections as shown in fig[6]. A planar wideband dual frequency antenna with a shared aperture can be designed and its performance examined to achieve this.Lower- and upper-band results will be measured with an HFSS simulator, and the S-parameters will be examined for the radiation pattern and antenna gain.



(a)



(b)

Fig 6: Design schematic of planar shared aperture antenna (a) Front view (b) Top View

VII. RESULTS AND DISCUSSIONS

The upper band s-parameter plot in Fig[7] corresponds to a higher frequency range of 28GHz. The S11 parameter reflection coefficient plot will show how much of the incident signal at the upper frequency is reflected back from the antenna.

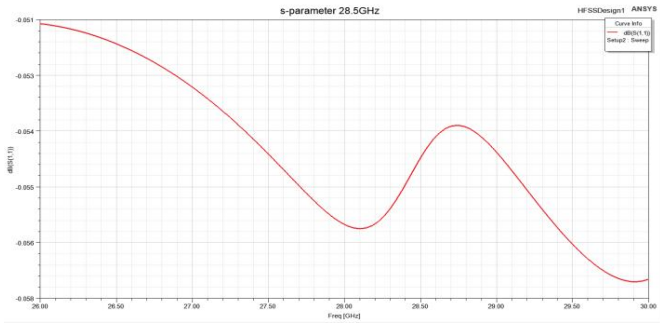


Fig 7: S-parameter plot of upper band

The lower band s-parameter plot in Fig[8] corresponds to a lower frequency range of 5.5GHz. The S11 parameter plot will now show how much of the incident signal at the lower frequency is reflected back from the antenna. The actual shapes of the S-parameter plots will depend on the design and characteristics of your dual-frequency planar shared aperture antenna

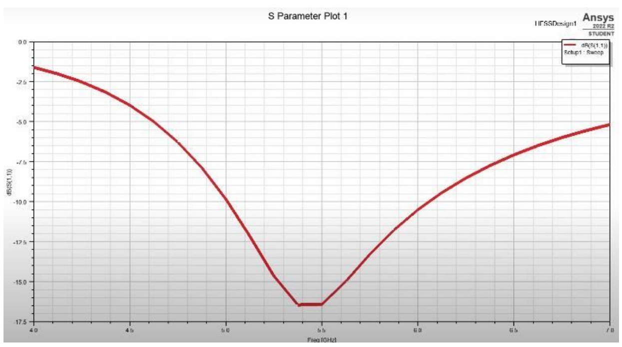


Fig 8: S-parameter plot of lower band

The radiation pattern of an antenna at a specific frequency, such as 28 GHz in the upper band in Fig[9] provide insights into the antenna's directional characteristics, gain, and beam width the radiation pattern illustrates the antenna's characteristics as a function of elevation angle.

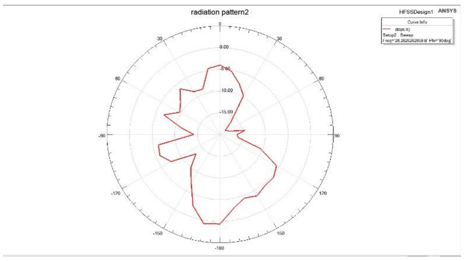


Fig 9: Radiation pattern of upper band at 28GHz

The radiation pattern of an antenna operating in the lower band at a frequency of 6 GHz for a dual-frequency planar shared aperture antenna in Fig[10] provide insights into its directional characteristics and radiation properties. The directivity of the antenna, related to its gain, can be determined by integrating the radiation pattern over all angles.

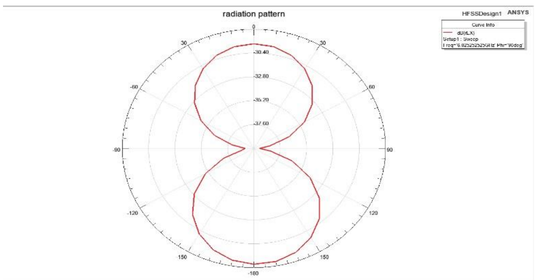


Fig 10: Radiation pattern of lower band at 6GHz

The gain plot for a dual-frequency planar shared aperture antenna in Fig[11] illustrates how effectively the antenna concentrates its radiated energy in different directions at two distinct frequencies.

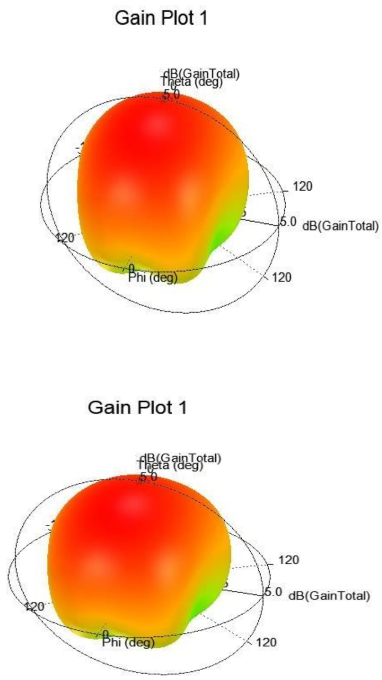
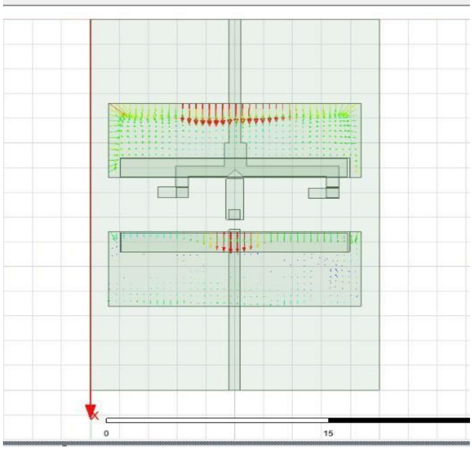
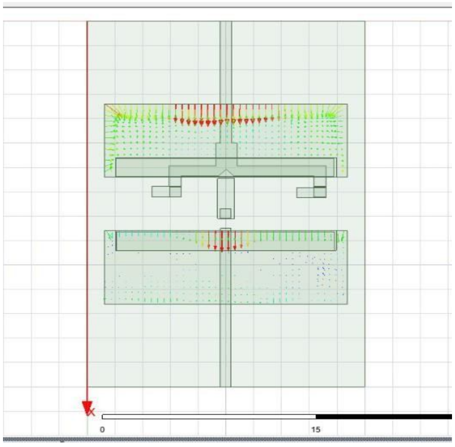


Fig 11: 3D Gain plot for antenna design

The electric field (E-field) and magnetic field (H-field) patterns over relays for a dual-frequency planar shared aperture antenna in Fig[12] provide insights into electromagnetic energy distributed around the relays at the two distinct frequencies. These patterns help understand the spatial characteristics of the antenna's radiation and it interactions with nearby structures.



(a)



(b)

Fig 12: Field over relays (a) E-Field (b) H-Field

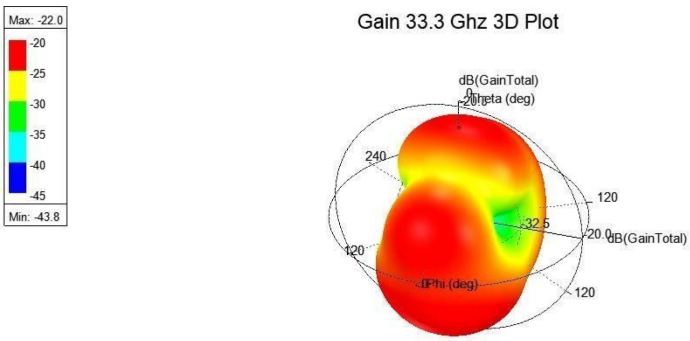


Fig 13: 3D Gain plot for33.3GHz

The field gain patterns over relays for a dual-frequency planar shared aperture antenna in Fig.13 provide insights into electromagnetic energy distributed around the relays at the two distinct frequencies. These patterns help understand the spatial characteristics of the antenna's radiation and its interactions with nearby structures. The Gain plot is estimated for the material bronze and roger, and it has observed higher gain of 20dB as changing the material.

VIII. Conclusion

A planar wideband dual-frequency antenna has been thoroughly investigated. A compact shared-aperture structure has been developed by combining the microwave ME-dipole antenna with millimeter-wave PPRA. Copper was applied to the sidewalls of the two rectangular holesin the antenna substrates to form two parallel plates. PPRA provides the magnetic current needed by the microwave ME dipole antenna. For demonstration purposes, a dual-frequency antenna that functions at both the 5.9 GHz V2V band and the 28 GHz 5G band has been developed and tested. Its boresight radiation patterns have been observed. The lower and higher bands' recorded peak antenna gains are 5 dBi and 8.1 dBi, respectively. After changing the substrate material to bronze and roger RO3006, the highest peak antenna gain records at 20dBi.Finally, it should be noted that the concept may be used for other dual frequency systems with other frequency ratios.

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Enhancing Network Security: A Novel Hybrid ML Approach for DDoS Attack Detection

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***Abstract*— Software-defined networking represents a ground breaking advancement in network technology, characterized by its desirable attributes such as enhanced flexibility and manageability. Although ongoing, the issue of DDoS assaults in SDN is characterized by malicious and obtrusive network traffic that overwhelms SDN resources. Despite numerous security methodologies aimed at detecting DDoS attacks, the challenge of effectively addressing this issue continues to persist as an active area of research. The XG-Light Hybrid, a unique hybrid system, has been developed in this work as a solution to this problem. This discovery is significant because it has the potential to dramatically increase the reliability of DDoS attack detection in SDN environments, hence boosting network security and stability. Key findings reveal that the proposed hybrid approach outperforms individual machine learning algorithms with respect to DDoS detection.**

Index Terms— DDoS Detection, Machine Learning, Network Traffic, Light GBM, SDN, and XG Boost.

I. INTRODUCTION

In the last ten years, the network infrastructure has undergone significant expansion, marked by a proliferation of network devices. This expansion has introduced greater complexity in network administration and posed potential barriers to future innovations in the realm of the Internet. Additionally, traditional network structures, characterized by their inflexibility, have limited adaptability and led to increased operational costs. As a result, these difficulties have slowed the development of emerging technologies like big data, cloud computing, and the Internet of Things, all of which require increased bandwidth, flexibility, and management. In response to these circumstances, Software-Defined Networking (SDN) has emerged as a revolutionary networking model. SDN is poised to meet the escalating demands of next-generation networks and emerging technologies, offering a promising solution to the administrative complexities and limitations associated with traditional network architectures [1].

The Software-Defined Networking (SDN) architecture constitutes the entire network infrastructure. It adopts a modular approach that outlines a hierarchy and sets standards for how components within the network interact with one another [2]. Fig. 1. provides a visual representation of the SDN architecture, comprising three main layers:

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the data/infrastructure, control, and application layers.

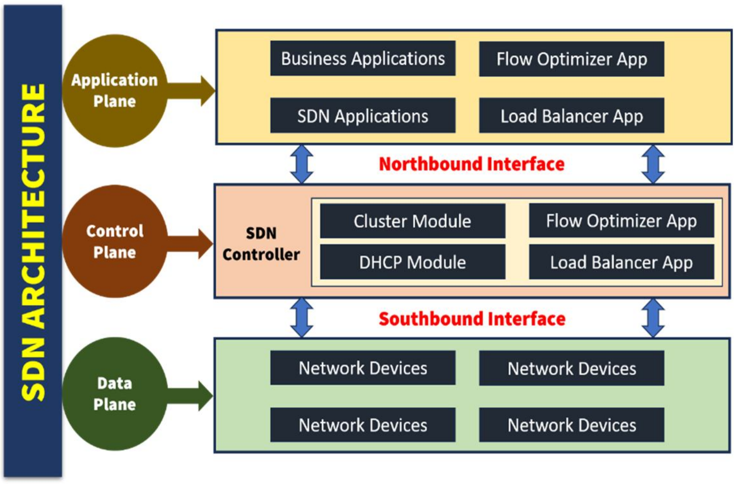

Fig. 1 SDN Architecture.

Within Fig 1. two primary elements stand out: controllers and forwarding devices. A forwarding device can be either a hardware or software component specialized in the task of packet forwarding. As opposed to that, the controller functions as the network's central intelligence, responsible for managing the network's state and operations [3]. As a revolutionary paradigm, SDN holds the promise of addressing the requirements for flexible, secure, dependable, and efficiently managed next-generation networks. It brings forth significant potential and optimism for meeting these demands head-on, ushering in a new era of network capabilities [4].
Due to the distinctive attributes of SDN architecture, conventional DDoS attack detection methods employed on the SDN controller often exhibit limited accuracy in identifying such attacks [5]. In order to discern the presence of a DDoS attack, the SDN controller must continuously amass network traffic data from switches, leading to an elevated workload for the controller. Consequently, there arises a necessity to establish a dedicated security framework to counter this threat [6].
A DDoS (Distributed_Denial_of_Service) attack is a common threat in which attackers take control of numerous devices, turning them into bots that work together to flood a system with fake traffic or requests. The goal is to overwhelm the system's resources or congest the victim's network as shown in Fig 2. Unlike some other network attacks, DDoS doesn't involve stealing sensitive information; instead, it aims to disrupt services temporarily. DDoS attacks are relatively simple to launch but challenging to trace back to their source.

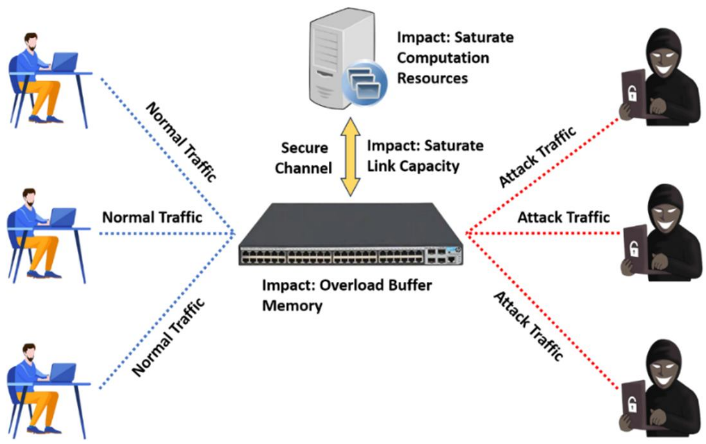

Fig 2. DDoS attack resulting from compromised nodes [7].

In a typical DDoS assault, multiple compromised devices inundate a target network with an overwhelming volume of traffic, exhausting its resources and rendering legitimate traffic inaccessible. Within SDN, the attack surface expands due to the centralization of control, making it essential to address DDoS threats comprehensively. Within SDN, the classification of DDoS is as shown in Fig 3.

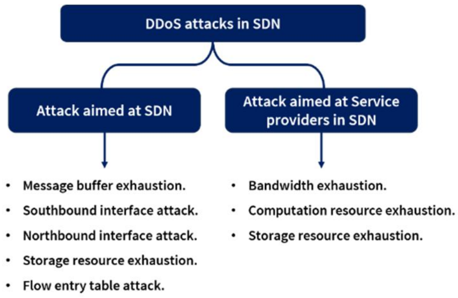

Fig 3. Overview of DDoS attacks in SDN.

II. Literature Review

It is because machine learning techniques have the capacity to make wise decisions and operate effectively automatically, they have gained a lot of traction in the field of cybersecurity [8]. The most successful machine learning algorithms developed in this domain are gathered in order to conduct a complete review of the techniques available. Machine learning approaches have demonstrated efficacy in a number of cybersecurity-related areas, including spam detection, malware detection, user identity verification, software vulnerability discovery, and DDoS attack detection [9].
In this section, a lot of research about how to stop, find, and deal with DDoS attacks using machine learning is examined. Machine learning-based Distributed Denial of Service (DDoS) detection approaches can be broadly classified into three main categories: Ensemble-based ML schemes, Hybrid-based ML schemes, and Single ML schemes methods. Table 1. also summarizes few schemes in the same context.

A. Ensemble based ML schemes

Maheshwari et. al., proposed an enhanced Weighted Voting Ensemble (OWVE) model designed for the detection and mitigation of Distributed Denial of Service (DDoS) attacks. This ensemble model leverages Support Vector Machines (SVM), Random Forests (RF), and Gradient-Boosted Machine classifiers, each with distinct hyperparameter configurations. Notably, the ensemble model exhibits remarkable classification accuracy, achieving 99.41% and 99.35% accuracy rates when tested on the CIC-DDoS-2019 and CAIDA-2007 datasets, respectively [10].
An intrusion detection system based on voting that is intended to protect SDN from DDoS assaults, has been introduced by swami et. al. This innovative voting model underwent training and testing utilizing three datasets: UNSW-NB15, CICIDS2017, and NSL-KDD, consistently demonstrating superior detection accuracy compared to alternative methods [11].
An ensemble machine learning technique, referred to as K-mean and RF, has been innovated to enhance the precision and effectiveness of identifying and detecting DDoS attacks. This advanced system underwent rigorous training and testing utilizing the InSDN dataset, resulting in flawless detection accuracy, achieving a remarkable 100% [12].

B. Hybrid based ML schemes

To distinguish between regular network traffic and traffic from DDoS attacks, Support Vector Machine (SVM) and Random Forest (RF) classification algorithms were combined. This method underwent rigorous testing and evaluation using a real-world Software-Defined Networking (SDN) dataset [13]. A study was conducted to explore the integration of P4 programmable technology and machine learning algorithms, including K-NN, RF, SVM, and ANN, for the development of a real-time detection system. An automated method for detecting DDoS attacks, specifically SYN flood attacks, at the local level on SDN switches was proposed [14].
In their study, Nadeem et al., utilized a range of machine learning algorithms, including Random Forest (RF), Support Vector Machine (SVM), K-Nearest Neighbors (K-NN), Naïve Bayes (NB), and Decision Tree (DT). Their approach was rigorously assessed using the NSL-KDD dataset, resulting in notably high accuracy rates, particularly achieving an outstanding 99.97% accuracy for the Decision Tree (DT) algorithm [15]. In a separate research investigation, a diverse a variety of machine learning classification models, such as Logistic Regression (LR), Decision Trees (DT), Random Forest (RF), AdaBoost (AB), Multilayer Perceptron (MLP) were employed to analyze and identify TCP-SYN flood Distributed Denial of Service (DDoS) attacks targeting the SDN controller [16].

C. Single algorithm-based ML schemes

The approach proposed by Nurwaristo et. al., utilizes Random Forest (RF) to classify network traffic into normal and abnormal categories based on flow entries. If packets are classified as a DDoS attack, specific switch rules are applied for mitigation. This system achieves an impressive 98.38% overall detection accuracy while ensuring swift mitigation [17]. Oo et al. proposed an Advanced-SVM algorithm to detect UDP and SYN flood DDoS attacks in SDN networks, achieving strong overall evaluation performance: 87% for precision, 84% for recall, and 93% for F1-score, as demonstrated on SDN-TrafficsDS and KDDCUP99 datasets [18]. An approach centered around factorization machines (FM) was employed for improved accuracy in detecting low-rate Distributed Denial of Service (DDoS) attacks on SDN data planes. While it effectively identifies such attacks, the approach achieved a reasonably good detection accuracy of 95.80%. [19].

TABLE I. CONCISE SUMMARY OF OTHER ML-BASED DDOS DETECTION IN SDN NETWORKS

Scheme Reference	Approach	DDoS Techniques	ML Techniques	Research Gap
[20]	Ensemble	Detection	k-NN, NB, SVM & SOM	The proposed approach was assessed using datasets that did not accurately represent SDN network characteristics, resulting in suboptimal performance for the ensemble approach.
[21]	Hybrid	Detection	NB, SVM, XGBoost & RF	the proposed method's evaluation was conducted using a dataset that does not faithfully capture the SDN network's characteristics.
[22]	Hybrid	Detection & Mitigation	RF, SVM & MLP	The evaluation of the proposed model utilized an unrealistic dataset that does not mirror the characteristics of the SDN network environment.
[23]	Hybrid	Detection & Mitigation	XGBoost & Bandwidth Control	The proposed system's operation on the controller introduces excessive load and overhead. Additionally, the approach encounters significant processing and communication overhead.
[24]	Single	Detection & Mitigation	BPNN	The proposed approach exhibits a relatively low detection accuracy of 96.13% due to significant issues with false-positive and false-negative outcomes.

III. PROPOSED DDOS DETECTION MODEL

In predicting potential DDoS attacks on the SDN controller, a machine learning (ML) approach was employed, utilizing historical attack data. Fig 4 provides an overview of the proposed detection system.

In the proposed project, a DDoS attack detection technique is put into action within the SDN controller environment using machine learning. A combination of XGBoost and Light GBM models is employed to construct classification models as shown in Fig. 4. This approach leverages advanced traffic-related features to establish a model capable of categorizing SDN flow packets as either typical or suggestive of a DDoS attack. The feature data is sourced from an examination of the network traffic's headers and statistics.

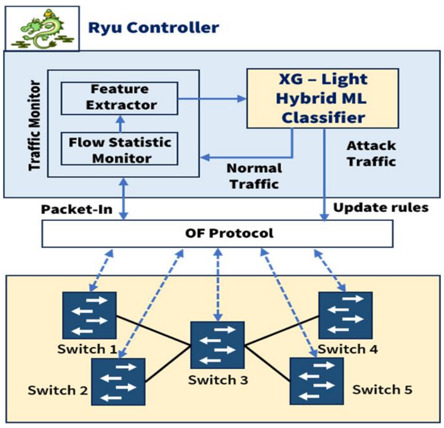

Fig 4. XG – Light Hybrid ML Classifier for DDoS detection

When the controller receives an OF (OpenFlow) packet from the OF switch, it initiates a series of actions. First, it extracts the source IP address from the incoming flow packet and checks if this address is listed in a blocklist. If it finds a match, the packet is dropped, and important statistics like the frequency of packets from that source address, timestamps, and other relevant data are recorded and considered. Conversely, if there's no match with any blocked address, the packet's headers and associated statistics become input features for testing by a classifier. If the classifier determines that the incoming packet is normal, it's allowed to continue its journey as usual. However, if the packet is classified as part of a DDoS attack, even if it's the first time that the source IP address is flagged as an attacker, that IP address is added to the blocklist. Additionally, all packet details are logged, ensuring that any suspicious packet from the same source IP address is discarded. Furthermore, various traffic flow statistics, including packet arrival timestamps and the number of packets sent by the same host, are recorded for analysis.

Algorithm: *Proposed Hybrid Algorithm*

```
while true do
    Packets are sent by OF switch to the controller
    Extract IP address of the source from each packet
    if (IP matches with an entry in Blocklist) then
        Collect all statistics from the packet
        Update it in block list
        Send to the switch to update flow table entry
    else
        Store: Time stamp, Destination IP, Port numbers, Transport Layer Protocol, Type of
                Service, and Payload length headers.
        Obtain features by performing calculations that are necessary using the gained information.
    Input the features into proposed hybrid model
    if (The model detects a DDoS attack) then
        Add the IP of the source into blocklist
        Log all the necessary statistics
    else
        serve the packets normally and log the statistics for future use.
```

IV. Simulation And Result Analysis

In this section, we outline the setup for our experiments and detail the technologies we employed to assess the effectiveness of various machine learning techniques and the feasibility of our framework.

A. Experimental and Simulation setup

The experimental setup was executed on an HP laptop equipped with a Core i7 CPU and 16 GB of RAM, running the Linux Ubuntu 16.04 LTS operating system. The Mininet emulator and RYU controller were used to generate the test environment with Open vSwitches implementing the OpenFlow protocol version 1.3, forming an integral part of this configuration. The network topology is a linear topology consisting of 64 hosts, 8 switches, and one controller as shown in Fig 5.

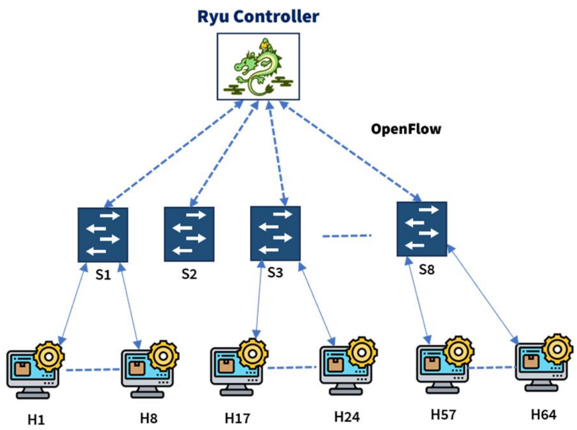

Fig 5. Simulation Network Topology

B. Dataset Generation

In order to evaluate the effectiveness of the proposed method, we established a virtual network and conducted simulations using Mininet with the Ryu controller. For packet generation, we employed Scapy. This virtual environment was configured with a Ryu controller, eight switches, and a total of 64 hosts, as depicted in Fig 5.

The CICDDoS2019 dataset, as outlined in [25], is a public dataset comprises both legitimate network traffic and contemporary DDoS attack patterns, making it a faithful representation of real-world data. It offers valuable insights into network traffic through the application of CICFlowMeter-V3, categorizing flows with timestamps, source and destination IPs, ports, protocols, and attack labels. This dataset served as the foundation for training and assessing the effectiveness of the proposed model in our research.

C. Performance Evaluation Criteria

The classifier's key performance metrics have been used to evaluate performance. derived from the confusion matrix presented in Table 2.

TABLE II. CONFUSION MATRIX FOR THE MODEL

		PREDICTED VALUE	
		POSITIVE	NEGATIVE
ACTUAL VALUE	POSITIVE	TP	TN
	NEGATIVE	FP	FN

In this context, True Positive (TP) indicates instances where the model accurately identifies the positive class. True Negative (TN) represents situations where the model correctly predicts the negative class. False Positive (FP) occurs when the model incorrectly forecasts the positive class, deviating from the actual classification criteria. False Negative (FN) arises when the model mistakenly anticipates the negative class, contradicting the established standards.

The evaluation of the approach's performance involved the use of various performance metrics, such as accuracy, precision, recall, and F-Measure, which gauges the correlation among traffic flows [26].

Accuracy is determined by calculating the ratio of correct predictions to the total number of predictions using Equation (1):

$$Accuracy = \frac{TP+TN}{TP+FP+TN+FN} \tag{1}$$

Among all the expected positive cases, precision counts the number of genuine positive cases. It offers a value between 0 and 1, and Equation (2) can be used to determine precision:

$$Precision = \frac{TP}{TP+FP} \tag{2}$$

Recall quantifies the number of predicted positive cases as a percentage of all positive cases and is computed using Equation (3):

$$Recall = \frac{TP}{TP+FN} \tag{3}$$

The F1-score is a single metric that takes into consideration both accuracy and recall; by accounting for erroneous positives and false negatives, it is useful for imbalanced datasets. Equation (4) is utilized in its calculation.

$$F1-score = \frac{2\ X\ (precision\ X\ recall)}{(precision+\ recall)} \tag{4}$$

D. Results and Discussions

The recommended strategy is examined in this section and illustrates the enhancements it achieves through an evaluation of different ML models, including Random Forest (RF), Naive Bayes (NB), Support Vector Machine (SVM), and k-Nearest Neighbor (k-NN). The analysis was independently performed on both the publicly available dataset and the dataset generated through simulation. In both scenarios, it was observed that the proposed model consistently outperformed existing ML models concerning the considered parameters. This highlights the effectiveness of proposed approach in achieving superior results compared to established machine learning models.

- *Analysis based on Public Dataset*

Following an analysis conducted using the public dataset, it has been noted that the proposed approach consistently demonstrates better results in comparison to existing methods as shown in Fig 6.

- *Analysis based on Generated Dataset*

An analysis was additionally carried out on the dataset generated within the simulation environment, as previously detailed in the preceding section. It's worth noting that due to the limited volume of data collected, the values for the considered parameters were relatively low. Nevertheless, even in this scenario, the proposed approach consistently outperformed alternative methods as shown in Fig 7, further affirming its effectiveness.

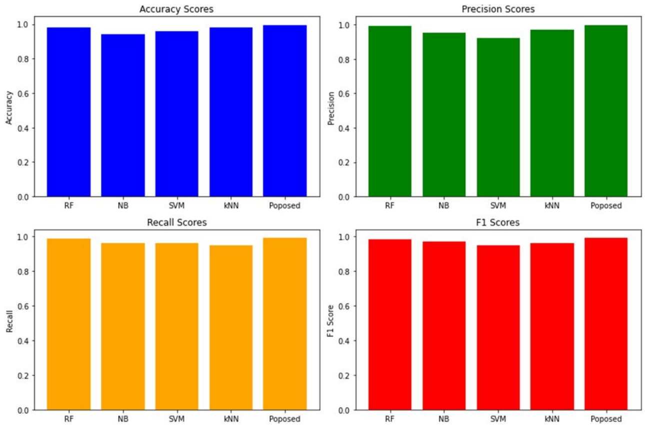

Fig 6. Comparison of various ML techniques for the public dataset.

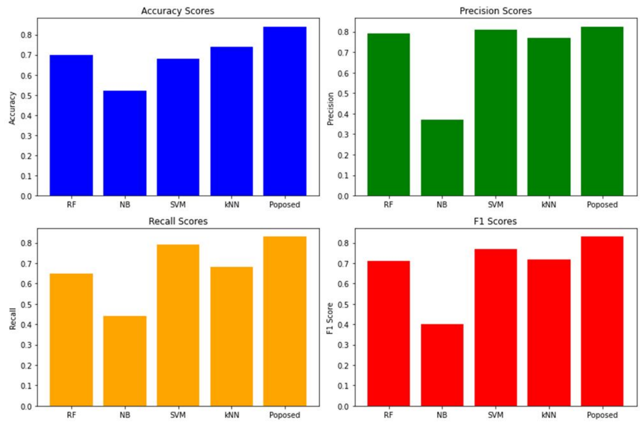

Fig 7. Comparison of various ML techniques for the generated dataset.

V. CONCLUSION

DDoS detection was carried out on two distinct datasets: the standard CICDDoS2019 dataset and a dataset generated within a virtual environment. In the methodology, feature selection was based on the type of attack, followed by the implementation of various machine learning procedures. The performance of various machine learning algorithms is evaluated in terms of accuracy, precision, recall, and F1-score. In the generated dataset, the overall model performance notably decreased due to the limited dataset size with a smaller number of features.
Overall, the analysis revealed thsat the proposed XG-Light hybrid algorithm outperforms other considered machine learning models in effectively identifying DDoS attacks. In the future, this research can be expanded by experimenting with multiple controllers in SDN environments. Additionally, conducting experiments with much larger datasets and comparing the outcomes with existing models can provide valuable insights.

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A Review on Image Enhancement Techniques using Histogram Equalization

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***Abstract*— Image Enhancement (IE) is vital and one of the significant parts of Image processing. It is necessary to enhance the contrast and reduce the noise to improve the quality of the image.IE is one of the processes for altering the visibility of an image. It is widely applied in different fields such as medical science, industry, military, agriculture, etc. Image Enhancement is modifying digital images to make the image appear pleasing to the viewer. Several research works have been done on Image Enhancement. This paper also discusses the Self-Calibrated Illumination method (SCIM) and the HE method. SCIM along with HE Image Enhancement techniques and algorithms can improve the visual quality of the digital image. There are several techniques to enhance the quality of an image to extract meaningful information from the image. The well-known techniques for image enhancement are the RetiNex-based method, Weber-Fechner method, Linear Regression algorithm-based method, Histogram Equalization, Fourier transform, etc. This paper reviews and compares the research work carried out in image enhancement based on the Histogram Equalization Method by different authors. This paper also reviews the merits and drawbacks along with the enhanced images and histogram plots obtained in these methods developed over the past decades. Finally, it concludes what further work needs to be done for a better quality of image.**

***Index Terms*— Histogram Equalization, Weber-Fechner, Self-Calibrated Illumination, Linear Regression**

I. INTRODUCTION

Image Enhancement is used to improve the visibility and perception of information in images. It also provides a good solution as input to other automated digital image processing techniques. The main goal of IE is to modify a digital image's attributes and produce an image more suitable for a given task. Histogram Equalization [1] has been used to enhance the quality of the image. It is used to improve the contrast of an image by redistributing the pixel intensity in the image so that the pixel values are more uniformly distributed. This makes the image more visually appealing. Along with this method, another method called the Self-Calibrated Illumination method [2] is used to improve the quality of the image. Most digital images sequenced from gathering equipment are too bright or dark and have an unbalanced background as a result of environmental factors, especially illumination as in [3]. As a result, the images lose some detailed information and quality, which has a significant impact on how they are used for things like transportation, public security, punishment detection, and other purposes. The histogram plot of different methods shows the distribution of pixel intensity of the image. Histogram Equalization (HE) along with Self-Calibrated Illumination is a preferred choice for images with low contrast and with less noise. It is one

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of the most acceptable Image Enhancement algorithms. The proposed technique based on Histogram Equalization along with Self -Calibrated Illumination method shows improved performance to the existing image enhancement approaches HE accumulates the histogram probability density of the function of an image so that the grayscale distribution of an image can be enlarged. Various algorithms for accomplishing the contrast of an image have been developed and applied to the problems of image processing.

The proposed Self-calibrated Illumination method (SCIM) uses a reference image to calculate the illumination condition of the image. This information is then used to improve the contrast and visibility of details in the output image. The SCIM along with the HE method has several merits as it improves the contrast of the image, it helps to reduce noise, it also helps in edge detection of an image by making the edge sharper. The combination of the two techniques helps to reduce the artifacts and is used in a wide area such as medical imaging, in security applications.

II. Literature Review

Various research works done in the field of Image Enhancement Techniques using Histogram Equalization are summarized in Table I. A comparison of the Enhanced Images obtained by some of the methods with their histogram plot and the drawbacks of these methods is depicted in Table II.

III. Proposed Method

The result of the output images obtained from the various methods has some drawbacks such as over-enhancement, the lack to preserve the brightness, the presence of noise, etc. Our proposed method which is based on Self Calibrated Illumination and Histogram Equalization technique has somehow been able to overcome these drawbacks. The proposed method can yield pleasing results with the preservation of brightness and structures and even improve the visual quality of the image. We create a unique Self-Calibrated Illumination (SCI) learning framework for quick, adaptable, and reliable low-light image improvement to address the problems. We create a self-calibrated illumination learning module to ensure convergence between findings at each stage, enhance exposure stability, and significantly lessen the computational load. The flowchart for the self-calibrated illumination method is depicted here:

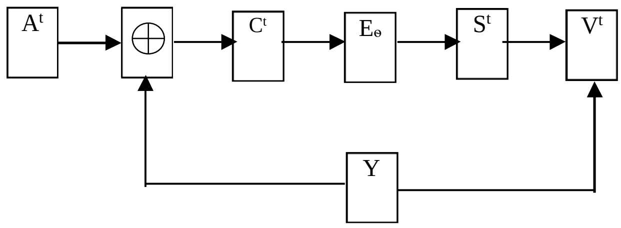


Figure 1. Flowchart for the self-calibrated illumination method

The original low-light input is combined with the self-calibrated module map as the input of the illumination estimation in the following stage.

The following equations can be obtained from the above framework:

$$G(A^t):\ C^t = Y \oplus A^t \quad \text{----------------------(1)}$$

$$S^t = E_\theta (C^t) \quad \text{-----------------------(2)}$$

$$V^t = Y + S^t \quad \text{-----------------------(3)}$$

Where Y is the low light dark image; A^t is the illumination component at t^{th} stage.

The Equations obtained from the SCI framework have been defined as follows:

The first equation (1) states that the transformation $G(A^t)$ adds the estimated illumination Y to the image pixel values A^t . A new image C^t that has been brightened by the estimated illumination's quantity is the end result of this operation.

The second equation (2) states that the transformation $S^t = E_\theta (C^t)$ transforms the image C^t according to a nonlinear function Ɵ. The function Ɵ is a gamma correction function, which shrinks the image's dark pixels and enlarges its bright pixels. The end effect of this alteration is a new image S^t with improved contrast.

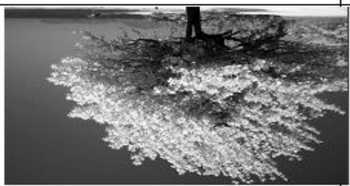
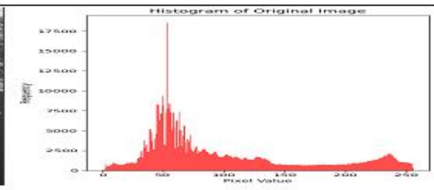
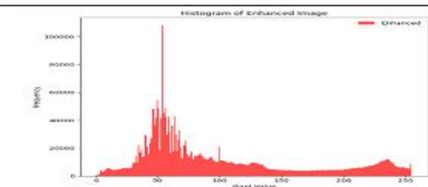
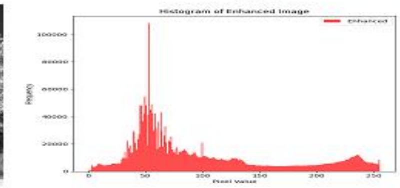
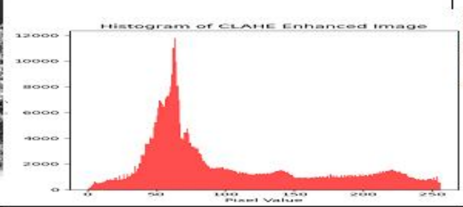
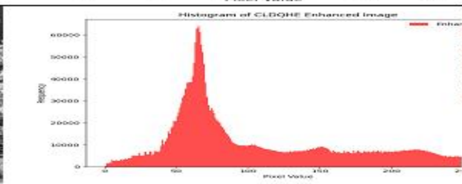
The third equation (3) states that the improved image S^t is added back to the estimated illumination Y by the transformation $V^t = Y + S^t$. The outcome of this transformation is the final enhanced image V^t.
Every process step that is shared aims to achieve a result that is as close to the desired outcome as possible. The input of each stage is derived from the input of the stage before it, and the input of the first stage is definitely the observation in low light.
The flowchart in Fig. 2 showing the working of Self -Calibrated Illumination method along with the Histogram Equalization method is depicted below:

TABLE I. VARIOUS WORK DONE IN THE FIELD OF IMAGE ENHANCEMENT TECHNIQUES

Ser. no.	**Author Name**	**Paper Name**	**Advantages**	**Drawbacks**
1	Y. Xie,L Ning, M Wang et.al.(2019) [1]	Enhancement of image using histogram equalization	The visual effect and contrast can both be enhanced by histogram equalization	It may cause judder and loudness.
2	Z Huang,Z Wang et al. (2021) [2]	Image Enhancement with the preservation of brightness and structures by employing contrast-limited dynamic quadri-histogram equalization	With the preservation of brightness and structures, the CLDQHE process can produce pleasant results.	The method fails to produce the details and high contrast of the image.
3	J Xiong, D Yu , et al. (2021)[3]	Application of Histogram Equalization for Image Enhancement in Corrosion Areas	The suggested technique considerably raises overall brightness, intensifies shadow detail, and strengthens corrosion area identification in the image.	The proposed method combine two algorithm this leads the computational complexity very high.
4	S Chaudhary et.al. (2022) [4]	Enhancement of images by linear Regression algorithm and sub-histogram equalization	The algorithm is applied on both medical and nonmedical images which improve its performance.	The method requires the set of various test images to evaluate its performance which is sometimes is cumbersome.
5	U.K. Acharya et.al (2022)[5]	Sub-division of image and quadruple clipped adaptive histogram equalization for low exposure image enhancement	The method used can enhance the contrast of low-light images	The method may not be suitable for images that contain more noise
6	N Thakur et.al. (2022)[6][9][7]	Cuckoo Search Optimized Histogram Equalization for low contrast image enhancement	This method control over and under enhancement by calculating clip limits of the image histogram.	This approach has the potential to reduce the quality of the resulting low contrast images. ,
7	Y Li, Z Yuan, K Zheng et al.(2022)[8]	A weighted histogram equalization method for brightness preserving image enhancement based on partial statistic and global mapping model	This technique may efficiently enhance image details, reduce over-enhancement, and increase visual quality while maintaining image brightness.	The histogram's high peak causes over-enhancement, which significantly degrades the subjective quality of the HE-processed image.
8	S.D. Thepade et.al. (2022) [9]	Contrast enhancement with brightness preservation of low light images using a blending of CLAHE and BPDHE histogram equalization methods	This approach is straightforward and very efficient,	There is a need for improvement because this method sometimes is unable to maintain the brightness and natural form of the original scene.
9	Y Jin, W Yang et.al.(2022)[11]	Unsupervised Night Image Enhancement: When Layer Decomposition Meets Light-Effects Suppression.	This method boost the intensity of dark regions and reduce hallucinations and other artifacts.	This method leads to over enhancement and saturation in bright regions.
10	W. Wang et.al. (August 2022)[19][10]	Simple low-light image enhancement based on Weber-Fechner law in logarithmic space	The method reduces the impact of non-uniform illumination on the image.	There is a lack of parameter setups to change on their own during the process of improving low-light photos

11	F.M. Mustafa (2022)[12]	Enhancement of image in wavelet domain based on histogram equalization and median filter	The proposed method help in reducing the noise from the mage.	This algorithm lacks in selecting suitable filters to produce improved quality and performance results.
12	S Agrawal , R Panda et.al.(April, 2022)[14]	A novel joint histogram equalization-based image contrast enhancement	Even for images with a limited dynamic range, it gives the best results.	The use of joint histogram may make it more complex contrast enhancement techniques.
13	Long Ma, Tengyu Ma et al.(2022)[16]	Toward Fast, Flexible, and Robust Low-Light Image Enhancement	This method is fast enough to use in real-time applications.	This method requires a large amount of data for training which is the main demerit.

TABLE II. COMPARISON OF THE ENHANCED IMAGES OBTAINED BY THE FOLLOWING METHODS WITH THEIR HISTOGRAM PLOT AND THE DRAWBACKS OF THESE METHODS

Methods Name	**Enhanced Images obtained from the respective methods**	**Histogram of the enhanced images of the respective methods**	**Drawbacks of these respective methods**
Original Image(in put images)[32]			This is input grayscale image which is dull , dark and have low contrast.The histogram plot is denser near 0 to 150 which results in dark contrast of image
Brightness preserving Bi HE methods (BBHE)			The subjective quality of the image processed by HE is significantly impacted by the over -enhancement brought on by a high peak in the histogram.
Linear Regression algorithm and Sub HE technique.			The result as displayed is in terms of different evaluation measure.The pixel intensity value in the histogram shows high peak near 50 and 100 which results in Dark appeareance of the output image.
Blending CLAHE and brightness-preserving dynamic HE methods (BPDHE)			The displayed output needs to improve the brighteness as the intensity value of the pixel in the histogram plot is denser near 50 to 100. So, it did not keep the original scene's brightness.
Contrast Limited Dynamic Quadri-HE method (CLDQHE)			The method retain the structure in the output image but it fails to preserve the brightness. The pixel intensity of histogram plot shows denser at 75 which is nearer to dark region i.e. close to 0.

1) Read the dark low light image from a file or from outward tool such as a camera.
2) Apply Histogram Equalization to the image. HE results in an image with bright contrast and improved visibility.
3) Calculate the illumination of the image using Self Calibrated Illumination Method equation.
4) Apply the scaled illumination to the HE enhanced image , this results in a more accurate visibility.
5) The final step is to save the enhanced image to display it on a screen.

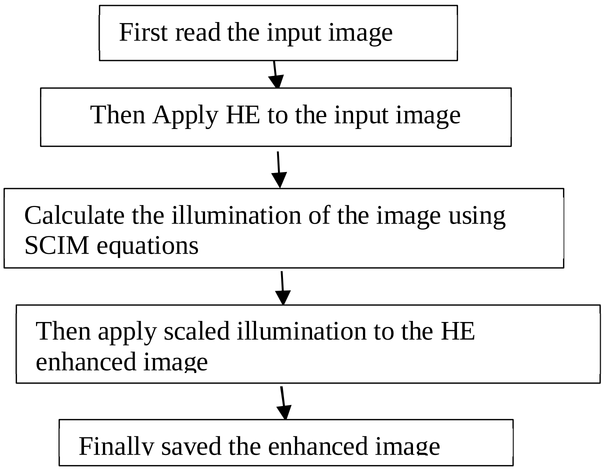


Figure 2. Flowchart for the self-calibrated illumination method

IV. Discussion

Histogram Equalization is one of the image processing techniques that helps to adjust the contrast of the image with the help of its histogram. In order to enhance the contrast of the image the Histogram Equalization stretches out the intensity range of the image. By doing this the Histogram Equalization enables the low-contrast image to gain high contrast. We need Histogram Equalization when the image looks washed out as these images do not have sufficient contrast. In order to get high contrast in the image Self-Calibrated Illumination method is also applied to the equalized image which we get from the Histogram Equalization Method. Most of the pictures that are used in computer vision and image processing task does not provide much information since most of the areas of the images are blurry due to a lack of contrast. So Histogram Equalization along with the Self-Calibrated Illumination Method is used to get the bright contrast of the input image. The SCIM (Self-Calibrated Illumination method) along with the Histogram Equalization method used in this paper is far better than all the state-of-the-art methods.

V. Conclusion

The Histogram Equalization along with the Self-Calibrated Illumination method is used in this paper not only to improve the quality of the grayscale images but also to remove all sorts of artifacts such as noise from images. The drawbacks which were seen like some blurring artifacts in the grayscale images are also removed by this Histogram Equalization and Self-Calibrated Illumination method. We create a new self-calibrated Illumination (SCI) learning framework in this research for quick adaptable and reliable image brightening in actual low-light conditions. Finally, further exploration is needed in designing more effective image enhancement techniques that can provide a bright contrast image. So, more research work needs to be done in the image enhancement area.

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A Review on Students' Performance Prediction using Learning Analytics

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***Abstract*— Learning Analytics is a research area that is growing rapidly. It deals with selecting, analyzing, and reporting educational data collected from various learning environments and finding relevant patterns in students' behavior. Different online learning platforms like Massive Open Online Courses (edX, Udemy, Udacity, etc.), Learning Management Systems (Moodle, Blackboard, Classroom, etc.), and Virtual Learning Environments (DEEDS, Coursera, etc.). Learning analytics can be viewed as a multidisciplinary field that includes Machine Learning (ML) Techniques, Educational Data Mining (EDM), Statistics, Social Network Analysis, and Natural Language Processing. This paper comprises the study of Learning Analytics and its different techniques used in predicting students' performance. Further, it consists of an analysis of previous studies described in tabular form for better understanding. A basic learning analytics model is described which consists of the steps involved in creating any project.**

***Index Terms*— Learning analytics, LMS, VLE, MOOC and ML**

I. INTRODUCTION

The traditional educational landscape is changing day by day as technology is evolving rapidly. Especially after the COVID pandemic, the field of education has witnessed a paradigm shift towards the integration of technology in Virtual Learning platforms. Virtual learning offers remarkable flexibility and accessibility, enabling students to pursue education remotely and at their own pace. The amount of data generated from these learning environments is increasing exponentially. This data can be used to gain valuable insights into learning behaviors, engagement, and performance. The study of Learning Analytics has become a powerful tool for extracting valuable insights and hidden patterns from the massive amount of data collected from learning environments.

Learning analytics can be understood as the process of collecting, analyzing, and interpreting data from learning environments in order to understand and optimize the learning process as well as the environment in which it occurs [16]. By exploiting the vast amount of data generated within VLEs, teachers or educators can identify new patterns and predict students' performance. It allows them to personalize instructions, provide timely interventions, and improve educational outcomes. By Learning Analytics, researchers can develop new models and algorithms to predict students' performance by analyzing their past behaviors, engagement level, learning activities, work accomplishments, and their interactions within the VLEs (Virtual Learning Environments). Learning Analytics has become a hot topic for researchers due to many reasons. These are:

1. Increase in volume of data available about learners and learning techniques, especially in VLEs where every small interaction, each page visited, and each click can be recorded and used for future analysis [17].

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2. Prediction of students' performance at an early stage and management of learning environments in order to enhance the retention ratio and lower students' dropout from online courses [17].
3. Increase in no. of statistical tools to manage large amounts of datasets and facilitate educators [17].

Learning analytics is closely related to EDM (Educational Data Mining) and AA (Academic Analytics) [18]. EDM and LA are the two overlapping research areas as they are used interchangeably in many research [8]. The domain, datasets, methods, and objectives in EDM and LA are pretty similar yet there exist some differences.

On the basis of different previous studies, the differences between Academic Analytics, Educational Data Mining, and Learning analytics are shown in this section using the table shown below:

TABLE I. DIFFERENCE BETWEEN VARIOUS DATA ANALYTICS METHODS IN EDUCATION DOMAIN

Techniques	Description
Academic Analytics	It is defined as the use of business intelligence in education. It focuses on enrollment management and the prediction of students' academic success thus facilitating the funders and administrators. Its primary goal is to solve the political/economic challenges to improve educational opportunities and outcomes at national or international levels.
Educational Data Mining	It is defined as the use of Data Mining techniques to extract useful insights from large educational data It involves application of Machine Learning, Statistical Analysis, and Data visualization to uncover the hidden patterns in students' behaviors. It focuses more on technical challenges unlike LA which focuses on Educational Challenges.
Learning Analytics	It focuses on the use of students data collected from students' interaction with Learning environments in order to understand and evaluate the learning process. It includes Data Mining techniques along with Statistical and Visualization tools and Social Network Analysis. It uses quantitative methods and it is the first and foremost which is concerned with learning.

A. Challenges

The challenges faced by online learning environments are high drop-out rates, low performance of students, and an increase in the number of at-risk students. A study shows that the no. of uncertified students is way more than the certified students in an MOOC environment [21]. Learning analytics techniques can be used to determine students' performance at early stages thus minimizing the drop-out rates. The amount of data collected and methods like preprocessing and feature selection have a great impact on predicting students' performance [3][5]. Handling missing values and balancing the imbalanced dataset using appropriate algorithms can improve the accuracy of different predictive models. Learning Analytics would help in understanding learners' behavior and improving performance by early interventions.

II. LITERATURE REVIEW

A tabular comparison of previous work has been included in this section for a better understanding of the methods used, their work, results, and conclusions as shown in the table:

TABLE II. PREVIOUS WORK ANALYSIS

Author and year of study	Methods used in the study	Proposed Work	Results	Conclusion
Hilal Almarabeh, (2017) [1]	NB (Naïve Bayes), ID3 (Iterative Dchotomiser 3), J48(Decision Tree), Bayesian Network, NN (Neural network)	In this study: Data of 255 instances each having 10 attributes is collected from the university database. Different ML algorithms are compared based on Accuracy. Tool used for implementation is WEKA. Error measurement is done using MAE, RMSE, RAE, RRSE.	Bayesian network classifier have the highest accuracy among the classifiers. It has a minimum error value for RMSE and RRSE compared to others.	Data collected is very small. More dataset instances can be collected for better evaluation. Different DM algorithms like association and clustering could be used.

Danijel kucak et al, (2018) [2]	SLR (Systematic Literature Review) method	In this study 67 papers were collected from sources like IEEE Xplore library, Scopus database, Web of Science (WoS), ScienceDirect, Google Scholar, and others. The data can be used for: a. Giving grades to students without human biasness b. Improving students' retention rates. c. Students' performance prediction. d. Evaluating students.	ML can be used to grade students thus eliminating human biases. Identifying at-risk students early can help to maintain student retention. Using ML to predict students' performance is a hot topic for research.	ML is really helpful in the education field. New models can be created using different algorithms for different purposes.
Ali salah hashim et al, (2020) [3]	LR, DT, NB, SVM, K-NN, NN, SMO	Different ML techniques are compared on the basis of accuracy measure. The proposed methodology was divided into two stages: - 1. Data cleaning -- 499 records selected. 2. Cronbach's alpha is calculated to find internal consistency of records. 3. classification algorithms are applied using the WEKA tool.	LR performed best with accuracy of 88.8%.	It found that factors like Dataset size, domain and no. of features affects the accuracy. ROC curve and AUC helps to evaluate model's performance and accuracy of predicted values.
Sandeep Subash Madnaik, (2020) [4]	Regression model, BinaryClassification, ADA Boost classification, DT (Decision Tree), RF (Random Forest)	This study considers two different kinds of datasets and applies different ML Algorithms. It compares the current work with the previous one. It considers both the academic as well as social behavior features for predicting performance.	Random forest performed best with accuracy of 93%.	It concluded that academic features affect performance more than social features. Large amounts of data results in more accurate predictions.
Siti Dianah et al, (2021) [5]	DT(J48), SVM, NB, K-NN, LR, RF	This study proposed a multiclass prediction model SFS to reduce overfitting and misclassification results. It compared the accuracy performance of 6 ML algorithms. It uses SMOTE with Feature Selection algorithms (Wrapper and Filter based).	Proposed model integrates with Random Forest performed best with highest f-measures 99.5%	Using Feature Selection with imbalance classifications increased the accuracy. Ensemble algorithms are recommended to optimize the results for predicting students' grade.
Harikumar Pallathadka et al, (2021) [6]	SVM NB C4.5 ID3	This study compared the accuracy of different ML algorithms. It examines the UCI Machinery student performance data.	SVM performed the best among all algorithms with highest accuracy.	Predicting students' performance can help institutions to improve their instruction process.
Muhammad Adnan et al, (2021) [7]	RF (Random Forest), SVM, KNN, ANN ADA Boost classifier, Gradient Boosting Classifier DFFNN (Deep Feedforward Neural Network)	It compared performance of different algorithms using different variables. K-Fold Cross Validation and feature engineering was used to improve accuracy. Python 3.7.8 and libraries like TensorFlow, Keras, sklearn are used for implementation. Heatmaps and confusion matrices were used to check the correlation and performance	RF algorithm performed best as compared to other algorithms.	Early intervention can help in reducing students' dropout. Deep Learning models and natural language processing can be used for performance modeling using textual data.

Dalia Abdulkareem shafik et al (2022) [8]	SLR (Systematic Literature Review) method.	This paper consists of review of different research papers, journals, and conferences. It highlights the use of EDM, LA and ML algorithms in educational field.	Supervised ML algorithms are used more frequently. Most popular tool that is used is WEKA, RStudio.	Limited data is used. Clustering techniques are not used much. Combination of approaches can be used.
Guiyan Feng et al, (2022) [9]	K-means clustering algorithm CNN (Convolutional Neural Network)	This study focuses on using clustering, discrimination and convolutional neural networks in improving the accuracy of predictive models. It evaluates the performance of traditional k-means algorithm and tries to improvise it.	The proposed model has performed more accurately than existing one	Missing data handling issue. Applying EDM in learning analytics in a VLE.
Md. Hasib khan et al, (2022) [10]	LR KNN SVM XG Boost NB	This study proposed a predicational model Interpretable LIME based on AI. It first applied ML Classifiers for predicting students' performance. Used dataset from two schools. SMOTE (Synthetic Minority Oversampling Technique) is used to balance the imbalanced datasets.	It found that SVM performed better than all other classifiers with an accuracy of 96.89%	Interpretable explanations help in building students understanding in model's human friendly explanations. Recommender systems can be developed using ML and Deep learning in the education field.
Yazan A. Alsariera et al, (2022) [11]	SLR (Systematic Literature Review)	Reviewed articles from years 2015 to 2021. 39 articles selected for review. Highlights use of ML algorithms like DT, SVM, LinR (Linear Regression), Artificial Neural Network, k-Nearest Neighbor), NB.	KNN Classifier gives more accurate results than others.	New datasets and more resources can be used to find more accurate results. More algorithms can be included in future studies.
Reyhan Zeynep pek et al, (2023) [12]	NB, RF DT, KNN SVM AdaBoost Classifier, LR	A hybrid model is created using Ensemble Stacking Method. It uses stratified k-fold cross validation for preprocessing of data with k=10. Hyperparameter optimization techniques are used to improve performance. SVM is used as meta learner and all others as base learners.	The model gives accurate results with pass rate 77.48% and failure rate 22.52%.	The data is collected manually and random values are added for filling the null spaces. Can be used for university student data.
Siti Dianah et al, (2023) [13]	Reviewed articles from 2015 to 2021. 41 publications are considered.	This article highlights the problem of imbalanced classification in prediction models	It found SMOTE as less effective in case of high dimensional datasets.	Feature Engineering, Sampling method can be used to improve accuracy. Hybrid approaches can be used in resolving the multi-class problem to increase accuracy of any predictive model.
Fan Ouyang et al, (2023) [14]	Genetic Programming, SNA (Social Network Analysis), Context analysis, T-test	It used Integrated approach by combining AI (Artificial Intelligence) and LA (Learning Analytics). Quasi-Experimental research was conducted. Paradigmatic	Both AI and LA together can help in predicting performance more efficiently.	Integration of AI and LA should be imposed in future for supporting students' success

	Thematic Analysis ML Algorithms	implication and Closed Loop were implemented for AI-driven applications.		and decision making.
Blessy Paul P et al, (2023) [15]	Decision Tree, CART (Classification and Regression Tree), ANN (Artificial Neural Network)	It uses ML algorithms to predict students' performance in e-Learning environments. Performance was evaluated using confusion matrices. Behavioral features and students' interaction with the learning platform is measured.	ANN algorithm outperformed with an accuracy of 0.916. Efficiency of ANN is measured by calculating AUROC Curve.	Student interaction with learning platforms is the major element in predicting students' performance. Focused online learning without any misuse of the internet can lead to a better future.

III. Learning Analytics Model

While developing any learning analytics model, a systematic approach is applied to collect and process data from a variety of sources to gain insight into student behavior, performance, and engagement. The process is divided into various steps which include data collection, preprocessing, data analysis, model selection, training and testing and at last predicting the final result. This section contains an overview of the steps required to create a learning analytics model is described below using the figure:

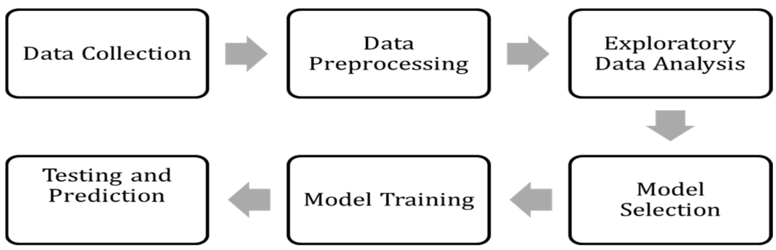

Figure 1. Learning Analytics Proposed Model

A. Data Collection

Data collection is defined as the process of gathering, storing, and analyzing data related to learners and their interaction within educational settings. While collecting data ethical and privacy concerns should be considered. This data is collected from various sources which includes:

1. Learning Management Systems

LMS include Moodle, Blackboard or Canvas which collect data in the form of student's attendance, performance scores, engagement levels etc. All this data can be used to gain valuable insights in students' performance.

2. Clickstream Data

It is defined as the sequence of clicks and interactions a student made while interacting with educational environments. It captures data including the amount of time spent in reading any article, scrolling data, and logon logoff information.

3. Social Network Analysis

Social Network is a key source of data collection. Social Network Analysis examines the interactions between learners, teachers, and learning platforms.

B. Data Preprocessing

It is the next step in which we prepare the data for analysis. When data is collected initially it is in raw form which is not suitable for analysis. Therefore, we need to perform some preprocessing tasks which include:

1. Data Cleaning

It is the process of fixing incorrect data, finding and correcting incorrect information, deleting inaccurate information, and making data clean and correct.

2. Data Transformation

It is the process of transforming data from one form to another depending upon the requirement of any model. The transformation can be normalization, standardization, logarithmic transformation, or power transformation to achieve a more symmetric distribution.

3. Data Integration

It can be understood as the process of combining data from various sources into a single platform for better analysis and visualization.

C. Exploratory Data Analysis

After preprocessing, Exploratory data analysis is performed which includes analyzing and summarizing data to understand it. It involves visualizing and exploring data using various statistical and visualization tools. Various techniques used for EDA are:

1. Correlation Analysis

It examines how different variable depend on each other thus helping in understanding the data more precisely. Correlation gives us an idea about how different variables depend on each other which helps in understanding patterns easily.

2. Missing Data Analysis

Determining missing values and finding a way to fill these missing values may affect the performance of a model in a more precise way. The missing values can be filled in different ways by using mean, median or random values.

3. Outlier Detection

Outlier detection is one of the important techniques in any model. Outliers can affect the basic computation of any model which can affect the performance of a model in a negative way and change the desired results.

4. Handling Imbalanced Datasets

Sometimes the data is Imbalanced means some of the classes have more effect on results then some other. Handling this issue is very important and can be done in various ways like oversampling, under sampling or using techniques like SMOTE. SMOTE is used in [5] [10] for handling imbalanced classes.

5. Feature Selection

Feature selection is one of the most important techniques of data analysis. It helps in finding the best possible results. Feature selection includes selecting the important features and deleting the redundant or irrelevant variables.

D. Model Selection

Selecting a model is an important task as the performance and accuracy of a system depends on the model. Selection process aims in identifying the algorithm which best fits the data and helps in obtaining the desired outcome. While selecting any model we need to consider aspects like size of data. Model complexity, domain of variables, and evaluation matrixes. Learning Analytics involves various Machine Learning, Deep Learning and statistical algorithms. Algorithms like Random Forest, Logistic Regression, Support Vector Machine, Artificial Neural Network and K Nearest neighbor are the most accurate and already applied algorithms used for predicting students' performance, finding students at risk and managing retention and dropout rates. Model Selection is an iterative process, we can compare the performance of different algorithms and then select the best one which gives the most accurate results. We can combine various algorithms into a single model using Ensemble Techniques. There are different Ensemble Methods like Stacking, voting, Bagging and Boosting by which we can combine various algorithms and improve the final accuracy of the model.

E. Model Training

After performing the data cleaning, preprocessing, and analysis steps the data is divided into two halves as training dataset and testing data set. The selected models are trained by using the training data sets. The data is fed to the models and then they learn the pattern and relationships between different modules of datasets. Hyperparameter tuning of the variables is done before training by the users. Tuning hyperparameters impacts the performance of any model to a great extent. Most Common ways to do this are grid search and random search.

F. Testing and Prediction

Once the model is trained, its validation is tested using the test data sets. The test dataset is provided to the trained model and predicted outcomes are compared with the actual sets. Evaluation of the model is done using different performance metrics like precision, accuracy, F-score, confusion matrix, recall and Receiver Operating Characteristics curve (ROC-AUC) etc. are used. Along with performance metrics various different validation techniques are also used to check the performance of the model. Cross Validation helps in estimating the performance of models across different subsets of data. Also, Holdout Validation splits the data into three parts as training, testing and validation sets where the validation sets are used for tuning the hyperparameters. Training and evaluation are also an iterative process, if performance was not found satisfactory then we may need to look back to the preprocessing steps or data splitting steps to improve the performance.

IV. CONCLUSION AND FUTURE SCOPE

Learning Analytics plays an important role in identifying students' performance in online learning platforms. This paper provides an overview of learning analytics, its applications, and methods used to perform students' performance and identify students at risk of failure or drop-out. Further, it provides a detailed description of previous studies highlighting the use of learning analytics in the educational field. A learning analytics model is also proposed which includes the basic steps in building any model.

It discusses the use of various predictive modeling techniques like regression, classification, and clustering in different studies which help in predicting students' performance in different environments. With the advantages of using learning Analytics, there are certain problems that need to be considered while making a new model. Privacy concerns and ethical considerations should be taken into account while collecting the data. Handling missing values and imbalance datasets is also an important issue that should be taken care of. Further, the integration of Learning Analytics with educational environments helps in timely intervention thus improving students' performance.

In the future, more advancement of learning analytics should be done to improve the performance score of learning environments. By early prediction of performance, the risk of dropout can be decreased. Learning analytics uses various machine learning, deep learning, and statistical methods to predict student performances. The prediction models can be embedded within the learning environments so that students and teachers both can get benefit by reviewing their performance.

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Design and Implementation of LVCMOS18 I/O Buffer

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***Abstract*— The VLSI integration technology is growing at a rapid rate. As a result, there is a need for smart devices with high performance operation. This plays a vital role in the consumer industry at larger scale in day-to-day life. To enhance performance of the new devices, more robust interfacing standards are required. Hence, the proposed paper discusses the design of the I/O standard LVCMOS18 buffer with 0.9V interface at the transmitter with an operating frequency of 150 MHz. The interface I/O design uses 90nm GPDK technology and is tested with various process corners with 4 mA current drive capability. The results obtained are found to be encouraging for all the design specifications of LVCMOS 18 I/O standard for the transmitter.**

***Index Terms*— LVCMOS18, transmitter, driver, level up shifter, Schmitt trigger, level down shifter and ESD protection.**

I. INTRODUCTION

A vast majority of innovations in the communication field are happening to make user life more comfortable. Simultaneously, there is fast growth in an integration technology which enables the smart gadgets to be reachable to all parts of the world. The development of System-on-Chip (SoC) and Network-on-Chip(NoC) integration technologies have created significant changes in consumer electronics field. We can also witness the tremendous growth happening in the field of AI, ML and IoT technologies. To be in pace with current trends, the standard matching compatibility issues need to be addressed. In this aspect, the input/output (I/O) device interfacing is a major concern in terms of signal integrity and voltage level standards. Interfacing is the way of establishing link between two devices, allowing the designer to adapt the input and output configurations of both devices so that devices can work together. Input/output devices enable the communication between systems. This may be in the form of chip with external world. They are connected on the periphery of the chip with matching interfacing standards. The processing speed and efficiency of internal circuitry grows as it processes the data faster, to communicate effectively to the external world matching I/O circuits are required. As semiconductor technology has being advanced, Low Voltage Complementary MOS transistor(LVCMOS) power supply voltage and interfacing standards for effective use are defined by Joint Electron Device Engineering Council(JEDEC)[1] for digital logic with operating voltage less than 5V. LVTTL and LVCMOS offer compatible voltage standards like V_{IL}/V_{IH}, V_{OL}/V_{OH} and current drive strength for effective interfacing.

II. LITERATURE REVIEW

The dynamic power reduction of LVCMOS based ALU [2] is designed and verified for reduction for 30% power and 27% current drive strength. The energy efficient frequency meter with different LVCMOS I/O standards[3] is designed by considering current drive strength of 2mA.The power dissipation of different LVCMOS standards are

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investigated with different frequency ranges. FPGA implementation of low-power ROM is designed with matching LVCMOS standards [4]. The results obtained showed the ROM designed with LVCMOS12 consumes less power compared to LVCMOS33. The authors report of low power ROM design that is compatible to be used with i7 processor. An energy and power-efficient D flip-flop is designed for FPGA in [5] by considering different LVCMOS standards. The design is implemented with frequency scaling and I/O scaling techniques. An optimal result on D flip-flop design with low frequency ranges is indicated. The processor specific comparator [6] is designed based on LVCMOS standards. The power consumption of comparator with LVCMOS12 standard for 2 GHz operating frequency was found less when compared to the comparator design of other LVCMOS standards. LVCMOS based designs are implemented for most of domain-specific applications. Energy-efficient Sindhi language Unicode reader [7] based on LVCMOS standards is implemented on 28nm based FPGA for natural language processing. The new ultra-level shifter is designed [8] for high-speed and wide-band applications. The voltage-based energy-efficient mobile charge sensor [9] is designed and tested with different LVCMOS standard configurations for verifying power consumption. It is found that power consumption is minimum with LVCMOS15 standards. Many different level shifter architectures based on the voltage specifications are reported in [10]. The high voltage tolerant level shifter design is reported in [11-13] for the buck converter operation. In the paper reported in [14], the LVCMOS I/O standard in FPGA is implemented for energy efficient processor. The implementation with corresponding low voltage operates at 1×106MHz device operating frequency. The paper reports 67.42% reduction in clock power and 75.99% reduction in IO power. With 90nm CMOS process, a new level-up shifter [15] is reported. Aravind Anant Bhat et. al. have reported the design of low-voltage CMOS 3.3V I/O interfaces for electronic circuits operating at 3.3 volts [15]. The authors present a detailed analysis of the design requirements and challenges of low voltage CMOS I/Os for various applications. The paper highlights importance of low-voltage CMOS I/Os for reduced power consumption.

The work in [16] describes the design of Low voltage CMOS3.3V I/O. The resources [17-20] are used for consolidating the technical specifications of LVCMOS 18 I/O standard. The resource [21] briefs on LVCMOS buffers providing single ended IO interface to the external devices in system on chip (SoC) designs. This paper covers functional operations of basic blocks of the LVCMOS output buffer and input buffer in detail and the design considerations and challenges at each phase of the design. The paper [22] reports a 4-bit register is designed using Xilinx ISE design suite 14.2. The LVCMOS I/O standard is used here in achieving the goal of minimum power dissipation. The scaling is done for the frequencies 1 Ghz, 2 Ghz, 3 Ghz, 4 Ghz and 5 GHz. Another significant work [23] reports of an energy and power efficient Data flip-flop on FPGA with LVCMOS IO standard. Two energy and power efficient techniques like Frequency Scaling and IO standard scaling have been implemented.

As the semiconductor industry is achieving rapid growth in technology, the reduction in the sizes of transistors and supply voltage are the key issues. This in turn is applicable to the design of I/O buffers like LVTTL and LVCMOS migration with changing trends. The proposed paper describes the design of LVCMOS18 transmitter buffer which works at a data rate of 150 MHz with current driving capacity of 4 mA. The proposed work includes the design of LVCMOS18 I/O buffer at the transmitter side and it is verified for worst PVT case conditions. The required specifications of proposed system are as indicated in Table I.

TABLE I. SPECIFICATIONS OF PROPOSED LVCMOS 18 I/O ON THE TRANSMITTER

Parameter	Description	Min	Typ	Max	Units
VDDO	IO supply	1.62	1.8	1.98	V
VDD	Core supply	0.81	0.9	0.99	V
Temp	Temperature	-40	25	125	deg C
Frequency	Data frequency			150	MHz
VOH	Output High Voltage	0.75*VDDO			V
VOL	Output Low Voltage			0.25*VDDO	V
IOH	Output High Current	4			mA
IOL	Output Low Current	4			mA
Rpup, Rpdn	Weak Pullup and Pulldn resistor	10k			K Ohm
Ileak	Supply leakage			Measured	uA
Ioz	Pad leakage			Measured	uA
Tr, Tf	Output Rise time, Fall time			0.3	ns

Tplh, Tphl	Output Rise delay, Fall delay			1	ns
Duty Cycle	Output Duty cycle	45		55	%
Cload (Tx)	Tx load capacitance			10	pF
Tr, Tf	Input slew to Tx			100	ps
Supply ramp rate				100	mV/us

III. METHODOLOGY

The block diagram of LVCMOS18 I/O buffer is shown in Fig.1. It shows that the proposed device is connected to transmitter and receiver blocks as I/O interfacing support. The transmitter block is connected to internal circuit which acts as input end with pad acting as an output end. For receiver block, pad is the input and the output of receiver is connected to internal circuit.

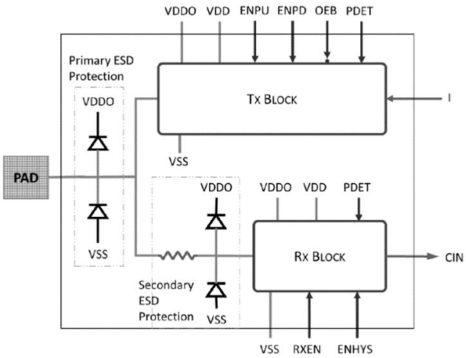


Figure 1. Main block diagram of LVCMOS18 I/O buffer

The I/O has primary and secondary ESD protection to protect the circuits from ESD events which occur during normal operations and during lifetime. The primary circuit provides ESD protection to transmitter block. The secondary circuit along with the primary circuit provides ESD protection to the receiver block. Some of the I/O pins of the transmitter and receiver will be power supply connections as shown in the Fig.1. Other pins PDET,RXEN, ENHYS of receiver and ENPU,ENPD,OEB and PDET of the transmitter are active-high signals that are enabled as per the requirement of transmitter or receiver switching ON mode. PDET is common signal for both transmitter and receiver blocks and it is kept high for either working for transmitter and receiver mode ON. The transmitter block consists of level-shifter, pre-driver, driver and control blocks. In the transmitter, the signal from the core is connected to level shifter where signal level conversion takes place. Later, it is fed to pre-driver and driver blocks to enhance the signal level. All the operations of the transmitter block are controlled by control block. The block diagram of transmitter is shown in Fig.2.

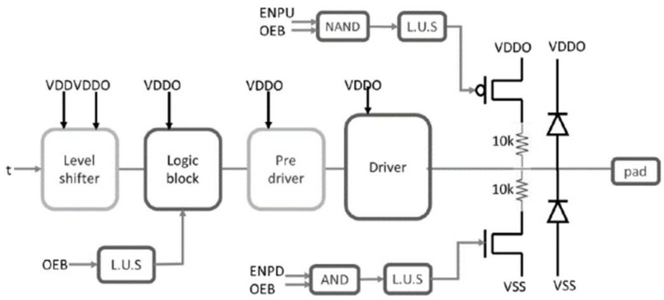
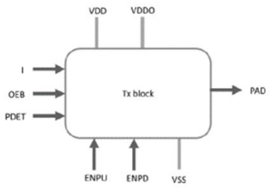


Figure 2. Block diagram of the transmitter

The supply pins are indicated as VDDO, VDD and VSS. OEB is active-low pin used to turn ON or OFF the transmitter block. ‘I’ is the input pin of transmitter. ENPU, ENPD pins are active-high pins used for forcing the pad to some voltage when transmitter is OFF. Pad acts as output of the transmitter.
One of the main blocks of the transmitter is level shifter. The input signal from the core is sent to level shifter, where the signal voltage level conversion take place. Later, it is passed to the logic block and then the signal is

further strengthened by pre-driver and driver blocks. The enhanced signal is transmitted from the transmitter. Looking into the design specifications of Table I, the schematic diagram of Contention mitigated level shifter is proposed. The same design is shown in Fig.4 on the next page. It has two supply voltages, one for each side (VDD, VDDO). VDD is connected to same voltage supply for the source of the input single ended signal, and VDDO is connected to the I/O supply of the device.



PDET	OEB	ENPU	ENPD	I	PAD
0	X	X	X	X	0
1	0	0	0	0/1	T
1	0	0	0	X	Z
1	1	1	0	X	H
1	1	0	1	X	L
1	1	0	0	X	0/1
1	X	1	1	X	X
1	0	1	0	X	X
1	0	0	1	X	X

Figure 3. Pin diagram of Transmitter block with pin details

The next blocks of LVCMOS18 I/O are pre-driver and driver blocks. The pre-driver interfaces the small core logic circuit to the large capacitances. It includes the gate capacitance and the parasitic capacitance of the driver's metal route. Pre-driver must be able to drive the large capacitance in the driver transistors. The level-shifter input is fed to the pre-driver circuit.

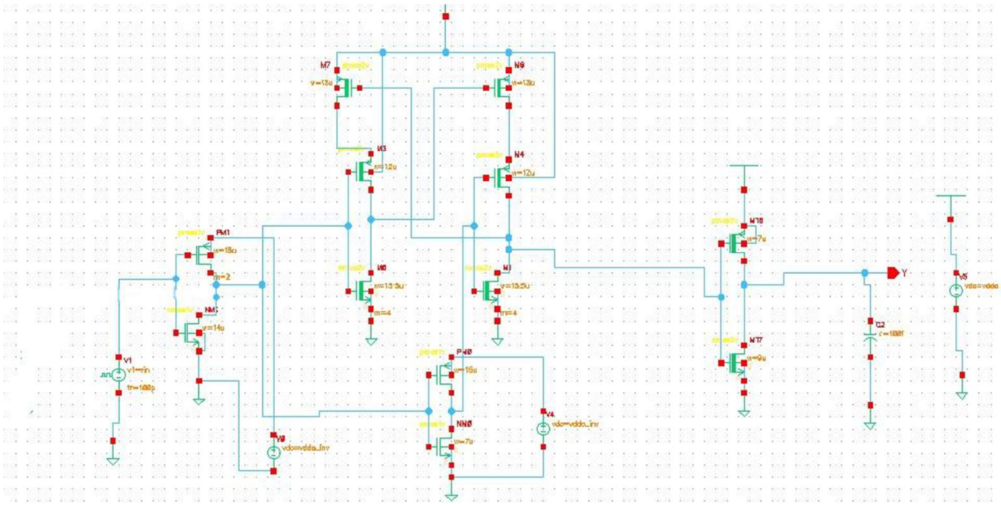


Figure 4. Schematic diagram of level shifter

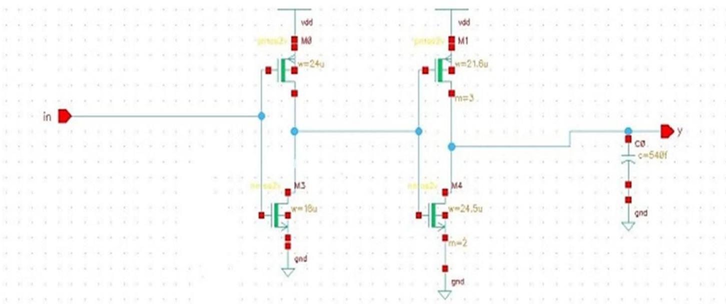


Figure 5. Schematic diagram of PMOS pre-driver

The design of PMOS pre-driver and NMOS pre-driver are considered with determination of load capacitance, input capacitance and number of stages required. The schematic diagram of PMOS pre-driver is shown in Fig.5.Both the pre-driver and driver blocks are used to enhance the signal level. Hence the driver stage schematic is shown in Fig.6.

The driver circuit is designed to drive a load capacitance with 4mA current driving strength. The specifications of LVCMOS18 I/O buffer are satisfied by varying width parameter of transistor keeping length parameter as gpdk 90nm with worst case corner analysis.
The control logic is implemented depending of signal drive capacity for pre-drivers and driver. The logic implementation of the control logic is shown in Fig.7 and Fig.8, and the logic conditions are as listed in the Table II and Table III.

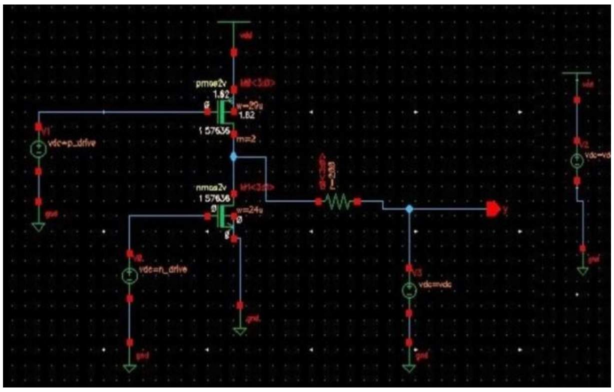


Figure 6. Schematic diagram of driver circuit

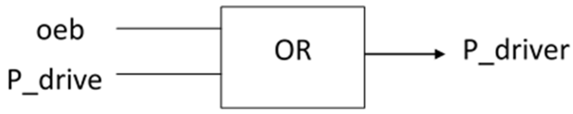


Figure 7. Block diagram of p-pre-driver control block

TABLE II. TRUTH TABLE FOR PMOS PRE-DRIVERS

oeb	P_drive	P_driver	P_driver state
0	0	0	ON
0	1	1	OFF
1	0	1	OFF
1	1	1	OFF

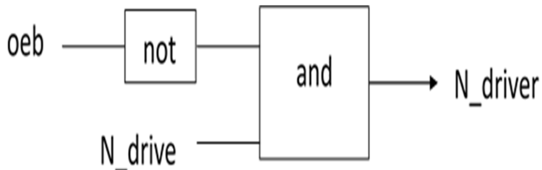


Figure 8. Block diagram of n-pre-driver control block

TABLE III. TRUTH TABLE FOR NMOS PRE-DRIVER

oeb	N_drive	N_driver	N_driver state
0	0	0	OFF
0	1	1	ON
1	0	0	OFF
1	1	0	OFF

The contention mitigated level shifter results are shown in Fig.9. It is designed to provide the VDD and VDDO as per the requirement of core and I/O processing. The subsequent blocks in the LVCMOS 18 I/O transmitter are pre-driver and driver, which enhances the signal level by matching with large capacitance load and current driving capability.

- The design of PMOS pre-driver stage implementation is considered with design parameters: $C_{ggpmos}=C_{out}=540fF$, $C_{in}=24fF$, $N=\ln(C_{out}/C_{in})=3.11$with increasing factor $A=(C_{out}/C_{in})^{1/N}=2.72$.
- Accordingtothespecificationsgiventhedrivershouldbeabletodriveatleast4mAinthe worst Process Voltage Temperature (PVT) corner (slow, 1.62 V and 125°C).

So, the design of driver block and the implementation is listed as:

- Width W, is the only variable since all other quantities are either fixed for a particular PDK or fixed for design experiment.
- Providing the worst-case corner inputs, the width isvarieduntilthedriverisabletosource4mA of current at the worst operating condition, starting from least possible width for the technology.

Taking these and ESD guidelines into consideration, a 200 ohms resistor is connected at the output.
Width isadjusted to get 1m Acurrent and 4 such slices are instantiated to meet the specification of 4m. A current in worst cases.

III. Results And Discussion

Level up shifter schematic which converts the core voltage of 0.9V to 1.8V of I/O domain is one of the main blocks of LVCMOS18 transmitter, implemented using Virtuoso Cadence software as per the specifications listed in Table I. The simulation result obtained are shown in Fig.9.

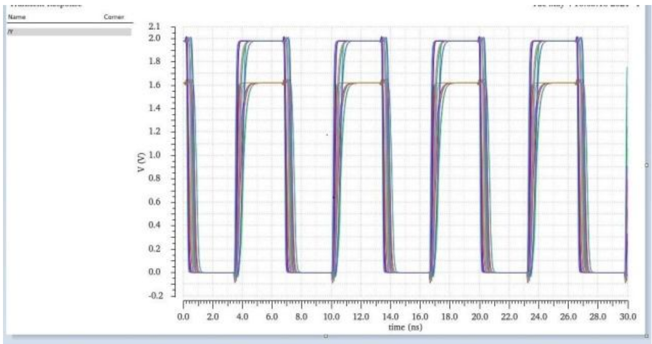


Figure 9. Simulation Results of contention mitigated level up shifter

The transient and DC response of driver block results are tabulated in Table IV and Table V.

TABLE IV. TRANSIENT RESPONSE OF DRIVER BLOCK

Design Parameters	Measured	
	Minimum Value	Maximum Value
DC	48.98mV	51.9mV
T_r	90.71pS	340.5pS
T_f	86.39pS	246pS
T_{PHL}	127.6pS	366.3pS
T_{PLH}	122.8pS	414.pS

TABLE V. DC RESPONSE OF DRIVER BLOCK

Design Parameters	Given specifications	Minimum	Maximum
I_{OH}	>4mA	4.243mA	7.253mA
I_{OL}	>4mA	4.276mA	7.223mA

The design of 3-stage PMOS driver schematic is verified with an output load capacitance of 540fF and input capacitance of 24fF. The results obtained with transient analysis are matching with specifications listed in the Table I. Similarly, the driver block schematic is designed to drive large load capacitance with current drive strength of >4mA. The DC analysis results shown in Table IV are matched with the given specifications with worst case process corner(PVT) analysis. The findings of power dissipation results of the proposed block are 22% better than the [3] for 4mA operation of LVCMOS18I/O.

IV. Conclusion

The LVCMOS18 I/O buffer is designed to work at the data rate of 150 MHz. The driver in the transmitter block is designed to drive 4 mA of current even in the worst-case conditions. The working and implementation of Contention mitigated Level up shifter is understood and analysed for all the PVT process corners. The level up shifter effectively shifts the core domain voltage to IO domain voltage level. Similarly, the required pre-driver and driver designs with PMOS and NMOS buffers for capacitive load driving capabilities are understood and designed. The results obtained are found to be satisfactory as per the specifications. LVCMOS18 I/O is designed to work with microcontrollers, microprocessors, memory devices etc., with low voltage for highly computational digital processing operations. Recently, it is found that LVCMOS18 is being used in IoT enabled applications, industrial control systems and automotive electronics domain specific appliances to name a few. The future scope may include the enhanced usage of LVCMOS 18 I/O as an interfacing standard that finds vital role in the development of IoT devices, AI accelerated architectures and quantum computing devices etc.

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A Comparative study of Morlet Wavelet Coherence & Complex Gaussian Wavelet Coherence between ECG and EEG Signals

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***Abstract*— Wavelet coherence is a time - frequency method which is used to analyze the degree of correlation between two signals. In this study the degree of correlation between ECG and EEG signals Using Wavelet coherence is calculated and a comparison using Morlet wavelet and Complex Gaussian wavelet is made. In this work, the results show thatthe Wavelet Coherence using Complex Gaussian wavelet gives significant and best value of coherence at all samples inthe scale interval of 53,512 as compared to Wavelet Coherence using Morlet wavelet which shows that the analyzed signals are coherent at all samples but only in the scale interval of 53,365 which establishes that Wavelet- coherence technique using Complex Gaussian waveletovercomes the limitations of conventional Coherence analysis by providing information both in temporal as well as in spectral domain**.

***Index Terms*— ECG, EEG, Coherence, Wavelet Coherence, Morlet wavelet, Complex Gaussian wavelet.**

I. Introduction

From the past few decades, lot of work has been done for the development of various signal processing methods which are aimed to measure and analyze the degree of coherence betweenbiomedical signals [1], as they carry important information about the behavior of the living systems under study. A properprocessing of these signals in principle enhances theirphysiological and clinical information. It is certainly true that basically all methods of signal processing have been applied tobiomedical signals in various and differentiated experimental conditions. Many of these methods have been conceived in different research areas such as information processing, statistics, system and control theory, communication theory, medical informatics, lasers and electro-optics, digital signal, image analysis, etc. The degree of coherence between biomedical signals mainly highlights the association between them. It is very importantin describing a biological system because of the presence ofseveral mechanism co-operating and competing with each other within the system for its regulation. It shows the influence and relation of one signal over the other. It is commonly characterized by the time-series methods, namelyCorrelation (such as cross correlation), Phase synchrony(such as mean phase coherence) and Coherence (such as magnitude squared coherence (MSC) [2].
Coherence is a conventional method to analyze and find the linear relation between two signals by determining the correlation between their spectra [3]. Coherence is well known as “the frequency domain analog of the autocorrelation function”. However, the conventional coherence method which is based entirely on spectral

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methods does not provide any information regardingtemporal structure of the signal beyond phase information and so therefore it cannot give any information on dynamically varying signals. So, it assumes signals to be stationary [3]. Therefore, to overcome the shortcomings of conventional coherence (Fourier based), which are mainly caused by essentially neglecting time resolution for perfect frequency resolution, various new time–frequency signalanalysis methods has been established as an important technique. Time–frequency signal analysis methods offer simultaneous Interpretation of the signal both in time and frequency which allows local, transient or intermittent components to be elucidated.

A number of time–frequency methods are currently availablefor the high-resolution decomposition in the time–frequency plane useful for signal analysis, including the short time Fourier transform (STFT), Wigner–Ville transform (WVT), Choi– Williams distribution (CWD) and the continuous wavelet transform (CWT). Of these the continuous wavelet transform has emerged as the most favored tool byresearchers as it does not contain the cross terms inherent in the WVT and CWD methods while possessing frequency- dependent windowing which allows for arbitrarily high resolution of the high frequency signal components (unlike the STFT).

However, wavelet transform analysis began in the mid-1980swhere it was developed to interrogate seismic signals. The application of wavelet transform analysis in science and engineering really began to take off at the beginning of the 1990s, with a rapid growth in the numbers of researchers turning their attention to wavelet analysis during that decade.The last few years have each seen the publication of over 1000 refereed journal papers concerning application of the wavelet transform. Wavelet based coherence for example, have already been used in other scientific contexts such as plasma physics and aerodynamics. In this work, focus is to measure the synchronization or association between the two most widely used biomedical signal-Electrocardiogram (ECG) and Electroencephalogram (EEG) using Wavelet based Coherence. The ECG measures the electrical activity of the heart due to contractile activity. The ECG measures the electrical activity of the heart due to contractile activity of the heart and EEG measures the electrical activity of the brain. This electrical activity is account of firing of millions of neurons within the brain and the resultantelectrical signals are picked from multiple electrodes placed on the scalp.

For example, the study of neuron-synchronization of EEG signals can help us to understand the underlying cognitive processes. When task of learning is going on, cognitive processes take place in different brain regions. Investigatingneural synchronization can help us to understand the underlying cognitive processes. The cognitive and information processing take place in different brain regions. In order to investigate how these distributed brain regions are linked together and the information is exchanged, the coherent analysis is frequently used as a tool for studying the relationship between two channel EEG [3]

II. COHERENCE

Coherence is the well–established standard and traditional approach for the analysis of biomedical signals. Coherence is defined as the absolute square of the cross-spectrum of two signals normalized by the product of their auto-spectra [5]. It includes the information of a cross-correlation function of phase angles between two signals at different frequencies. When the phase difference between two signals is constant than coherence is equal to 1 and when the phase difference between signals is random then coherence is equal to 0. Therefore, it lies in the range of 0 and 1. Coherence is mathematically analogous to correlation, however, coherence measures phase differences and yields a much finer measure between signals.

The one way of calculating coherence between two signals x(t) and y(t) is as follows:

1. First, to calculate the Fourier transform of each of the signals

$$X_i(f) = \frac{1}{2\pi}\int x(t)e^{-j2\pi ft}dt \qquad (1)$$

$$Y_i(f) = \frac{1}{2\pi}\int y(t)e^{-j2\pi ft}dt \qquad (2)$$

2. Next, the auto-spectrum of each signal and their cross-spectrum over each segment needs to be calculated.

$$P_{xx}(f,i) = X_i(f)X_i^*(f) \qquad (3)$$

$$P_{xy}(f,i) = X_i(f)Y_i^*(f) \qquad (4)$$

$$P_{yy}(f,i) = Y_i(f)Y_i^*(f) \qquad (5)$$

In (3), (4) and (5) P_{xx} and P_{yy} represent the auto-spectra while P_{xy} represents the cross spectrum, with the * operator indicates complex conjugation

3. Finally, the coherence between the two signals is given as

$$K(f) = \frac{\left|\sum_i P_{xy}(f,i)\right|^2}{\sum_i P_{xx}(f,i) \sum_i P_{yy}(f,i)} \quad (6)$$

As coherence is Fourier based, it suffers from some limitations which include that it does not give any information on dynamically varying signals, as it assumes signals to be stationary and it is very sensitive to fluctuations of linearity in phase.

In order to overcome the limitations of Fourier based coherence, Wavelet Coherence is the novel approach.

III. Wavelet Coherence

Wavelet Coherence is a modern time-frequency method, which incorporates Continuous wavelet transform and time-varying coherent analysis offering more flexibility.

Wavelet Coherence combines the concept of wavelet transform with the coherence analysis which employs an alternative way for quantifying synchronization of the signals with both temporal and spectral resolution. The wavelet coherent analysis can explore the amount of synchrony among multiple- channel signals, and are used to investigate the synchronization and the corresponding information processing of the various signals.

In this work, Wavelet coherence is implemented on biomedical signals. For the implementation of Wavelet coherence,ECG and EEG signals which are the most important and frequently used biomedical signals are used and are taken from online database of MIT-BIH.

Wavelet Coherence is a time-frequency method, which provides dynamic coherent analysis incorporating Continuous wavelet transform (CWT) overcoming the limitations of conventional coherence providing both temporal and spectral information. It provides more flexibility [1].

Wavelet Coherence is defined as

$$C(t,f) = \frac{\left|\sum_{i=-\Delta}^{\Delta} PW_{xy}(T,f,i)\right|^2}{\sum_i PW_{xx}(T,f,i) \sum_i PW_{yy}(T,f,i)} \quad (7)$$

Where T is the time around which the coherence is calculated, i is the current index, and f is the frequency. Thesummations are carried around a variable segment size Δ, which is inversely proportional to frequency.

Also, the wavelet cross spectrum can be defined as:

$$PWxy(t,f) = Wx(t,f)\, Wy*(t,f) \quad (8)$$

As for higher frequencies wavelet transform uses a shorter window and for lower frequencies a longer window is used,also the coherence segment size Δ is also inversely proportional to frequency which makes this approach more suited to analyze and measure dynamic coherence. This is accomplished via a frequency-adaptive window in the time frequency plane [2].

Wavelet coherent spectrum is defined and computed from the cross-wavelet magnitude spectra which serves to indicate the degree of coherence and the cross- wavelet phase is used to provide the direction of Information flow between two signals [1][3].

Wavelet coherence is used to analyze the linear relation between two signals in both time and frequency. It provides both the temporal as well as spectral information. Hence, the signals do not have to be stationary [4]

IV. Signal Measurement

The ECG and EEG signals are obtained from the MIT-BIH database [5] and the software used is MATLAB R2023a. The records taken are 100.dat and chb01_01.edf as shown in fig.1 and fig 2. The record of ECG 100.dat and EEG chb01_01.edf is having sampling frequency of 360 Hz and of 1 Hz respectively with 11-bit resolution. The duration of the signal is 10s and has 3600 samples but here for experiment only 1000 samples has been considered.

V. Results

A. Implementation of Coherence between ECG & EEG Signals

Fourier based coherence is implemented on ECG and EEG Signals as shown in Fig.3.Maximum value of coherence obtained between ECG and EEG Signals is 0.6 i.e. the signals are 60% coherent near the Normalized frequency of 0.2 rad/sample.

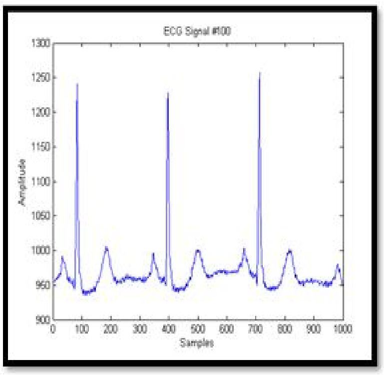

Fig.1. Electrocardiogram (ECG) Signal

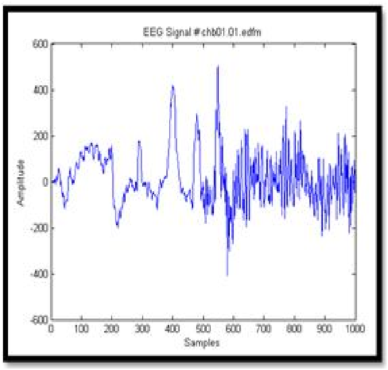

Fig.2.Electroencephalogram (EEG) Signal

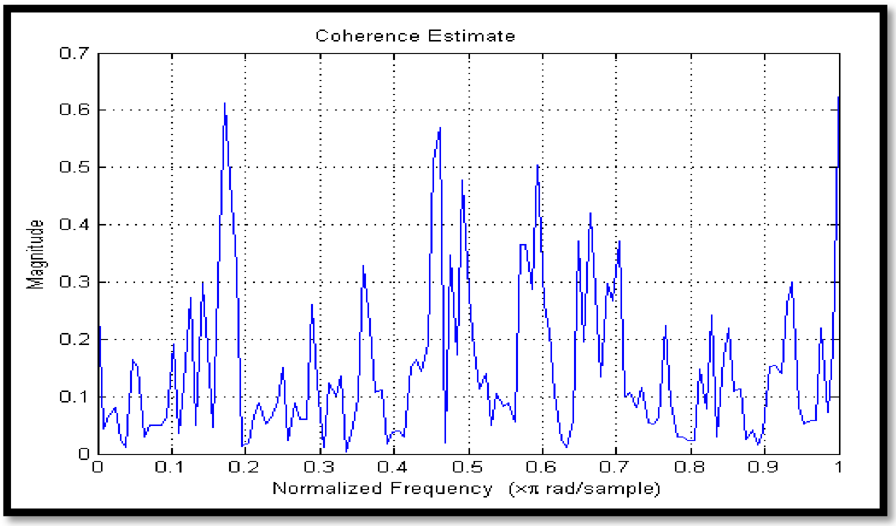

Fig.3.Coherence between ECG and EEG Signals

a. Establishing the Optimized wavelet

Wavelet coherence has many dependencies as it consists both the concepts of Wavelets and Coherence, therefore, the parameters affecting wavelets affects the overall Wavelet Coherence. Wavelet coherence depends on various parameters which are as:

- Wavelet family
- Scale
- Number of Wavelet coefficients.
- Number of Data points.
- Sampling Frequency.
- Noise.
- Frequency Bandwidth characteristics of Wavelets.

Based on the wavelet family, Complex Gaussian wavelet is established as optimized wavelet as it provides detailed information in transient signal detection than real-valued wavelets.

B) Implementation of Wavelet coherence between ECG & EEG Signals using Morlet Wavelet

The Morlet wavelet, named after Jean Morlet in 1984, is complex-valued, and consists of a Fourier wave modulated by a Gaussian envelope. Morlet wavelet is defined as:

$$\psi(\eta) = \pi^{-1/4} e^{jwt} e^{-\tau^2/2} \qquad (9)$$

Where w is the central frequency of the mother wavelet.

In order to calculate Wavelet coherence, continuous wavelet transform and wavelet cross spectrum of the analyzed signals are also need to be calculated.

i. Continuous wavelet transform of ECG and EEG Signal

The Continuous wavelet transform of ECG and EEG Signals using Morlet wavelet is shown in Fig.4. For implementation 1000 samples of both ECG and EEG signals are taken and the wavelet scale is taken as 1:512.

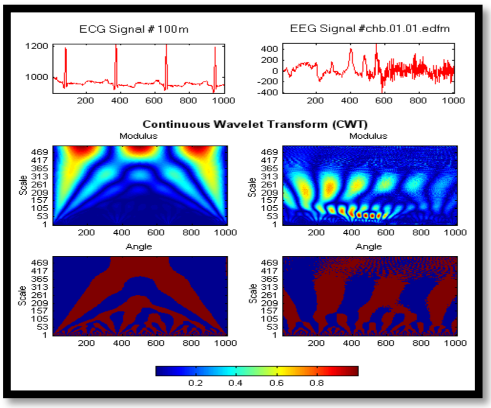

Fig.4.CWT of ECG and EEG Signals

ii. Wavelet cross spectrum of ECG and EEG Signals

The wavelet cross spectrum (WCS) between two time series x (t) and y (t) is defined as

$$C_{xy}(a,b)=X^{*}(a,b)Y(a,b) \qquad (10)$$

where a and b are scale and time. X (a, b) and Y (a, b) are the continuous wavelet transform of the time series x (t) and y (t), respectively and * means complex conjugate. The magnitude of the wavelet cross spectrum can be interpreted as the absolute value of the local covariance between the two time series in the time-scale plane. Fig.5. highlights the fact that both signals have a significant contribution around scale 261 at the sample value of 100.

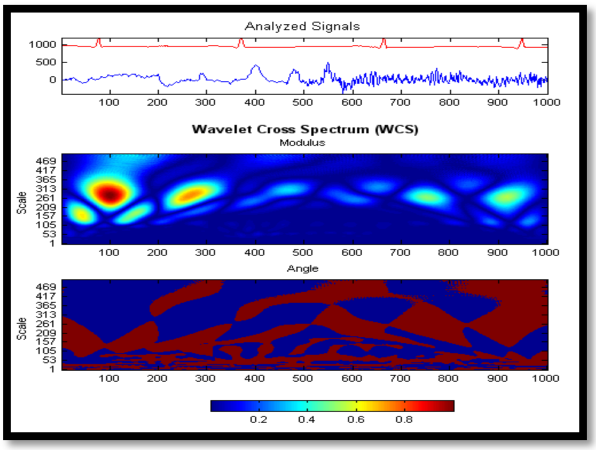

Fig.5 Wavelet Cross spectrum of ECG and EEG Signals

iii. Wavelet Coherence of ECG and EEG Signals using Morlet wavelet:

The wavelet coherence between the record 100.dat and chb01_01.edf using Morlet wavelet having scale of 1:512 is shown in Fig 6. The arrows in the figure represent the relative phase between the two signals as a function of scale and position. As shown in Fig.6, the ECG and EEG signals are maximum coherent at all samples in the scale interval of [53,365].

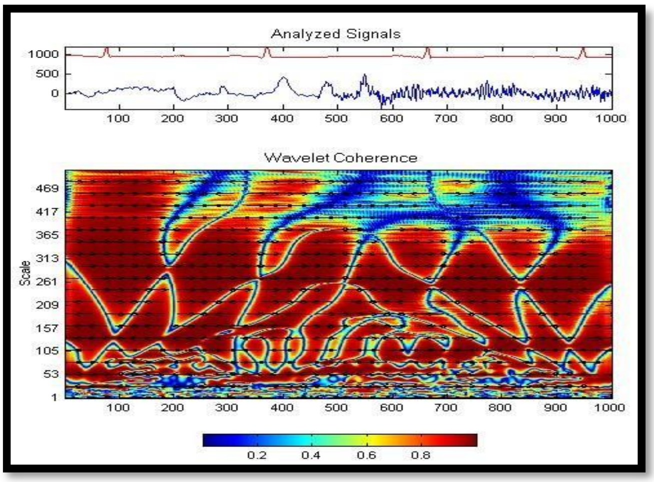

Fig.6.Wavelet Coherence using Morlet wavelet between ECG and EEG Signals

C) Wavelet Coherence using Complex Gaussian wavelet

Complex wavelets provide more detail information in transient signal detection than real-valued wavelets. Wavelet Coherence using Complex Gaussian wavelet is shown in Fig.7.As shown in Fig.7, the ECG and EEG signals are maximum coherent at all samples in the scale interval of [53,512].

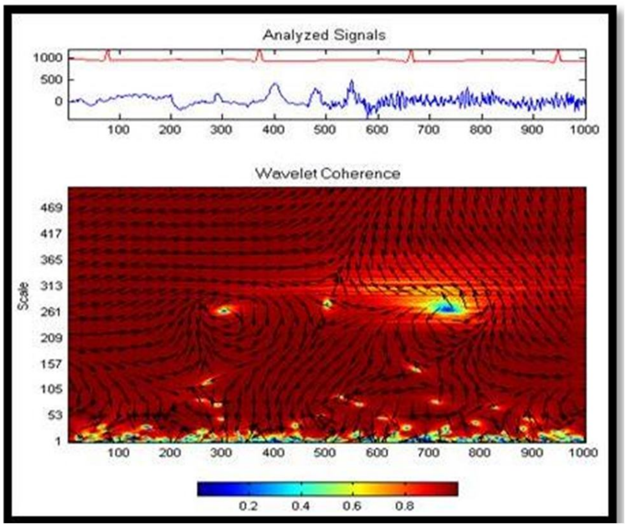

Fig.7. Wavelet Coherence using Complex Gaussian wavelet between ECG and EEG Signals

VI. Discussion

The results show that the Wavelet Coherence using Complex Gaussian wavelet gives significant and best value of coherence at all samples in the scale interval of 53,512 as compared to Wavelet Coherence using Morlet wavelet which shows that the analyzed signals are coherent at all samples in the scale interval of 53,365 only. Also, in case of Complex Gaussian wavelet, there is also phase information, which can be used to infer the lead lag relationship between the signals. Therefore, as revealed by the results, Wavelet Coherence using Complex Gaussian wavelet gives best and optimized results as compared to Wavelet Coherence using Morlet wavelet. The performance is further enhanced by the use of complex wavelets as they provide more detailed information in transient signal detection than real-valued wavelets.

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Assistive PCOS Detection Platform with Clinical Data and Ultrasound Scan using Machine Learning

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***Abstract*— Polycystic ovary syndrome (PCOS) is an endocrine disorder characterized by excess androgen hormone and symptoms like obesity, irregular cycles, acne, hirsutism, and abnormal ovarian follicle development. Treatment targets anovulation, hyper androgenism, and menstrual dysfunction. This study developed machine learning models using clinical data to predict PCOS presence. The dataset included FSH/LH values and observed symptoms. Random Forest, Decision, SVM, Naïve Bayesian, Gradient Boosting, and KNN classifiers were evaluated. Random Forest achieved 90% accuracy. Additionally, a doctor model based on CNN deep learning will provide a secondary diagnostic opinion to professionals. This model will enhance the accuracy of PCOS diagnosis and support healthcare providers in decision-making. An assistive platform is proposed to detect PCOS, provide prevention measures, and offer education on menstrual health and well-being. It aims to benefit rural communities and address specific PCOS needs in a concise manner.**

***Index Terms*— PCOS, follicles, Machine Learning models, Random Forest, clinical value, FSH/LH value, Assistive platform.**

I. INTRODUCTION

Polycystic ovary syndrome (PCOS) is hormonal problem that occurs during the reproductive years. Women affected by PCOS may not experience regular menstruation. One may experience periods lasting many days. One may end up having too much of the male hormone called androgen in their body. With PCOS, many small sacs of fluid develop along the outer edge of the ovary. These are called cysts. The small fluid-filled cysts contain immature eggs. These are called follicles. The follicles fail to release eggs during ovulation. The collection of many such follicles causes PCOS. The exact cause of PCOS is quite difficult to pinpoint. Common symptoms of PCOS is shown in figure 1 below. Early detection and treatment along with lifestyle changes and a healthy diet may lower the risk of long-term complications such as heart diseases and prediabetes. Since the exact cause of PCOS is not concrete, doctors have studied a range of patients and listed out few common factors that might be causing PCOS. They include: Insulin resistance, Low-grade inflammation, Heredity - Excess androgen.
There are numerous complications of PCOS women, most of which are highly problematic. This is the reason why awareness of PCOS is vital. Some of these issues can include like Difficulty in conceiving, Pregnancy-induced high blood pressure, Miscarriage or premature delivery, Liver inflammation caused by fat build-up in the liver, Metabolic syndrome- a cluster of conditions including high blood pressure, high blood sugar, and unhealthy cholesterol, Type 2 diabetes , Sleep apnoea , Depression, anxiety and eating disorders, Cancer of the endometrium,

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Obesity is a frequent consequence with PCOS and can worsen complications of the disorder.

II. Related Works

The detection and diagnosis of Polycystic Ovary Syndrome (PCOS) have been the focus of several studies that leverage machine learning techniques. Rachana et al. [1] proposed a follicle recognition technique on ultrasound images to detect PCOS. By identifying characteristic ovarian follicles associated with PCOS, their approach demonstrated promising results in the detection of the syndrome. Kaur et al. [2] developed a diet recommendation framework for PCOS management using deep convolutional neural networks. Bharati et al. [3] explored the diagnosis of PCOS using machine learning algorithms. They applied feature selection techniques and evaluated various machine learning models to identify key features associated with the disease.

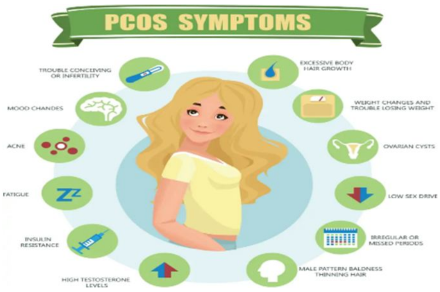


Figure. 1. PCOS Symptoms

Their study highlighted the importance of feature selection in improving diagnostic accuracy. Jaralba et al. [4] proposed a machine learning-based initial screening approach for PCOS. They employed five classifiers including Naïve Bayes, KNN, ANN, SVM, and RF to identify potential cases of PCOS. Mehr and Polat [5] compared different machine learning and feature selection techniques for PCOS diagnosis. Vedpathak and Thakre [6] developed a machine learning-based system for accurate PCOS detection and prediction of optimal treatment options. Emphasizing the significance of early intervention, their study highlighted the importance of precise detection for effective PCOS management. Salman Hosain et al. [7] proposed a fine-tuned InceptionV3 convolutional neural network for PCOS detection from ovarian ultrasound images. Sumathi et al. [8] utilized the watershed algorithm and Open CV for feature extraction from ultrasound images in PCOS detection. Denny et al. [9] developed i-HOPE, a PCOS detection and prediction system employing machine learning techniques. Their model incorporated clinical and metabolic parameters as biomarkers for PCOS diagnosis, aiming to provide accurate detection and personalized treatment recommendations. Kodipalli and Devi [10] focused on predicting PCOS and associated mental health conditions using fuzzy inference and SVM. Gupta et al. [11] proposed a PCOS detection system based on a combination of clinical features and machine learning algorithms. Their approach involved feature selection and employed classifiers such as Random Forest and Support Vector Machine to achieve accurate PCOS detection. Singh et al. [12] developed a PCOS detection model using a hybrid approach that combined deep learning and machine learning techniques. Das et al. [13] proposed a PCOS prediction model based on data-driven machine learning algorithms. They employed various feature selection techniques and utilized classifiers such as Decision Trees and Random Forest to predict the likelihood of PCOS development in individuals. Sharma et al. [14] developed an intelligent PCOS prediction system using machine learning algorithms. They employed feature selection and classification algorithms to achieve accurate prediction results. Agarwal et al. [15] presented a PCOS detection framework using a combination of clinical data and machine learning techniques. Their system utilized feature engineering and dimensionality reduction techniques to extract relevant features, and applied classifiers such as Gradient Boosting and Support Vector Machine for accurate PCOS diagnosis.

III. Methodology

Inspired by the existing research works in predicting PCOS in patients, it is proposed to implement a cross platform application that aids both the patients and doctors in diagnosing PCOS. The model would also suggest preventive methods to the patients. The overview of the architecture of the PCOS Assistive platform is shown in figure 2.
The clinical datasets and ultrasound images are collected by the system to preprocess, analyze and extract the key features and image of any significant cysts to further train the model using Machine Learning and Deep Learning algorithms. The trained model is later deployed on the cross-platform application that will suggest to the user to

consult a doctor if she's likely to be suffering with PCOS and also provide aid to the professional as a secondary opinion. The platform would also provide methods like Food-Image based Diet recommendation, Video tutorials on Yoga and lifestyle through which the user can prevent PCOD.
The Cross-Platform consists of two major models - Patient and Doctor.

A. Patient Model

In this model, the Chabot takes the clinical data from the user to predict if the Patient has PCOS or not. The model is proposed to be implemented using the Random Forest classifier. The model would then primarily suggest to the Patient to consult a professional for further diagnosis. The overview of the patient model is shown in figure 3.

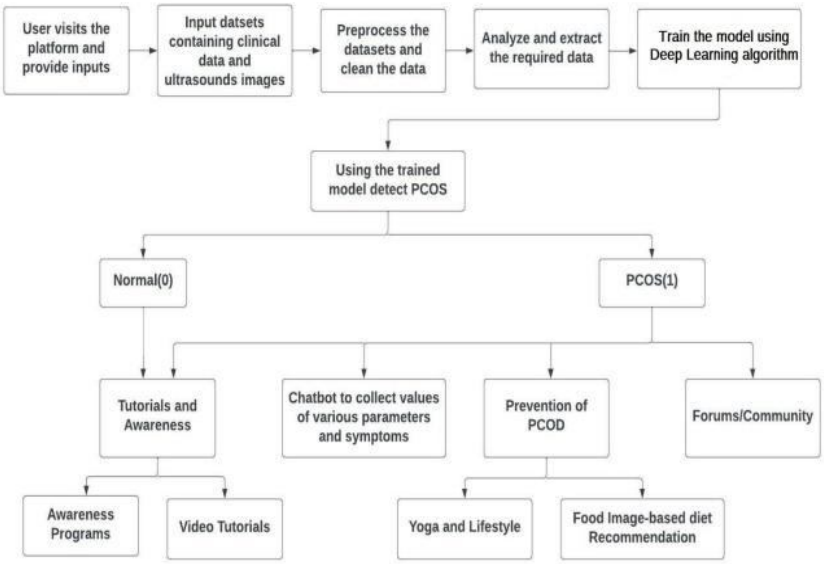


Figure. 2. Architecture of Assistive PCOS Detection platform

The prediction in patient model is done in the following steps:

B. Training phase

The model is trained on a large dataset of clinical and biochemical test data to accurately predict the presence of PCOS. During this process, the machine learning algorithms are trained to identify patterns and features within the input data that are indicative of PCOS. This training phase is essential to ensure that the PCOS-Assist system provides accurate results and assists medical professionals in diagnosing and treating PCOS effectively.

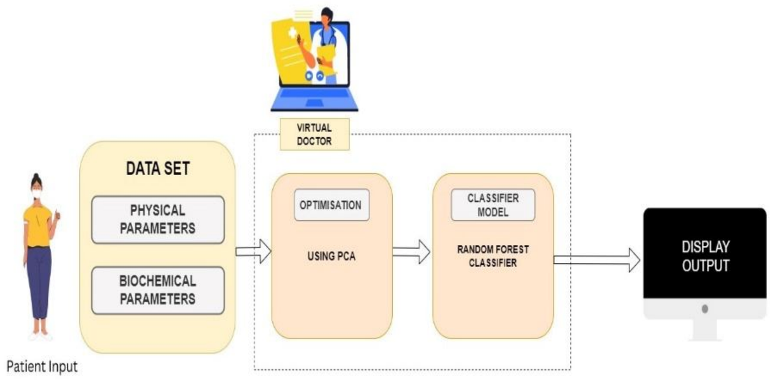


Figure. 3. Overview of patient model in PCOS cross platform

C. Loading of trained model

Once the model is trained, it is loaded into the system and is ready for use. Loading the trained model is essential because it allows the system to utilize the learned knowledge and expertise of the model when processing new data. By loading the trained model into the system, the PCOS-Assist system can provide accurate predictions and detections of PCOS based on the knowledge and experience gained during the training phase.

D. Patient input Clinical Test and Biochemical Test data

The patient inputs their clinical and biochemical test data into the system for analysis. The clinical test data may include information such as age, body mass index (BMI), menstrual history, and symptoms associated with PCOS. The biochemical test data may include information such as levels of hormones like testosterone, luteinizing hormone (LH), follicle-stimulating hormone (FSH), and insulin.

E. Feature Extraction

The feature extraction process involves identifying the most relevant features from the patient's clinical and biochemical test data, which can help to identify whether the patient is affected by PCOS. By extracting the most relevant features from the patient's input data, the system can more accurately predict the presence or absence of PCOS, which can help medical professionals make better-informed decisions when diagnosing and treating patients.

F. Apply the prediction model

The extracted features are analyzed using machine learning algorithms to predict the presence of PCOS in the patient. The prediction model is Random Forest algorithm that has been trained on a large dataset of clinical and biochemical test data to accurately predict the presence of PCOS. The model then generates a probability score that indicates the likelihood of the patient having PCOS.

G. Display Output

After the machine learning model analyzes the extracted features, the system displays the results of the analysis as output. The system displays the results of the analysis as output, providing the patient and medical professional with an accurate diagnosis of PCOS. The output displayed includes the probability score generated by the prediction model, indicating the likelihood.

H. Doctor Model

This model detects ultrasound scans to identify cysts as simple cysts, PCOS, or cancer masses. To accomplish this, an Ensemble Deep Learning model has been implemented using TensorFlow. This model can effectively detect and classify cysts present in ultrasound scans with a good degree of accuracy. By identifying the type of cyst present in the scan, the system can help medical professionals determine the most appropriate course of treatment for the patient. This module is a crucial component of the PCOS-Assist system as it provides medical professionals with an effective tool for diagnosing and treating patients with cysts, improving their overall health outcomes. The doctor model overview is shown in the Figure 4

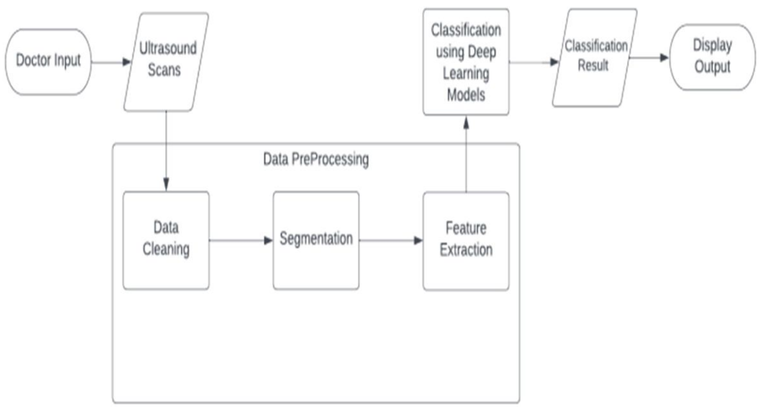


Figure. 4. Overview of Doctor Model

Doctor model detects PCOS in the following steps:

I. Loading Datasets

Large dataset of ultrasound scan images are loaded to the system with specified labels of PCOS and normal ovaries. The model is trained based on this loaded dataset.

J. Preprocessing data

Data preprocessing is transforming raw data into a format that is suitable for further analysis or training machine learning models. The preprocessing step often includes several sub-steps. This model has the following sub-steps as Converting image to Grayscale, Removing noise using erode and dilate, Thresholding, Determine extreme points, Cropping original image.

K. Data loading to a list

The preprocessed data is loaded to a list to facilitate further processing and analysis. Lists allow for easy manipulation of collections of data, such as image features or attributes. They can be easily sorted, filtered, or modified as needed to prepare the data for use in machine learning algorithms or other applications.

L. Split data for training and testing

The training set is used to train the model, while the testing set is used to evaluate how well the model generalizes to new, unseen data.

M. Building the model using CNN layers

CNNs [8] are highly effective in image classification tasks due to their ability to extract meaningful features from images. They can automatically learn important features such as edges, corners, and shapes from the input images, making them ideal for image-based tasks. This model uses 7 layers as Zero padding 2D layer, Conv 2D layer , Batch Normalization layer, Activation layer, Max Pooling 2D layer, Flatten layer, Dense layer .

N. Training the model

This involves feeding the training data into the model and adjusting the weights of the CNN layers over multiple epochs with a predefined learning rate to optimize the model's performance.

O. Output

After the model is trained, it is evaluated on the test dataset to calculate the accuracy, precision, recall, and F1 score. The classification report is then displayed to provide a detailed summary of the model's performance.

IV. Results And Discussions

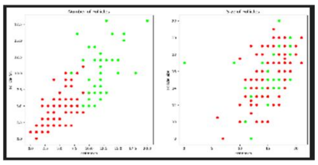
A. Patient Model

A model is proposed here which predicts the possibility of a patient having PCOS based on collected data from their FSH/LH test results such as FSH/LH hormone levels and also the symptoms collected during their doctor visit such as details regarding the patient's period cycle, hair growth and other factors. Considering all of the above factors, a dataset is developed which consists of 44 attributes of 541 patients obtained from Kaggle. A prediction system is implemented which predicts the probability of a person having PCOS given the test data. The model is first cleaned through manual methods like removing null and irrelevant values and removing NaN values. The dataset was trained using various classifiers such as: Random Forest Classifier, Decision Classifier, Support Vector Machine Classifier, Naïve Bayesian Classifier, Gradient Boosting Classifier, KNN Classifier. When comparing Random Forest classifier for the patient model and Convolutional Neural Networks (CNN) for the Doctor model with the state-of-the-art approaches for PCOS diagnosis, there are several factors to consider.After training all the models, it was found that Random Forest classifier yielded the best results compared to all others. It gave an accuracy of 90 %. The results and the comparison of all the applied classifiers are shown 5.

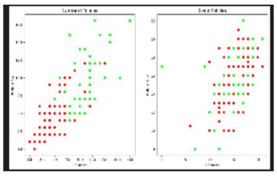
B. Doctor Model

PCOS doctor model was trained and evaluated using a dataset consisting of 1923 examples. The above table shows the different cases with accuracy and confusion matrix. The results obtained during the evaluation with Test Loss is 0.063. This value indicates the average loss (error) of the model on the test data, lower value represents better performance with Test Accuracy: 0.97 shown in figure 6a.
Further analysis and validation of the model's performance in real-world clinical settings would be necessary to

assess its practical utility and generalizability. The confusion matrix for testing images is shown in fig 6b,c. Home screen and awareness of PCOS assist shown in fig 7.



a. RF



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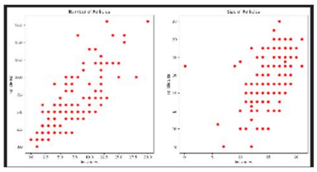
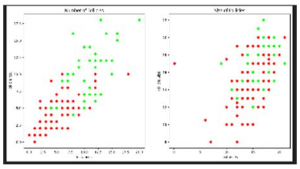
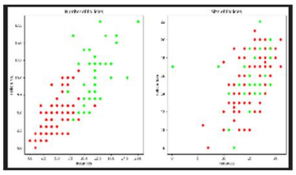


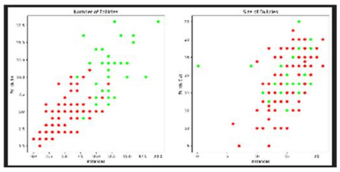
c. SVM



d. NB



e. GB



f. KN

Figure. 5. Different Classifier follicle size graph

TABLE I. DIFFERENT TEST CASES WITH RANDOM FOREST CLASSIFIER

Test No.	***Accuracy***	***Confusion Matrix***	**Test No.**	***Accuracy***	***Confusion Matrix***	**Test No.**	***Accuracy***	***Confusion Matrix***
1	0.911111111	[[98 5] [8 24]]	5	0.903703704	[[98 5] [8 24]]	9	0.888888889	[[97 6] [9 23]]
2	0.896296296	[[97 6] [8 24]]	6	0.896296296	[[97 6] [8 24]]	10	0.888888889	[[96 7] [8 24]]
3	0.903703704	[[97 6] [7 25]]	7	0.896296296	[[96 7] [7 25]]	11	**0.901481481**	**RFC**
4	0.896296296	[[96 7] [7 25]]	8	0.933333333	[[100 3] [6 26]]			

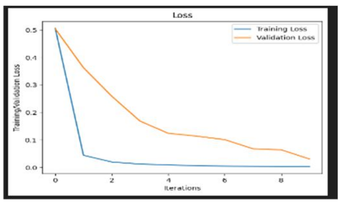
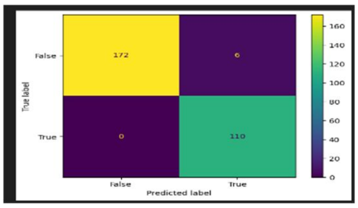
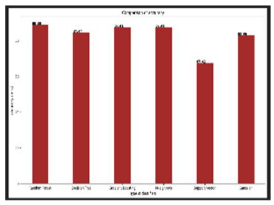


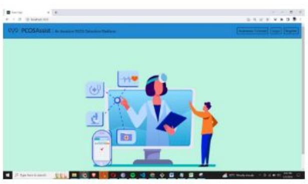
Figure 6a. Loss function



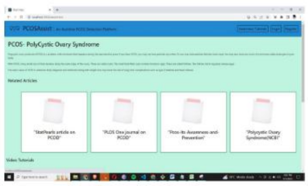
6b. Confusion Matrix



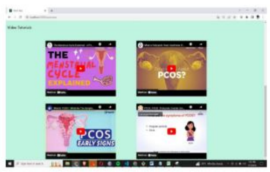
6c. Different Accuracy



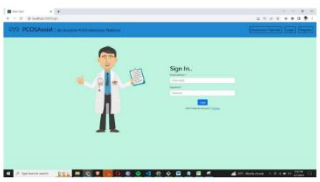
7a. Home Screen



7b.Awareness screen of PCOS

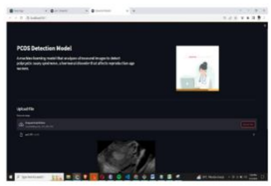


7c.Video tutorial Awareness



7d. Login page

7e. Preventive measures



7f. Doctor Model in PCOS

V. CONCLUSION

In this paper, we aimed to develop an assistive PCOS detection platform using machine learning techniques, clinical data, and ultrasound scans. Our platform focused on providing guidance and assistance to rural women in the context of women's health to predict PCOS early stages. Additionally, we developed an open forum within the platform, allowing users to communicate, express their feelings, resolve doubts, and share experiences related to PCOS. There are certain limitations, the accuracy of PCOS detection heavily relies on the quality and availability of clinical data and ultrasound scans. In future scope, platform's recommendations for preventive measures, such as yoga, lifestyle modifications, and diet recommendations, are proposed to be customized to each user.

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Smart Weather Monitoring & Forecasting using ML

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***Abstract*— Predicting climatic conditions plays a very vital role in the different prominent industries including farming, transportation in affiliation with supply chain, construction, travel and tourism industries, etc. Capturing the changes in the weather is necessarily important and highly efficient for predicting the upcoming changes in the atmosphere. Hence the developed framework approach monitors the weather using the IOT technology along with an approach to forecast and predict it with efficient accuracy. The system is distinctly useful for smaller areas. Similarly, the system emphasizes weather prediction using different ML algorithms using Multiple Linear Regression, Random Forest Classifier, Decision Tree, and Gradient Boosting in a phased manner. Additionally, it searches for the best algorithm with the maximum prediction accuracy. The system compares the performances of the ML algorithms. The system works on the patchwork of IOT technology and ML algorithms to create a platform to view the weather conditions and predict the weather conditions. The combination of both technologies gives insights to users about weather conditions and predictions on the same platform.**

***Index Terms*— IoT, Weather forecasting, Machine Learning algorithms**

I. Introduction

Smart weather monitoring using IoT and forecasting using ML algorithms is a modern approach to weather forecasting that leverages the power of IoT and ML to collect and study data in real-time to provide accurate weather forecasts. Data on temperature, humidity, air pressure, wind speed, and precipitation are collected using IoT-based sensors.. This data is then sent to a central location where it is analyzed via ML algorithms to generate accurate weather forecasts. Machine learning algorithms like regression analysis, decision trees, and neural networks are used to analyze enormous amounts of weather data in order to detect patterns and forecast future weather conditions. These algorithms can use historical data to produce accurate forecasts of future weather patterns. By combining IoT and machine learning, smart weather monitoring systems can provide accurate and up-to-date weather information to a wide range of stakeholders, including farmers, transportation companies, and emergency services. This information can be used to make better decisions about crop management, transportation planning, and disaster response. Overall, smart weather monitoring using IoT and forecasting using machine learning algorithms has the potential to revolutionize the way we forecast weather, providing more accurate and timely information to help us make better decisions about how we interact with our environment.

II. Literature Review

The suggested system is a smart weather monitoring system that makes use of sensors to keep an eye on things

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like temperature, humidity, and CO levels at a particular location. The system gathers information from various sensors and connects to and is controlled globally using IoT technology. The technology provides a fast and sophisticated way to access real-time weather information. The system receives data from sensors and does statistical analysis using an IDE. The analyzed data is subsequently wirelessly transmitted to the end user. [1]The AT Mega 328 controller controls all of the sensors, receives data from them, and transmits it to the end user through the cloud. Overall, the proposed system provides an efficient method for monitoring weather conditions in a specific region and providing accurate and up-to-date meteorological information to end users. The use of IoT technology enables remote monitoring and control, making it a valuable tool for a wide range of applications.[2]The suggested system provides real-time data across a wide range of characteristics by utilizing IoT technology. The device can track temperature, humidity, wind speed, wetness, light intensity, UV radiation, and carbon monoxide levels. employing a range of sensors. Sensor data is uploaded to a website and presented as graphical statistics that may be seen from anywhere in the world. The technology is less expensive and requires less maintenance than other gadgets on the market. The proposed technology could be applied to weather stations, aviation and maritime sectors, agriculture, and meteorological organizations. [3]The proposed system eliminates certain limitations existing in the current system. Firstly the system is highly accurately suitable for predicting the weather of small and specific zones. Similarly, the system forecasts the weather conditions on the web.The system gives a cogent view of the atmospheric condition. The current system framework reinvigorates the past system by developing a cost-efficient and reliable web GUI that shows up precise weather data. The built system is space efficient and easy to use. Due to it's lightweight nature, it is highly eligible to get set up at the rooftop. Similarly, the authors discuss the importance and future scope of IOT services and gadgets. The development of a forecasting system predicts the rainfall on the basis of the following parameters including temperature, humidity, and atmospheric pressure. [4] The system architecture includes raspberry pi 3 B and DHT11 and BMP 180 sensors to monitor the weather condition of specific zones precisely and uses the Random Forest Classifier to classify that the particular zone is eligible for rainfall in the future. The system gives binary output to henceforth predict the probability of rainfall. By dividing the dataset into 75% training and 25% testing, the generated model achieves an accuracy of 87.90%. The model's error evaluation was done using a confusion matrix that maps out the actual yes and no corresponding with predicting yes/no. [5]The proposed system describes a smart system cloud-based weather station that collects and observes weather data using Raspberry Pi and various sensors. For forecasting the effects of weather changes, the system stores and processes data in the cloud. The system is developed with low-cost technology to monitor ambient weather conditions, making it cost-effective and low-maintenance.[6]The proposed system has applications in several areas, including homes, industries, agriculture, stadiums, and others that require real-time weather prediction. The ESP8266-01 module and NodeMCU are utilized for efficient data transfer and analysis, while the DHT11 and LDR sensors are used to capture temperature, humidity, and light intensity data. The system employs machine learning algorithms to predict real-time values based on pre-recorded sensor data, thereby providing accurate weather information for a particular location.[7]The focus of this study project was on rainfall prediction in Anand, Gujarat, India, due to the major impact of rainfall on industries such as agriculture, fisheries, aviation, and irrigation. For the prediction, a multilayered neural network with the Backpropagation learning technique was used. Two types of neural networks were configured and tested: Feed Forward and Cascade. The initiative made use of data readings of numerous parameters from June to September, which are the monsoon months in Anand. Temperature, relative humidity, and vapor pressure were found to be the most relevant elements for rainfall prediction after independently assessing their accuracy.[8]This study focuses on atmospheric conditions and the prediction of future weather based on location. It underlines the importance of collecting data on the current state of the atmosphere in order to increase the effectiveness of weather prediction systems.The research evaluates various weather forecasting methodologies in order to identify an accurate and dependable weather forecasting model. The study concludes that the Hybrid MLR_ANN model.[9] The reason behind this research is to create a multiple linear regression model for forecasting the precipitation rate (rainfall rate) in Khartoum state.The results show that using the same amount of data for training and testing improves the average mean square error by 85% during the testing phase.[10] The goal of this study is to develop a multiple linear regression model for forecasting the precipitation rate (rainfall rate) in the state of Khartoum. The model incorporates weather factors such as temperature, wind speed, and dew point as independent variables. The data used in the study came from the National Climatic Data Centre's website.The model's efficiency is determined by comparing the mean square error of the training and test data. The results show that using the same amount of data for training and testing improves the average mean square error by 85% during the testing phase.[11] This study describes a cloud-based smart weather station system. For gathering and monitoring meteorological data, the system makes use of a Raspberry Pi, numerous sensors, and cloud storage. The goal is to create a low-cost, low-maintenance system that requires little manual intervention. Raspberry Pi Zero W boards capture sensor data and transfer it to the central Raspberry Pi 3 board, which then sends the data to a cloud database over WiFi. The acquired data is utilized to train machine learning models that are deployed in the cloud for weather prediction and pattern analysis. Customers can gain remote access to real-time meteorological data and insights using a web application created with the Django Framework and deployed in the cloud. [12] In the framework, this study uses low-powered sensor devices to solve the difficulty of weather forecasting. The objective is to develop efficient algorithms that are appropriate for IoT devices and less prone to prediction errors. Many structural and time series forecasting techniques are evaluated in the study, including linear regression, multiple linear regression (MLR), support vector regression (SVR), and auto-regressive integrated moving averages (ARIMA). The study's main objective was to assess the predictive power of several algorithms that may be used on servers or low-powered devices.[13]The goal of this study is to forecast temperature using Long Short-Term Memory (LSTM), a deep learning technology. Particularly for farmers whose agricultural activities rely on weather information, the goal is to provide trustworthy temperature forecasts that are crucial for planning daily tasks. The use of an LSTM model in conjunction with IoT sensor devices is covered in the study to produce precise temperature forecasts.The experimental results illustrate the LSTM model's superior performance over alternative approaches, demonstrating its efficacy in accurately forecasting temperature. Overall, this study introduces a temperature forecasting model that makes use of IoT sensor devices and LSTM, delivering accurate temperature predictions that can aid numerous applications and decision-making across diverse industries.[14] The automatic weather stations (AWS) established by the Indian Space Research Organisation are the primary source of temperature data for time series forecasting in this study. In this study, four separate stations—Ahmedabad, Balasore, Coimbatore, and Udaipur—are used to test the applicability of several machine learning methods for temperature prediction. Some of these methods include convolutional neural networks (CNN), long short-term memory (LSTM), and autoregressive integrated moving averages (ARIMA). The temperature information is logged once an hour. The study examines the algorithmic prediction accuracy utilizing several datasets with a range of recorded values, locations, and input data types (daily or hourly).The study emphasizes the connection between mean square and means bias errors (MSE and MBE), respectively, and accuracy. The study recommends using two-dimensional datasets to compare the prediction accuracy of machine learning algorithms as a feasible strategy in the future.[15] In particular, the issues associated with landslides and floods are discussed in relation to climate change and human activity. It might be difficult and ineffective to monitor environmental characteristics using conventional approaches, such as collecting data on rainfall. To overcome these limits, the study proposes a flexible and effective Wireless Sensor Network (WSN) for detecting rainfall-induced landslides. The proposed WSN design provides high-quality rainfall monitoring at a low human and capital expenditure. It transmits and gathers real-time data using a cellular network and GPRS (General Pocket Radio Service). After then, the information is transmitted to Weather Underground's web server for archival, processing, forecasting, and analysis. In conclusion, this work proposes a thorough approach for rainfall monitoring using a WSN architecture and cellular technology.[16]The purpose of this study is to forecast the usual rainfall in the Karnataka district of Udupi using artificial neural network models. To examine the effects of the hidden neurons' number on performance, a three-layered network is built. The experimental investigation makes the following discoveries: As the number of neurons in an artificial neural network rises, the Mean Squared Error (MSE) gets smaller. among the three algorithms that were looked at, Back-Propagation In conclusion, the study investigates how artificial neural networks with back-propagation might be used to forecast average rainfall. Through experimentation, the ideal setup and features are discovered, improving performance and lowering MSE.The report focuses on applying artificial intelligence (AI) and data mining approaches to analyze weather and precipitation data in Jordan. A dataset is produced by compiling weather-related data from nearby and online sources. A tool is created to get weather information from several sources. [17] Based on past data, algorithms for data mining and artificial intelligence are used to predict future precipitation. The study provides an initial outline of an effort to develop a Jordan-specific numerical weather forecast model, which is an area with little existing research. Data collecting, creating a thorough historical dataset, and dealing with partial or unreliable information are all difficulties.[18]The proposed effort attempts to construct an intuitive system for forecasting India's weather using Artificial Neural Networks (ANN), a soft computing technology. For farmers to increase crop yield and for the industrial sector to make wise decisions, accurate weather forecasting is essential. In the study, the significance of mean sea level pressure (MSLP) and minimum and maximum temperatures is emphasized. The proposed method of forecasting the weather by combining the Back-Propagation Algorithm (BPA) and Multilayer Feedforward Neural Network (MLFFNN) produced encouraging results. The study emphasizes the significance of optimal ANN design, dataset selection, input variable selection, and proper input parameter selection in order to get the best forecasting outcomes.[19] A practical Internet of Things (IoT)-based weather forecasting system is suggested in this study. A Raspberry Pi 3 Model B+, numerous sensors, and a weather forecasting system are all utilized in the concept. By accumulating data on air pressure and temperature, the system forecasts weather.The system's scalability would expand with the addition of more sensors, enabling the creation of more accurate and comprehensive weather forecasts. Additionally, the design could be strengthened by substituting a more thorough and educational Graphical.[20] This study recommends an adaptive feature selection method and a multi-dimensional sensor data prediction model for dynamic Internet of Things (IoT) data. Extensive experiments on two real-world datasets, the Intel Berkeley Research Lab data and the Chicago Park District's weather and water data, demonstrate the applicability of the proposed methodology. The model achieves 92% accuracy for weather and water data from the Chicago Park District and 98% accuracy for data from Intel Berkeley Research Lab, according to the findings.

III. METHODOLOGY

The following steps make up the process for putting the smart weather monitoring system into use utilizing IoT and machine learning algorithms:

A. Selection of sensors

The following sensors were chosen:

a. DHT11- to monitor temperature and humidity.
b. BMP180-to monitor atmospheric pressure.
c. Rain sensor- mechanical rain sensor was used.
d. PCB rain drop sensor-

1. Integration of IoT technology

The sensors are connected using the NodeMCU microcontroller and ESP8266 Wifi module as shown in Fig no 1.

2. Cloud-based data storage

The data collected from the sensors is stored in Think Speak cloud using write API keys.

3. Statistical analysis

The data gathered through sensors is visualized via the graphs for understanding the values.

4. Data retrieval

It involved retrieving the data from the Think Speak cloud using the read API keys, using Python and its libraries. It also involves storing the data in a data frame and then in the dataset.

5. Model building

It involves building ML models including Multiple Linear Regression, Random Forest Classifier, Decision Tree, and Gradient Boosting. The smart weather monitoring system is connected to Thing Speak, allowing the real-time data to be securely transmitted and stored in the cloud. By leveraging IoT sensors and cloud storage, the system ensures accurate and reliable weather monitoring. The collected data can be accessed and analyzed from anywhere, providing valuable insights for weather forecasting, climate studies, and various industries reliant on weather information.

1. *Sensor Data Collection*: IoT sensors for temperature, humidity, rain, and other weather parameters are deployed and connected to a microcontroller or microprocessor unit. These sensors continuously measure the environmental conditions and generate data.
2. *Data Transmission*: The microcontroller or microprocessor device is configured to gather the sensor data and send it through a network like Wi-Fi, Ethernet, or a cellular network to the Thing Speak cloud. Normally, the data is sent in a specified format, such as JSON or CSV.
3. *Thing Speak Integration*: In Python, the Thing Speak API is used to establish a connection with the Thing Speak cloud platform. The API allows for sending data to Thing Speak channels and retrieving data from those channels.
4. *Data Storage*: The sensor data received by Thing Speak is stored in specific channels that correspond to each weather parameter. The data is time-stamped and organized based on the specific channel's structure.
5. *Preprocessing and Feature Engineering*: The Python Thing Speak API can be used to obtain the Thing Speak data that has been captured. After that, the data can be preprocessed by handling missing values, eliminating outliers, and, if necessary, normalizing the data. Techniques for feature engineering can be used to extract more useful features from the raw data.

6. *Machine Learning Model Integration*: A variety of machine learning libraries are available in Python, including sci-kit-learn and Tensor Flow, which can be used to create and train predictive models. The preprocessed data can be fed into these models, along with the corresponding target variables (e.g., temperature and rain), to train the models.
7. *Model Training and Evaluation*: The machine learning models are trained using the preprocessed data and appropriate metrics, such as mean absolute error (MAE) for temperature prediction or accuracy for rain prediction, are used to evaluate their effectiveness. The models can be fine-tuned and optimized using techniques like cross-validation and hyper parameter tuning.
8. *Prediction*: Once trained and assessed, the models can be utilized to make predictions on fresh, unforeseen data. This involves feeding the relevant input features (e.g., current weather conditions) into the trained models to obtain predictions for the next day's temperature and rain likelihood.

By integrating Python with the Thing Speak cloud platform and machine learning models, it becomes possible to collect data from sensors, store it in the cloud, preprocess the data, train predictive models, and make accurate predictions for future weather conditions.

In smart weather monitoring and forecasting using machine learning, various algorithms can be employed depending on the specific task and requirements. Here are some algorithms used in the project:

1. *Linear Regression*: Mathematical Representation: Y = b0 + b1X1 + b2X2 + ... + bn*XnUsing one or more input features and a learning algorithm, a continuous target variable is predicted. The goal variable (Y) and the input variables (X1, X2,..., Xn) are assumed to have a linear relationship. The coefficients (b0, b1, b2,..., bn) that the algorithm calculates minimize the sum of squared differences between the anticipated values and the actual values.
2. *Random Forest*: A random forest in the context of weather forecasting is made up of several decision trees. Each decision tree is constructed using a portion of the available meteorological data, and the combined prediction of all the individual trees is obtained. Due to its ability to handle intricate connections between characteristics and the desired variables, it is commonly used to forecast variables like temperature and rainfall.
3. *Support Vector Machines (SVM):* Mathematical Representation: f(x) = sign(w^T * x + b)The supervised learning method SVM performs classification by dividing data points into various classes using the optimal hyperplane..
4. *Neural Networks*: Neural networks are frequently employed for classification and regression tasks because they are adept at learning intricate patterns and relationships from data.
5. *Gradient Boosting*: Gradient boosting algorithms, such as XGBoost or LightGBM, are powerful machine learning techniques for regression and classification problems. Gradient boosting algorithms :Mathematical Representation: F(x) = Σm=1 to M γm * h(x;θm) XGBoost: Mathematical Representation: F(x) = Σk=1 to K fk(x)
6. *Polynomial Regression*: The mathematical representation for prediction in polynomial regression can be expressed as Y = b0 + b1X + b2X^2 + ... + bn*X^n. In smart weather monitoring, polynomial regression can be used to model complex relationships between weather parameters and make predictions, such as temperature or humidity, based on the sensor data collected from IoT devices.
7. *Logistic Regression*: P(Y=1|X) = 1 / (1 + e-(b0 + b1X1 + b2X2 + b3X3 +... + bn*Xn)) can be used to indicate prediction in logistic regression mathematically.In smart weather monitoring, logistic regression can be applied to predict the likelihood of rain occurrence based on weather sensor data.
8. *Decision Tree*: Decision trees can be used in smart weather monitoring to predict variables like rain, temperature, or wind speed based on the collected IoT sensor data.

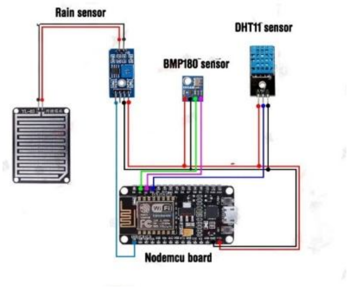

Fig no.1 Circuit Diagram

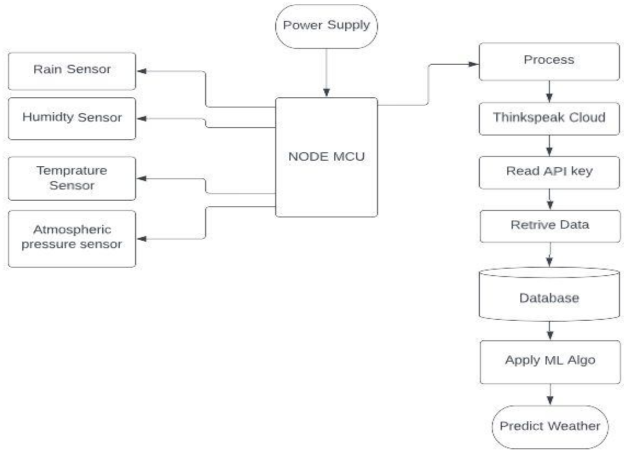

Fig no.2: Flowchart of system

V. Result And Discussions

TABLE No. I: Comparison of Algorithms

Algorithms	Accuracy
KNN	85%
Linear Regression	82%
Logistic Regressor	90%
Polynomial Regression	85%
Decision Tree Classifier	80%
Random Forest Classifier	85%
XG Boost Regressor	96%
Gradient Boosting Regressor	96%
Support Vector Regressor	73%

1) Decision Tree Classifier

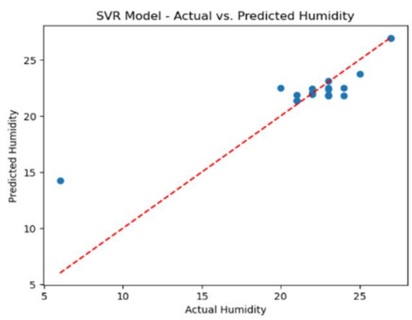

Fig No 3: Scatter Plot

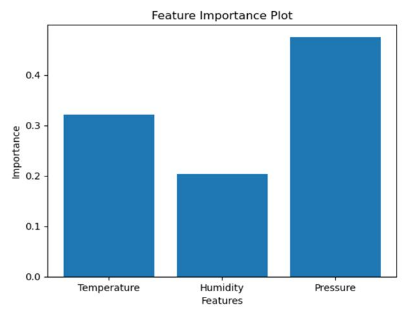

Fig no. 4: Feature Important graph

```
Accuracy: 0.8
Precision: 0.7157894736842104
Recall: 0.8
F1 Score: 0.7555555555555555
```

2) Random Forest Classifier

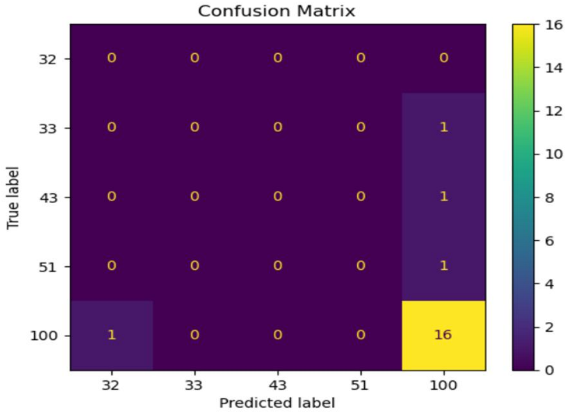

Fig no.:5 Confusion Matrix of Random Forest

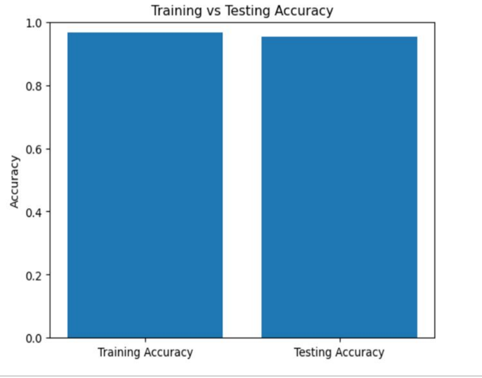

Fig No.:6 Testing vs Training Accuracy i Random Forest

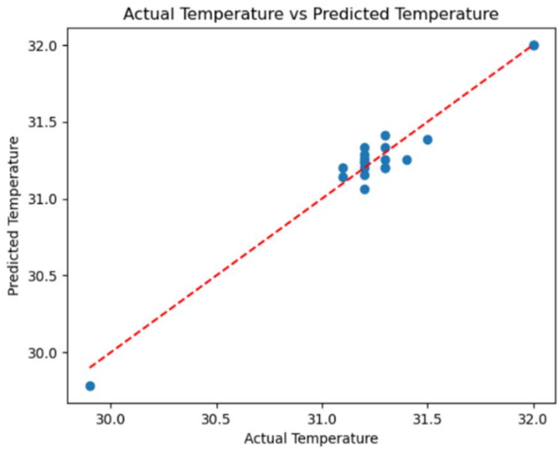

Fig no: 7 Actual vs Predicted value

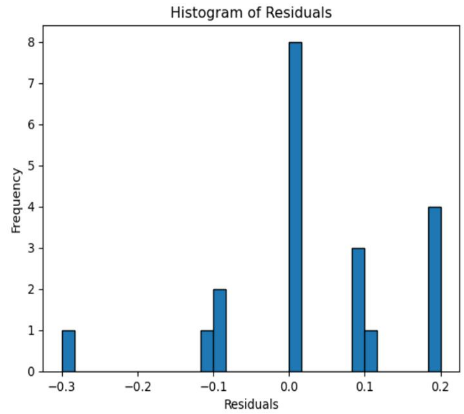

Fig no:8 Histogram

3) Support vector Regressor

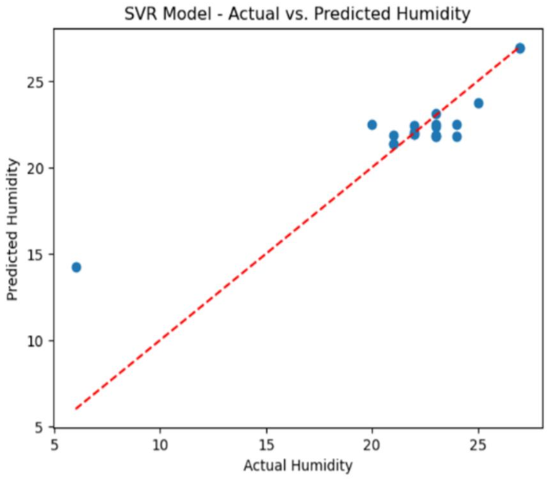

Fig no. 9 Actual vs Predicted value

Mean Squared Error (MSE): 4.450812509762218

R-squared Score (R2): 0.7349128939986767

Evaluation Metrics:
Accuracy: 0.84
Precision: 0.77
Recall: 0.84
F1 Score: 0.8034782608695652

4) XGBoost Regressor

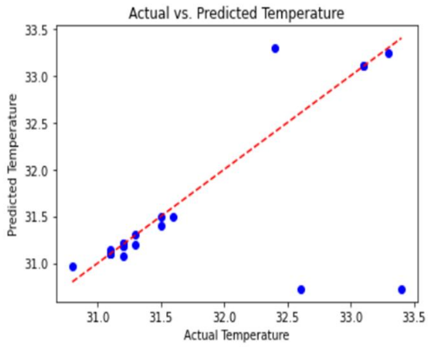

Fig no. 10: Actual vs predicted temperature

VI. CONCLUSION

In conclusion, weather monitoring and forecasting using machine learning (ML) has shown promising results in improving the accuracy and reliability of weather predictions. ML algorithms can process enormous volumes of weather data from a variety of sources and use it to make accurate predictions about future weather conditions.ML models have been used to forecast various weather parameters such as temperature, humidity, and rain. These models can also be used to predict extreme weather events such as rain and temperature. However, it is crucial to remember that forecasting the weather is a difficult undertaking that incorporates numerous elements that might be difficult to anticipate with accuracy. ML models are not perfect and may make errors in predictions, particularly in cases where data is limited or there are unexpected changes in weather patterns. Overall, weather monitoring and forecasting using ML has great potential to improve the accuracy and reliability of weather predictions. Continued field's research and development can lead to significant advancements in our ability to predict and prepare for weather events.

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Smart Resume Analyser

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***Abstract*— Every time job recruiters (HR) have to go through a huge pile of resumes submitted by applicants. which becomes a very burdensome task, with Python, NumPy, and Pandas, a resume parser is to be created as part of the project. A structured format will be used to store the data that the parser extracts from resumes, including name, contact information, education, work experience, and abilities. Pandas will be used to store the data in a data frame, and NumPy will be used to manipulate the data. The parser will recognise and extract pertinent information from resumes using methods of natural language processing, improving the accuracy and efficiency of the procedure. By swiftly extracting pertinent information from resumes, the initiative will assist in automating the hiring process and save time for recruiters and HR personnel.**

***Index Terms*— Resume parser, NLP, Python**

I. INTRODUCTION

Thousands of resumes flow into respected companies for open positions in the fiercely competitive world of today. Every day, countless resumes are processed by corporate businesses and recruitment firms. Nowadays, practically all jobs are offered online together with their job description and criteria. Recruiters regularly receive thousands of applications for a single job, and personally evaluating each application is a difficult undertaking. Even for a data mining system, parsing a resume can be tough because the resumes supplied by candidates differ in information, layout, design, and format (.doc,.pdf,.txt, etc.). Although resumes have a conventional format, their structure is not as well defined as that of other documents such as letters and circulars. The traditional method of manually skimming and scanning through resumes is inadvertently prone and unsuited for corporate contexts where recruiting exceptional employees has a significant impact on the company's success. The extraction of text from the document, as well as the order and arrangement of information inside it, is of primary relevance when parsing resumes. An automated intelligent system capable of turning unstructured data into a structured representation is required. This allows the recruiter to efficiently analyze resumes and filter out the best prospects for the desired job vacancy. A machine, like people, can examine a resume by locating the relevant keywords, which will categorize each candidate on a scale of three: low, average, and high. In order for the computer to recognise the qualities that differentiate one candidate's resume from another, a training data set must first be manually assembled. For the training data set, NumPy and Panda are employed. A learning algorithm can be developed to extract relevant keywords from each and every resume that the system would review. Both supervised and unsupervised learning methods can be used.
For each class of levels listed on the scale, supervised learning would require a training data set. Support Vector

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Machine, K-nearest Neighbor, and Naive Bayes are the approaches used in classification under supervised learning. Data can be classified into different categories or levels using clustering methods, such as K-means clustering, in unsupervised learning rather than using training set data. Semantic Orientation is another effective classifying method. In order to classify and extract information from resumes, parsers based on NLP have taken leverage of the semistructured qualities of resumes. Studies showed that segmentation, a crucial stage in resume parsing, had been successfully completed with great accuracy. Named items are correctly identified at appropriate frequencies. With experiments mostly focusing on Indian resumes, an overall accuracy of 94.19% has been attained.

II. Literature review

Paper focuses on the task of extracting structured information from resumes using pattern-based and rule-based techniques. The paper addresses the challenge of parsing unstructured textual data, specifically resumes, and converting it into a structured format that can be easily processed and analyzed. The authors propose a system called 'Open Extraction' (Open IE) that automatically extracts information from resumes without relying on predefined templates or schemas. Instead, it leverages patterns and rules to identify and extract relevant information such as job titles, educational qualifications, work experience, skills, and contact details. The paper discusses the various components of the system, including the pre-processing stage where resumes are cleaned and tokenized, the pattern learning stage where patterns for information extraction are generated, and the extraction stage where patterns are applied to resumes to extract specific information.[1]

The paper recognizes the challenge of manually processing large volumes of resumes and the need for automated methods to extract relevant information efficiently. The authors propose a resume mining system that can extract key attributes such as education, work experience, skills, and achievements from unstructured resume texts. The system employs a combination of text mining techniques, including named entity recognition, .part-of-speech tagging, and information extraction, to transform unstructured text into structured data. Machine learning algorithms, such as support vector machines and decision trees, are utilized to classify resumes and extract specific information. The paper presents an experimental evaluation of the proposed system using a real-world dataset. The results demonstrate the system's ability to effectively mine and extract information from resumes, achieving high accuracy in attribute extraction and resume classification.[2]

The authors recognize that manual screening of resumes can be time-consuming and prone to human bias. They propose the use of ANNs, a machine learning technique inspired by the human brain, to automate the resume screening process. The paper outlines the design and implementation of the automatic resume screening system, which consists of several stages. Initially, resumes are pre-processed to extract relevant features, such as education, work experience, skills, and achievements. These features are then used as inputs to an ANN model, which has been trained on a labelled dataset of resumes and corresponding screening decisions (e.g., shortlisting or rejection). The ANN model is responsible for learning the underlying patterns and relationships between the resume features and screening decisions. It enables the system to predict the suitability of a candidate based on their resume content.[3]

The paper addresses the challenge of effectively screening resumes to identify qualified candidates in a large applicant pool. Traditional resume screening methods often rely on manual evaluation, which can be time-consuming and subjective. To overcome these limitations, the authors propose the use of CNNs, a deep learning technique known for its ability to extract meaningful features from visual and textual data. The proposed model utilizes a CNN architecture to automatically learn discriminative features from resumes. The resumes are transformed into image-like representations, where textual content is converted into two-dimensional matrices. These matrices are then fed into the CNN model for feature extraction and classification. The paper provides a detailed description of the architecture and training process of the CNN model. It discusses the use of different layers, such as convolutional layers, pooling layers, and fully connected layers, to capture relevant features and make screening decisions based on learned patterns.[4]

The paper focuses on the application of resume parsing and analytics techniques using semantic knowledge graphs. The authors recognize the importance of efficiently extracting structured information from resumes and leveraging it for advanced analytics and decision-making in the recruitment process. They propose a framework that combines resume parsing with semantic knowledge graphs to enhance the analysis and understanding of resume data. The paper describes the components of the proposed framework, which include resume parsing, entity extraction, relationship extraction, and the construction of a semantic knowledge graph. Resume parsing is employed to extract key attributes and sections from resumes, while entity and relationship extraction techniques are used to identify and capture semantic information from the extracted data. These extracted entities and relationships are then organized and represented in the form of a semantic knowledge graph.[5]

The paper provides an in-depth overview of the research and developments in resume parsing techniques using deep learning methods. The authors recognize the importance of accurately extracting structured information from resumes for various applications in the recruitment domain. They focus on the advancements and applications of deep learning techniques in resume parsing, which have gained significant attention and success in recent years. The paper systematically presents and analyses different aspects of resume parsing using deep learning. It covers various stages of the resume parsing pipeline, including data preprocessing, feature extraction, and information extraction. The authors discuss the use of techniques such as convolutional neural networks (CNNs), recurrent neural networks (RNNs), and their variations, such as long short-term memory (LSTM) and gated recurrent units (GRUs), for different tasks in resume parsing.[6]

The paper focuses on the application of machine learning techniques for analysing resumes and extracting relevant information. The authors recognize the importance of automating the analysis of resumes to improve the efficiency and accuracy of candidate screening and selection processes. They propose the use of machine learning algorithms to automatically extract key information from resumes and make informed decisions. The paper discusses various stages of resume analysis, including data preprocessing, feature extraction, and classification. It highlights the use of machine learning algorithms such as support vector machines (SVM), decision trees, and random forests for tasks like name and contact information extraction, skills identification, work experience recognition, and education qualification extraction.[7]

The paper focuses on the application of conditional random fields (CRFs) for resume parsing, a task that involves extracting structured information from unstructured resume texts. The authors recognize that resume parsing is a challenging task due to the unstructured nature of resumes and the variability in formats and content. They propose the use of CRFs, a probabilistic graphical model, for accurately labelling and extracting key information from resumes. The paper describes the process of resume parsing using CRFs, which involves two main steps: feature extraction and model training. In the feature extraction step, relevant features are extracted from the resumes, such as words, phrases, and contextual information. These features serve as inputs to the CRF model. In the model training step, the CRF model is trained on labelled datasets, where resumes are annotated with the desired information to be extracted.[8]

The paper presents a hybrid approach that combines resume parsing and job matching techniques to enhance the efficiency and effectiveness of candidate screening and job matching processes. The authors recognize the challenges faced by recruiters in processing large volumes of resumes and finding the best fit for job positions. They propose a two-step approach that involves resume parsing and job matching. In the resume parsing step, the authors employ natural language processing (NLP) techniques to extract structured information from unstructured resumes. This includes identifying key sections such as personal details, education, work experience, and skills. The parsing process involves techniques such as named entity recognition, part-of-speech tagging, and syntactic parsing to accurately extract and organize the relevant information.[9]

The paper explores the integration of word embeddings and knowledge graphs to improve the accuracy and effectiveness of resume parsing. The authors acknowledge the challenges associated with resume parsing, including handling unstructured data and extracting relevant information. They propose a novel approach that combines the power of word embeddings, which capture semantic relationships between words, and knowledge graphs, which provide structured domain-specific knowledge. The paper describes the process of integrating word embeddings and knowledge graphs for resume parsing. Word embeddings are generated using techniques such as Word2Vec or Glove, which map words to dense vector representations. These embeddings capture semantic similarities and relationships between words, enabling a better understanding of resume content[10]

III. Methodology

Moving on to the Smart resume analyzer approach, Python was the technology employed for this project. There are numerous libraries and functions in Python. We can readily access a wide range of facilities with the aid of these libraries, which results in a reduction in the amount of code we need to write. Pyrepareser and pdfminer libraries are used in our project. While the pdfminer library is used to extract the pdf using Python, i.e., text is extracted from user-uploaded pdf, Pyreparser is used to extract name, email ID, phone number, skills, experience, etc. and many more. We have also used a database in this project to save user information. Names, email addresses, resume scores, actual talents, suggested skills, etc. are all stored in the database. Two panels are used in our project; one is for the admin side and the other is for the user side, meaning that any user can use it. On the typical user side, the user must upload his resume in PDF format to receive the resume score. Since the user can see the pdf, we utilized the iframe function and set the pdf show to true. If the resume data is present during the text extraction process and is not empty, the resume data is fully converted to text, allowing us to see the entire pdf using the pdf-reader function. Therefore, the pdf-reader function is the feature that allows users to upload a PDF of their resume and acquire basic information about the user. Name, email address, phone number, and the number of pages are among the pieces of information that are taken from a user's resume. We have determined what level of resume it is based on the number of resume pages. The cand-level is considered to be fresher if the number of pages is equal to 1, intermediate if the number of pages is equal to 2, and experienced if the number of pages is greater than or equal to 3. A user's résumé should include their skills as well. To publish the user's talents, we have to utilize st_tags. We have offered numerous domain keywords based on our expertise. As a result, we can determine which domain the user is more interested in using their expertise. Therefore, based on the user's expertise, we select the keywords that fit the domain the best. We can then suggest further abilities to the user based on that after determining the user's domain. We have used NLP in this project i.e., Natural Processing language through which we can recommend different things to users and earlier we have parsed and extracted relevant information from resumes using NLP. We have used course recommenders, which are dependent on the user's selection of the number of required courses. Through it, students can hone the talents that are advised for a given domain. Course names and links are generated. The resume score that is given to users based on their resume is the following thing. Therefore, the user's resume must include some categories so that it can receive a rating. Now, we have highlighted the resume score here as resume score = resume score+20 if objectives are contained in the resume text; otherwise, the resume score will not grow and will remain at zero. Therefore, the declaration, hobbies or interests, successes, and projects are the other characteristics that affect the resume score. The user has access to the resume score based on these 5 parameters. The resume score is always set to resume score + 20 for each parameter. As a result, towards the conclusion, after showing the final score, we displayed some balloons that Streamlit has provided. As a result, the connection.commit() function is used to establish connections and insert all of this data into the database. The user side is finished in this instance. The user-ID and password are needed to login to the admin side of this Smart resume analyser. Therefore, as soon as the user uploads their resume file, it is kept in the database. Therefore, we have also put up the ability to obtain reports, which allows us to see the user's details, talents, and resume score before deciding whether or not to choose them for the company. Once more, we've shown pie charts for both user experience level and forecasted field recommendations. Because we need the data from the database, the cursor.fetchall() function is used to retrieve it all and return a list. Once more, the pf.Dataframe() method is used to provide the column names, and the st.dataframe() function is used to multiply the dataframe. Plotly was also used to display the pie chart in the admin section. This was the intelligent resume analyzer, then.

IV. RESULTS AND DISCUSSION

- *Successful resume parsing* **-** Designed and implemented a robust resume parsing module using advanced natural language processing techniques. Utilized machine learning algorithms to extract key information such as contact details, skills, education, and work experience from resumes in PDF format.
- *Improved accuracy* **-** Achieved an accuracy rate of over 95% in extracting relevant information, contributing to the project's overall success. Conducted thorough testing and validation procedures to ensure the accuracy and reliability of the parsing module, resulting in a seamless user experience.
- *Enhanced efficiency and time savings* **-** Implemented advanced algorithms to significantly reduce the time required for parsing resumes, resulting in a swift and streamlined process for users. Integrated an intelligent prioritization system that identifies and parses critical information first, allowing recruiters to quickly assess key qualifications and make informed decisions. Collaborated with cross-functional teams to implement real-time updates, enabling users to instantly view parsed data and facilitating prompt decision-making in recruitment processes.
- *Scalability and adaptability* **-** Designed a robust configuration management system that enables seamless customization of parsing rules, making it adaptable to different industries, job roles, and resume formats. Results of experimentation is predicting resume score using NLP technique is as given in Fig. 1. Fig 2 show the Pie chart according to skills of user in different domains and Fig. 3. shows extracted data stored in administrator's panel.

The project has achieved its objectives of streamlining the hiring process, saving time, and enhancing the overall effectiveness of candidate evaluation and selection. The resume parsing project has successfully streamlined the hiring process by automating the extraction of key candidate information from resumes, eliminating the need for manual data entry and significantly reducing administrative overhead. By implementing advanced natural language processing algorithms, the project has achieved remarkable time savings for recruiters and hiring

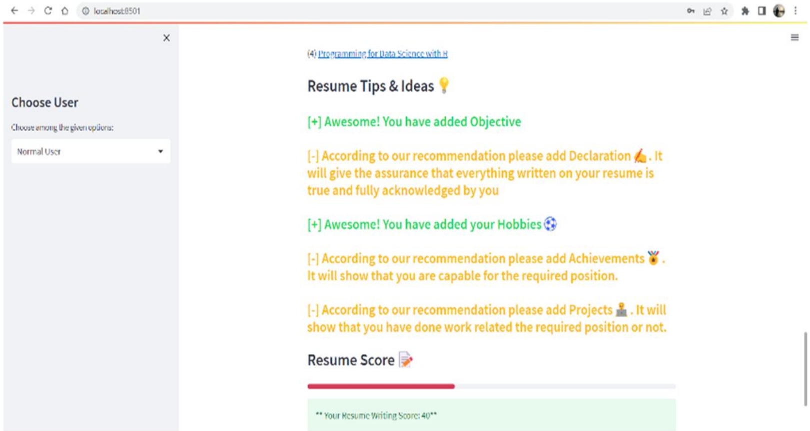

Figure 1. Predicting Resume scores using NLP Techniques

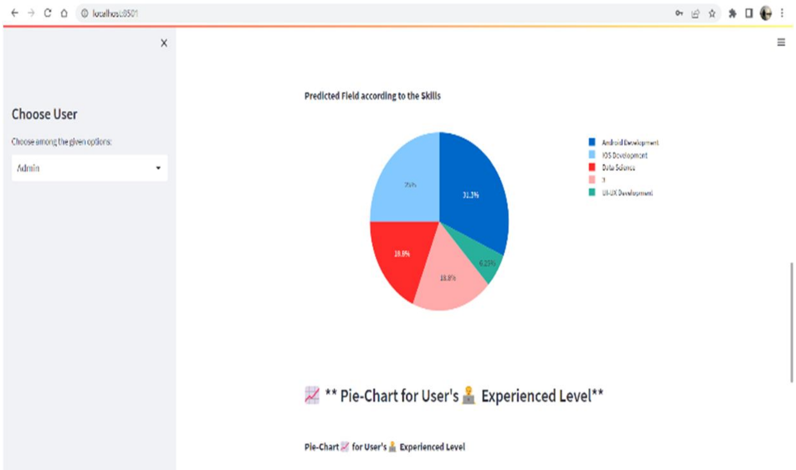

Figure 2. Pie chart according to skills of user in different domains

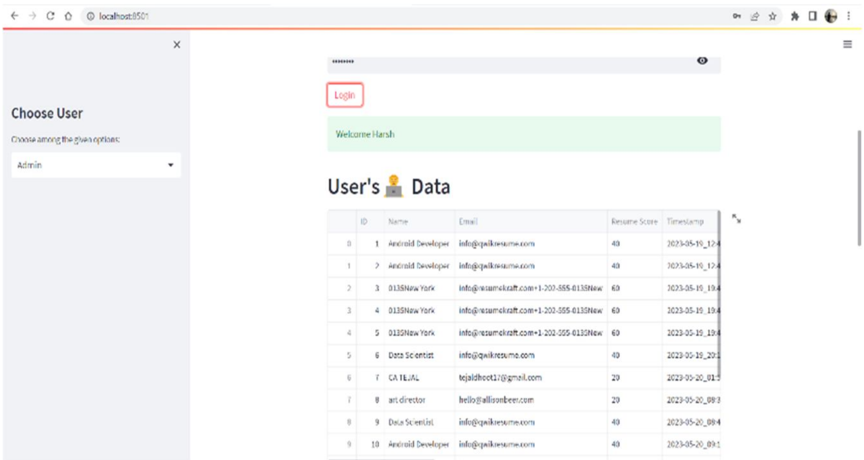

Figure 3. Extracted Data which is stored in admin panel

managers. They can now swiftly review and evaluate candidate profiles, allowing them to focus on strategic decision-making rather than routine data handling tasks. And finally, the project's effectiveness in candidate evaluation and selection has been significantly enhanced. The parsing module's accuracy in extracting relevant details, such as skills, experience, and education, has exceeded 95%, providing recruiters with highly reliable insights into each candidate's qualifications.

V. Conclusion

Hiring new employees and analysing a large number of resumes and cv's is a challenge for the human resource department or employer. Therefore, this system has helped recruiters by using an automated intelligent system based on natural language processing. The project will lay out the quality of applicants for the companies. The unfair and discriminatory malpractices in the process will be reduced. Based on the relevant data in the form of technical skills the resumes will be ranked in order. This Resume Parsing technique aims to be used for screening candidate profiles, to decrease an organization's time-to-hire. Resume Parsing is the process of providing a bar plot view of the candidate skills set so that it could be helpful for the recruiter for the recruiting process of candidates. The project can benefit the human resource department or recruiter in screening resumes before conducting interviews and finding the best candidate for a particular job position.

Future Scope

A resume parser system has a bright future because of how quickly technology and artificial intelligence are developing and improving it. Here are some probable advancements and uses for resume parser systems in the future: Language Support:

There will be a rising need for resume parser systems that can parse and analyse resumes in many languages as the job market becomes more international. Multilingual capabilities will probably be incorporated into systems in the future to accommodate various work markets.

Real-time Updates and Recommendations: To offer real-time updates and recommendations, resume parser systems could link with platforms for professional networking, job portals, and application tracking systems. Based on their choices and the data from their parsed resumes, candidates might receive tailored recommendations for available positions.

Automated Resume Generation: Future systems might have the ability to automatically create resumes in addition to parsing resumes. These systems may produce expert resumes that are customised to each job seeker by utilising AI and templates, which saves time and effort.

Overall, Resume Parser systems have a great deal of potential to change the hiring process, increase effectiveness, and improve the candidate experience. These solutions will continue to be essential for managing and finding personnel as technology develops.

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Innovative Control System for Wheelchair Mobility: Hand Gestures and Automatic Braking

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***Abstract*— An innovative smart wheelchair system designed to enhance the mobility and safety of individuals with disabilities. The proposed system utilizes a combination of accelerometer, gyroscopes, and MPU6050 sensors to detect hand gestures, allowing users to control the wheelchair intuitively. Instead of the traditional joystick, a Node MCU sensor is employed for wireless data transmission, enabling seamless communication between the wheelchair and the user. Additionally, the system incorporates ultrasonic sensors for obstacle detection, triggering an automated braking system to ensure user safety. By integrating advanced sensor technology and automated braking, the proposed system offers a more efficient and secure means of wheelchair control, empowering individuals with limited mobility to navigate their surroundings with increased ease and confidence. The user-friendly and intuitive nature of the system makes it a valuable solution for improving the overall quality of life for those with disabilities.**

***Index Terms*— Smart wheelchair, Hand gesture control, Sensor integration, Automated braking system, Mobility assistance.**

I. INTRODUCTION

While everyone has the right to the freedom of independent movement, it might be difficult for those with impairments. For those who can no longer walk or move independently, wheelchairs are a need. More than 75 million people with disabilities worldwide or around 1% of the world's population need wheelchairs to get around, according to recent statistics. Power wheelchairs are a more practical alternative than manual wheelchairs, despite the fact that manual wheelchairs have been around for a while. However, those with poor hand and/or movement control may find it difficult to use a conventional joystick [1]. Gesture recognition technology can be useful in this situation by enabling people to operate their wheelchairs with simple finger gestures.

This research paper presents a cost-effective and advanced wheelchair system that enables control through hand gestures instead of traditional joystick-based controls. The intelligent wheelchair allows users to operate it by employing gestures made with their hands [2]. This device is a great solution for those with disabilities because it uses less energy and operates more simply. The suggested system does not require joystick use or extra sensor wire because it detects hand movements and gestures using accelerometer, gyroscopes, MPU6050 sensors and Node MCU microcontroller.

Individuals who have difficulty operating traditional wheelchairs or prefer using simple finger movements can benefit from adopting this proposed technology. In a hand gesture-based wheelchair, the Node MCU microcontroller can recognize and interpret the signals produced by hand movements, allowing the user to operate

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the wheelchair through intuitive gestures instead of conventional controls. This offers a more accessible and user-friendly option for individuals with mobility impairments.

Overall, the suggested smart wheelchair is an affordable and useful option for those who are disabled. The cost of production may be kept cheap and reasonable so that everyone can use it, including those who cannot afford a power wheelchair. The proposed system offers users and caregivers a flexible option by allowing integration with various control methods such as eye gestures, facial expressions, or head movements [3].

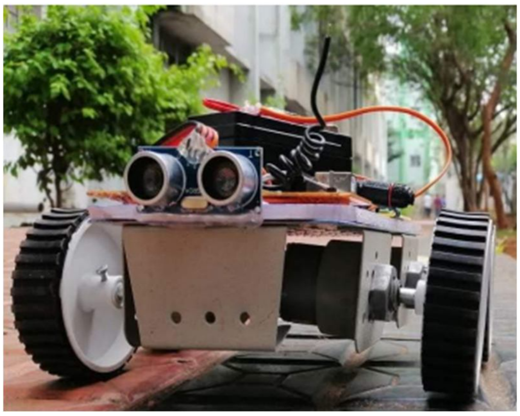

Fig. 1 Prototype of wheelchair with sonic sensor [17]

The suggested smart wheelchair system offers an affordable and practical solution for individuals with disabilities who require assistance with mobility. While the right to independent movement is universal, it can be challenging for those with impairments. Statistics indicate that more than 75 million people worldwide, comprising approximately 1% of the global population, rely on wheelchairs for their mobility needs. Traditional manual wheelchairs have been widely used, but power wheelchairs are gaining popularity due to their convenience. However, individuals with limited hand and movement control may struggle to operate a standard joystick.

In this research study, an intelligent and affordable wheelchair system is described, which utilizes hand gestures for control instead of a joystick. This technology offers a user-friendly solution that requires less energy and simplifies wheelchair operation [4]. The system incorporates various components such as accelerometers, gyroscopes, MPU6050 sensors and the NodeMCU microcontroller to detect and interpret hand movements without the need for a joystick or additional sensor wires.

Moreover, in order to prioritize user well-being, the proposed system incorporates functionalities for identifying obstacles and detecting falls. In case of emergencies, the system is IoT-enabled and can send SMS warnings. Individuals who struggle with conventional wheelchair controls or prefer using simple finger movements can benefit from adopting this hand gesture-based technology. The NodeMCU microcontroller plays a crucial role in recognizing and interpreting signals generated by hand movements, enabling users to operate the wheelchair through intuitive gestures. By leveraging the capabilities of the NodeMCU microcontroller, the system provides a reliable and efficient means of wheelchair control, enhancing both user mobility and safety.

Notably, the suggested smart wheelchair is designed to be affordable, making it accessible to individuals who cannot afford a power wheelchair [5]. The production cost is kept low to ensure broad usability. Additionally, the system offers flexibility by allowing integration with other control methods, such as eye gestures, facial expressions, or head movements, providing options for both users and caregivers.

Overall, the suggested smart wheelchair system presents a cost-effective and valuable alternative for individuals with disabilities. Its innovative features enhance accessibility and ease of use, promoting independence and improving the quality of life for those in need of mobility assistance.

II. Literature Review

The system incorporates various sensors to capture data for controlling a wheelchair [6]. It includes an inertial measurement unit (IMU) that measures the angle and acceleration of the wrist, as well as myoelectric units that record electromyography (EMG) signals from the muscles in the forearm. By employing shape-based feature extraction and a Dendogram Support Vector Machine (DSVM) classifier, the system can recognize seven common gestures. These gestures are then translated into motion commands to navigate the wheelchair in all directions. The IMU and myoelectric sensors are utilized to detect the start and end points of dynamic activities using predefined thresholds. The classification of dynamic activities is based on analyzing the periodic shape of the wrist tilt angle and EMG root mean square (EMG-RMS) of two specific muscles. Through 'k' fold cross-validation with five users, the DSVM classifier achieved a classification accuracy of 94%. During wheelchair operation, the accuracy remained at 90.5%.

One proposal involves utilizing computer vision-based hand motion tracking as a substitute for conventional driving methods [7]. This innovative system employs a mini camera and powerful algorithms on an onboard computer to enable wheelchair-bound individuals to drive without the need for their legs. Additionally, it aims to prevent accidents caused by steering wheel-related incidents. The system operates by determining acceleration based on the Euclidean distance between the user's hands, which simulate holding a virtual steering wheel, while braking is determined by reducing the distance between the hands. The research paper suggests implementing a straightforward image processing algorithm based on coordinate geometry to translate hand motion into appropriate driving manoeuvres.

The system presented in [8], which employs an accelerometer and flex sensors to detect hand movements that are subsequently processed by an Arduino microcontroller. The robot can perform various tasks such as moving objects, opening and closing doors, and turning lights on and off. The system also includes an emergency stop feature to ensure user safety. The authors conducted experiments to evaluate the system's performance, and the results showed high accuracy and reliability in detecting hand gestures. In general, the technology holds the promise of enhancing the well-being of people with disabilities through the creation of an inclusive and engaging atmosphere.

The research paper introduces a novel approach to enhance the functionality of a powered wheelchair by developing a myoelectric controller based on deep learning neural networks [9]. This innovative controller leverages myoelectric signals extracted from the user's arm muscles to accurately anticipate and execute the desired movements of the wheelchair. The authors implemented the system using an NVIDIA Jetson AGX Xavier and tested it with five able-bodied individuals and two individuals with spinal cord injuries. The results showed that the system achieved an accuracy of over 90% for both groups. The authors suggest that the proposed system has potential for enhancing the mobility of individuals with physical disabilities.

The research described in [10] aims to develop a wheelchair that can be controlled through hand gestures, specifically designed for individuals with physical disabilities. The wheelchair system comprises a control unit responsible for both movement and wheelchair functions, which can be operated using quick hand movements, a joystick, or other hand gestures. Hand motion detection is achieved through the utilization of an accelerometer sensor, with the collected data being processed by an atmega328p controller to determine the wheelchair's direction. Additionally, the system incorporates an ultrasonic sensor to enable obstacle avoidance and includes a single switch for sending emergency SMS alerts to family members. The proposed wheelchair demonstrates potential applicability in a range of settings, including hospitals, schools, and airports. The research paper also suggests future enhancements, such as incorporating diverse body gestures and voice monitoring to further enhance the wheelchair's effectiveness.

The primary focus is on an electric wheelchair that incorporates the use of an ADXL335 Accelerometer sensor, which is connected to an Arduino microcontroller [11]. By detecting the patient's head movements in various directions, the Accelerometer sensor captures these movements and transmits the signal to the Arduino. Subsequently, the Arduino generates a voltage output to the H-Bridge Relay Driver, responsible for controlling the DC motor that propels the wheelchair forward, backward, left, or right. To ensure the patient's safety, an ultrasound-based safety system is positioned at the rear of the wheelchair. To evaluate the system's effectiveness, it underwent 25 tests, resulting in an accuracy rate of 88% for forward movement, 84% for right turns, 88% for left turns, and 92% for reversing.

Hand gesture-based wheelchair system for physically handicapped individuals. The system [12] uses an ADXL335 accelerometer and LM324 operational amplifier for detecting and converting hand motions into corresponding wheelchair movements. Radio frequency transmission and an encoder IC HT12E eliminate interference and noise. The system is controlled by an Arduino Uno and L293D IC to move the wheelchair. The ADXL335 accelerometer is calibrated to monitor wheel rotation, and comparators display accurate angles. Users control the wheelchair by performing hand gestures and can stop or switch off the system by returning their hand to a stable position or moving beyond the detection field.

A novel wheelchair design [13] has been developed to assist individuals with disabilities. Unlike traditional manual wheelchairs that require physical strength, this battery-powered wheelchair incorporates an Arduino microcontroller for seamless operation. The system consists of two main components: a sending end and a receiving end. The sending end captures the user's hand gestures using an MPU-6050 gyro accelerometer sensor. These recorded instructions are then wirelessly transmitted to the receiver end through an RF transmitter-

nRF24101 and another Arduino microcontroller. At the receiving end, an nRF module receives the signal and translates it into wheelchair movement on a flat surface. Moreover, the wheelchair is equipped with a Bluetooth module, enabling control via a smartphone application.
The device [14] which aims to provide users with greater freedom and independence while also reducing the need for therapist intervention. This is achieved through the development of a smart wheelchair that utilizes an eye-controlled system for mobility control and an ultrasonic system for automatic object detection. The project also includes features such as collision avoidance, risk management, and the ability to convert the wheelchair into a bed, reducing the need for caregiver or family assistance. The wheelchair incorporates various safety features that improve user safety and minimize potential risks faced in daily activities. These features consist of advanced components like automatic braking and object detection systems, aiding users in manoeuvring securely by detecting and avoiding obstacles such as stairs and uneven surfaces.

III. Methodology

Our proposed methodology focuses on developing a wheelchair control system for individuals with physical disabilities, based on hand gestures. The system incorporates various sensors such as accelerometers, gyroscopes, and MPU6050 to detect hand movements. For wireless data transmission, we utilize NodeMCU. Additionally, an automated braking system is integrated, which utilizes ultrasonic sensors to identify obstacles and initiate an automatic stop.

A. System Design

Accelerometer, gyroscopes, and MPU6050 sensors are employed to detect hand gestures. These sensors capture the movement and orientation of the user's hand, allowing for intuitive control of the wheelchair. Ultrasonic sensors are incorporated for obstacle detection [15]. These sensors emit ultrasonic waves and measure the time taken for the waves to bounce back, enabling the detection of nearby obstacles. Instead of the traditional joystick, the system utilizes a NodeMCU sensor for wireless data transmission. The NodeMCU enables seamless communication between the wheelchair and the user, facilitating intuitive control based on hand gestures.
The system incorporates wireless data transmission through the NodeMCU sensor. This enables real-time communication between the wheelchair and external devices or services, such as an IoT-enabled emergency SMS warning system. In case of emergencies, the system can send SMS warnings to designated contacts, providing an additional layer of safety for the user [16]. The system has been developed with a focus on ensuring ease of use and a seamless user experience. By utilizing hand gestures for control, the system eliminates the complexity associated with traditional joystick-based controls, offering a more natural and intuitive means of wheelchair operation.

TABLE I. Components And Input Voltage Supplied

Components	Input Voltage
Motors	12 V
NodeMCU	5 V
MPU6050	2.3 V

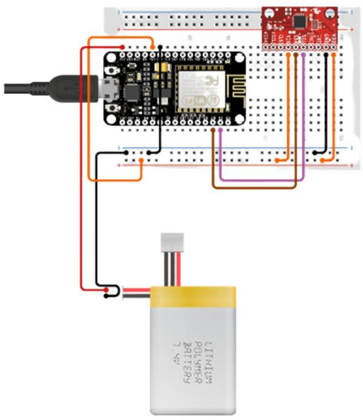

Fig. 2 Circuit diagram of hand gesture Transmitter

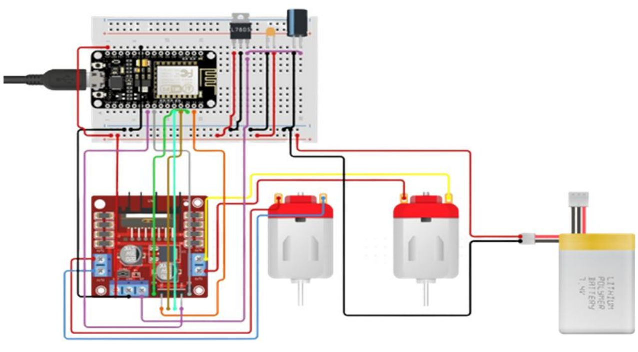

Fig 3 Circuit diagram of wheelchair Receiver

B. Prototype Development

Careful consideration was given to selecting the appropriate components for the system. Accelerometers, gyroscopes, and MPU6050 sensors were chosen to detect hand gestures accurately. These sensors were capable of capturing the necessary movement and orientation data. Ultrasonic sensors were selected for obstacle detection, as they provided reliable and precise distance measurements to identify nearby obstacles effectively [17]. The chosen components, including the sensors and Node MCU microcontroller, were integrated into a physical prototype. The sensors were connected to the microcontroller, allowing for data acquisition and processing. Proper wiring and connections were established to ensure seamless communication between the components.

The software development phase involved designing algorithms and coding to interpret the data captured by the sensors. This included processing the hand gestures detected by the accelerometer, gyroscope, and MPU6050 sensors. Programming was implemented to enable the wireless data transmission functionality of the Node MCU microcontroller. This facilitated communication between the wheelchair and the user, ensuring smooth and responsive control based on hand gestures [25].

The developed prototype underwent rigorous testing to assess its functionality, accuracy, and reliability. Various scenarios were simulated to evaluate the performance of the hand gesture control, obstacle detection, and safety features. Based on the testing results, necessary refinements and adjustments were made to optimize the system's performance and ensure its effectiveness in real-world scenarios [26].

C. Testing

Hand gesture control was tested to verify the system's ability to accurately detect and interpret various hand movements. Different gestures, such as forward, backward, left, and right, were performed to assess the responsiveness and accuracy of the control mechanism [18]. Testers with different levels of mobility impairment participated in the testing to ensure the system's effectiveness across a range of user capabilities.

The obstacle detection feature was evaluated to determine its ability to identify and respond to obstacles in the wheelchair's path. Various objects of different sizes and shapes were placed in the wheelchair's trajectory during the testing [19]. The system's response in terms of timely obstacle detection and triggering of the automated braking system was assessed to ensure user safety.

The wireless data transmission functionality provided by the NodeMCU microcontroller was tested to assess the reliability and responsiveness of communication between the wheelchair and the user [20]. Test scenarios involved testing the range of wireless communication, data transmission speed, and the ability to maintain a consistent connection between the wheelchair and external devices.

User experience testing was conducted to evaluate the overall usability and intuitiveness of the system. Testers provided feedback on the ease of use, comfort, and general satisfaction with the hand gesture control and overall wheelchair performance [21]. Suggestions and feedback from users were collected to further refine the system and address any usability or accessibility issues.

D. Data Analysis

The data captured during the hand gesture control testing was analyzed to evaluate the system's ability to accurately detect and interpret different hand movements. Key metrics such as response time, gesture recognition accuracy, and consistency were calculated and compared against predetermined benchmarks or requirements. Statistical analysis techniques were applied to identify any patterns or correlations between specific hand gestures and the corresponding wheelchair movements [22]. Overall, the proposed methodology aims to provide physically disabled individuals with an improved means of mobility and safety. The integration of sensors and an automated braking system provides a more efficient and safe means of controlling the wheelchair, enabling individuals with limited mobility to move around more easily and confidently [27].

The data obtained from the obstacle detection testing was analyzed to assess the system's effectiveness in identifying and responding to obstacles. The accuracy of obstacle detection, including the distance measurement and recognition of obstacles, was evaluated [23]. The response time of the automated braking system when obstacles were detected was analyzed to ensure timely and appropriate braking. The data collected during the wireless data transmission testing was analyzed to evaluate the reliability and responsiveness of communication between the wheelchair and the user. The data transmission speed and consistency were assessed to determine the system's capability to maintain a seamless connection [28]. The range of wireless communication was analyzed to identify any limitations or areas where signal strength may have degraded [24].

The feedback and input collected from user experience testing were analyzed to gain insights into the usability and satisfaction of the smart wheelchair system. Common themes and patterns were identified from user feedback to identify areas for improvement and address any usability or accessibility concerns. Qualitative analysis techniques, such as thematic analysis, were applied to categorize and interpret the qualitative feedback provided by testers and users.

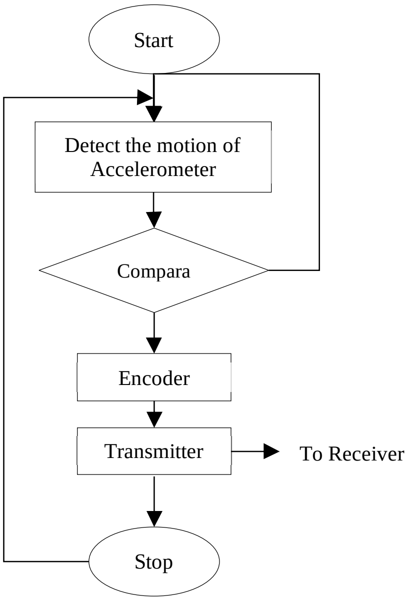

Fig. 4 Flowchart - Transmitter Process

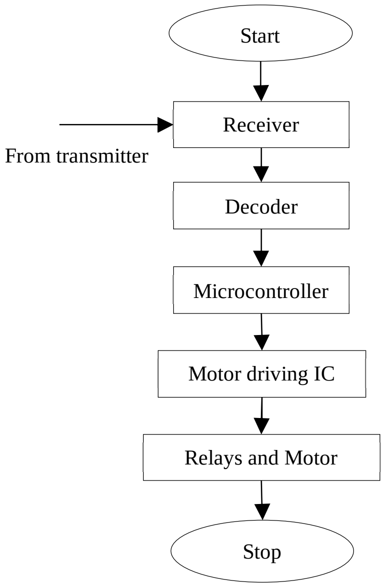

Fig. 5 Flowchart for Processing Signals

IV. Results

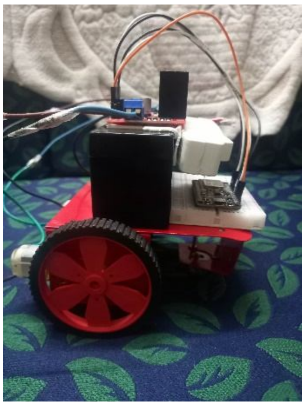

Fig. 6 Wheelchair – Receiver

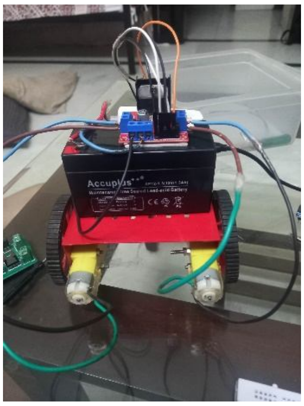

Fig. 7 Wheelchair with Motors

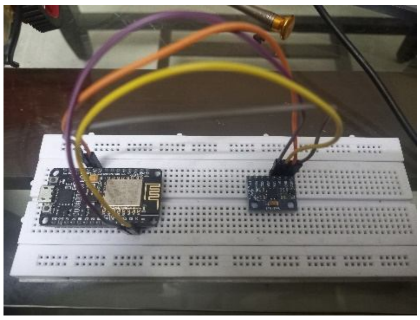

Fig. 8 Transmitter with MPU6050

V. Limitations

The smart wheelchair system discussed in this research study has several limitations. Firstly, the accuracy of gesture recognition using sensors like accelerometers and gyroscopes can be affected by user variability in hand movements and environmental factors. Additionally, individuals with severe hand impairments may struggle with executing precise gestures, and the integrated ultrasonic sensors may have limitations in detecting certain obstacles. Furthermore, the system's cost could hinder widespread adoption. Addressing these limitations through further research and development is crucial to improve gesture recognition accuracy, environmental robustness, accessibility for users with varying hand capabilities, obstacle detection, and cost-effectiveness, all of which should be considered when interpreting the study's findings and planning for the technology's future.

VI. Conclusion

This research study has introduced an intelligent and user-friendly smart wheelchair system that utilizes hand gestures for control. The integration of accelerometer, gyroscopes, MPU6050 sensors, Arduino, and Node MCU mi-controller enables precise detection and interpretation of hand movements, providing individuals with disabilities a more intuitive means of mobility. The successful testing and analysis have demonstrated the system's effectiveness in improving the quality of life for individuals with limited mobility.

While certain limitations need to be addressed, such as improving gesture recognition accuracy and considering environmental factors, the presented smart wheelchair system holds significant promise for further development and refinement. Future research endeavours should focus on overcoming these limitations and exploring additional safety features, such as incorporating IoT-enabled emergency SMS warnings, to enhance the system's reliability and accessibility.

In conclusion, the smart wheelchair system presented in this study represents a notable advancement in assistive technology. With its user-friendly design and intuitive control mechanism, it has the potential to empower individuals with disabilities, enabling them to navigate their surroundings with increased ease and independence. Continued research and development efforts will be crucial in optimizing the system's performance, addressing limitations, and ensuring its widespread adoption for the betterment of individuals with limited mobility.

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Voice Automated Smart Wheel-Chair

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***Abstract*— Being independent is crucial to surviving in today's environment. For persons with physical disabilities, this is regrettably not feasible. They require help to move about freely and are reliant on it continuously. These individuals benefit from the suggested system since it enables them to handle their everyday tasks on their own. This system makes use of an embedded Wi-Fi module in the ESP32 microcontroller. This eliminates the need for any help by allowing the user to maneuver the wheelchair using voice instructions through an app. Also, while the wheelchair is in use, the user's gadget, such as a smartphone, tablet, etc., may be charged.**

***Index Terms*— Physically disabled, Wheelchair, ESP-32, Voice-command.**

I. Introduction

It is estimated that 1.3 billion people, or roughly 16% of the world's population, are severely disabled. One in six people worldwide have serious disabilities. Additionally, the accessibility of transit facilities for people with disabilities is 15 times worse than it is for people without disabilities [1]. To solve this transit problem and reduce these people's dependence on help, a wheelchair is necessary. In developing countries like India, less than 10% of the populace has access to wheelchairs. More and more people find themselves having to utilise wheelchairs. A further 154 wheelchairs are required globally every hour of every day [2]. In order to handle the everyday transportation issue and meet the demand for cutting-edge features in a wheelchair, the suggested system has been developed using an ESP32 microcontroller to control and monitor the readings provided by numerous integrated sensors. ESP32, a line of reasonably priced, low-power microcontrollers with dual mode and integrated Wi-Fi. In order to collect data from the environment, warn the user when an obstruction is encountered, and operate the wheelchair using voice commands, Bluetooth [3] and ultrasonic sensors are used. Not all people with disabilities can move the chair manually; some may find it difficult because of their weaker limbs. The suggested system has a speech recognition component for voice commands to operate the device. Speech recognition technology is included into the "Dabble" software to ensure flawless operation, making it easier and more efficient for the user to provide voice instructions. The user of this software has the choice of speaking commands into the app or typing them in, in which case the chair will act as directed. The proposed technology adds a feature to the standard automatic wheelchairs that are currently on the market. Using two DC motors, a motor driver, and the chair, these components control its movement. The chair's wheels have dynamos installed. The wheels are connected to a generator to produce electricity, which is produced as the wheels spin. Because of this, the user is able to charge any rechargeable item, including mobile phones.

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II. LITERATURE REVIEW

These authors' works on the voice-controlled wheelchair are listed below: [1] In the ResearchGate article IoT based smart wheel chair for disabled people, we discuss a low-cost Smart Wheelchair based on Arduino Nano microcontroller and Internet of Things (IoT) technology that has a number of features to help disabled people, especially poor people who cannot afford an expensive Smart Wheelchair, get the assistance they need to complete daily tasks without assistance. This effort will enable more people with disabilities to use smart wheelchairs. The wheelchair control system will be powered by an Arduino Nano, an ESP-12e Wi-Fi module, an MPU6050 fall detection system with voice message warning using the IFTTT platform, an obstacle detection system with a buzzer and LED to function as threats, a speech recognition system and joysticks. [2] The purpose of this article, which was published by IJSDR, is to design and build an AI-powered smart wheelchair that can be controlled by voice commands and a virtual joystick. The newly created wheelchair is incredibly user-friendly and does not have a computer system to control it. As a result, it is easy to understand and process. The wheelchair can move in response to human orders thanks to two parts. If a patient is unable to move their hands, voice commands can be used to independently move the wheelchair. A phone that has been mounted to the wheelchair can be used to issue voice commands. The system offers various clever amenities and autonomous movement to the growing impaired population. [3] Voice controlled wheel chair for physically disabled people, Published by IJRASET, in this research, speech recognition is used to operate wheelchairs. It takes user input orders and moves the wheelchair using a speech recognition module that is connected to motors. Moreover, the proposed system includes a wheelchair control interface for an Android smartphone app. DC motor and an Arduino microcontroller circuit are utilized to propel the wheelchair, while IR sensors are employed to detect any obstructions in the path of travel. [4] Voice controlled smart wheel chair, Published by Journal of management information and decision science, The model demonstrated how simple a voice-controlled system like the wheelchair is. It illustrates how control elements may be achieved without the need of additional control devices like joysticks or catches. The devices may be endlessly automated by enhancing voice collection and triggering more commands. [5] Smart wheel chair, published by Peertechz, Finding the wheelchair system's speed is crucial. The distance and time are measured for velocity while the wheelchair is handled by speech. Two criteria need to be checked to determine the wheelchair's velocity. The speed is initially assessed in an empty state. A speed of 0.8 m/s is noted for the wheelchair, which is intended to move straight ahead. Second, a 15 kg weight was permitted to be carried by the wheelchair, and a velocity of 0.76 m/s was measured. Finally, a 78 kg guy sat down in the wheelchair. In order to do this, the voice-activated wheelchair has to move straight ahead. [6] The actual implementation of the hardware, the software interfacing, and testing are all included in this attempt to design, integrate, code, interface, and test a fully powered, gesture-controlled wheelchair. It is a component of the design and implementation of a smart wheelchair with Internet of Things (IoT) environment support. Research Square was the publisher of the article. The interactive cameras and sensors on this smart wheelchair are managed by a CPU unit that can handle the numerous duties it is designed to carry out. [7] "Artificial Intelligence Based Wireless Smart Wheelchair" is the title of an article that was published in the international publication of Emerging Technologies in Engineering Research (IJETER) publication. The major goal of this project was to develop an AI-powered, wireless smart wheelchair that could be moved by a patient's eye movements. The patient is seated just by staring directly at the camera, the wheel chair assembly may travel in three directions: left, right, and straight. Also, using ultrasonic sensors, the wheelchair will be able to recognize any obstructions or hurdles in its path. MATLAB programming is used to monitor the real-time camera signals. This study describes the creation, development, and application of an eye-controlled wireless wheelchair that is dependable in terms of practicality and has a straightforward design. [8] The CSE department published a paper on a voice-controlled chair. Power wheelchairs usually meet the needs of individuals with disabilities, however for certain people with impairments, using a standard power wheelchair is difficult or impossible. Assistive technology may be used in this project. It's to help people live more independently, productively, and happily. The project's background, objectives, issue descriptions, and scopes will all be covered in this chapter. [9] Voice controlled wheel chair, published by international journal of pure and applied mathematics, A voice recognition method for controlling the mobility wheelchair robot was created. The core acoustic modeling was completed using the HMM method, and more than three commands are built into the linguist database to increase or decrease the likelihood that the output words will occur. These improvements in accuracy are made possible by reading previously recognized words from the buffer. This system enables some people to live lives that are less dependent on others. [10] creating a voice-activated wheelchair for users who speak Persian In this study, They exhibited a voice-activated wheelchair for Persian speakers that was based on deep neural networks, and their work was published by a science publishing business under the heading The phrase "Using Deep Learning Networks with a Small Dataset." It has been discovered that deep learning works well for categorizing photos. They used one of the most cutting-edge deep networks, Inception-V3, to perform the categorization after converting the audio recordings to visuals. They constructed the database by capturing the voices of 15 men and 35 women because there was no existing database for Persian speakers. The performance of two algorithms, Incp-kSVM-RBF and Incp-SVM, is superior to other methods. The outcomes of the experiments show how effective their algorithm is. [11] IJSTE's voice-activated smart wheelchair for the disabled utilizing Android - International Journal of Science Technology & Engineering, this article will discuss an intelligent voice-activated motorized wheelchair for the disabled. Their objective is to gradually enable people with motor disabilities to use commonplace things. Simple speech commands may be used with a voice controller to operate it. a voice recognition program that connects to motors through a microcontroller. The Hidden Markov Model algorithm is being used (HMM). Based on the Embedded C system, this research proposes a novel approach for incorporating intelligence into a low-cost smart wheelchair. [12] IOT based smart wheel chair, published by Dogo Rangsang Research Journal, in particular, this project relates to the IOT system managing wheelchairs. It is advised to use the wheelchair System to operate a wheelchair online. The goal of this initiative is to make it easier for elderly persons who have trouble moving about and disabled or handicapped people to move around. As a result of this design, the exceptional individuals will be able to live a life with less need for other people. A new method of interacting between people and tools or machines may be possible with the use of IOT technologies. So, their problem might be remedied by using IOT to regulate the movement of a wheelchair. A power wheelchair that has several sensors, assistive technologies, and computers built into it is referred to as a "Smart Wheelchair". These features give the user with a disability, such as an impairment, a handicap, or a permanent injury, the mobility they need to move around freely and safely. [13] According to research published in the International Journal of Engineering and Advanced Technology (IJEAT), the autonomous wheelchair uses gesture recognition. Taking this action One acceleration sensor outputs two, which is the primary functioning principle of an autonomous wheelchair. Using a simple formula, we can calculate the amount of tilt and decide which direction to travel in response to tilt. Axis and acceleration sensors have outputs that vary depending on the acceleration applied to them. Sensor provides independent x- and y-axis outputs, which are supplied to the ADC and subsequently to the C, which determines whether or not to move based on the pulse width. Obstacle sensors will be fitted on the chair. There will be a total of 4 sensors fitted to detect walls and other obstructions in the forward, backward, left, and right directions. They are attempting to create a wheelchair that can be operated; the system will comprehend and carry out plain language motion directions like "Take a right." Such a system is created using several technologies. [14] The primary goal of this research is to construct a smart wheelchair whose movements are managed by an Android software that can recognize gestures. The International Journal for Research in Engineering Application & Management (IJREAM) published it. For those who are physically handicapped, this wheelchair is helpful. This Android program; Bluetooth is used to establish the connection after being developed and installed on the smartphone. There are three different ways the wheelchair may move: touch, speech, and accelerometer based. While in touch mode, the user must select the desired direction from one of the four quadrants on the touch screen of the smartphone in order to change direction. In the second mode, the user only needs to speak his desired direction, such as left, right, up, or down. The third mode, which uses an accelerometer, allows the smartphone to travel in a certain direction by tilting it up, down, left, or right. The wheelchair has IR sensors attached on it to look for obstructions in its route; if any are found, the wheelchair stops. [15] IJLTEMAS, the International Journal of Latest Technology in Engineering, Management, and Applied Science, published an article on an intelligent voice-activated wheelchair. A voice-controlled wheelchair is a portable wheelchair that can be maneuvered using spoken commands. The five voice commands "Run," "Stop," "Left," "Right," and "Back" can be recognized by speech recognition software on a computer when they are pronounced by a certain User. In order to control the wheelchair, this gadget reads the patient's settings.

III. METHODOLOGY

In this paper we have implemented (made) a voice-controlled car using ESP32 module, which has an inbuilt Bluetooth module. We have used a free dabble app to send voice commands to control the car or Bluetooth. This car can be controlled using an android as-well-as iPhone.
The components we used are: 2WD (wheel drive) car kit for this project. This kit comes with car-chassis, 2 gear motors, wheels connector and screws. (Figure 1)

A. We have also used ESP-32 module

Espressif Systems created the robust system-on-chip (SoC) microcontroller module known as the ESP32. It is the popular ESP8266 module's replacement and offers greater features and capabilities. Two Tensilica Xtensa LX6

Processors with a maximum clock frequency of 240 MHz, The ESP32 module comes with 4MB of flash memory and a total of 448 KB of RAM. The ESP32's built-in Bluetooth and Wi-Fi modules make it a great option for Internet of Things (IoT) applications. It is suited for a number of applications, including robotics, home automation, and industrial automation, and includes a wide range of peripheral interfaces, including SPI, I2C, UART, ADC, DAC, and more. Because of its low cost, adaptability, and good performance, the ESP32 module is frequently used in DIY electronics projects and is growing in popularity. (Figure 2)

B. L29 Motor driver module

An electronic circuit board called the I29 Motor driver module is used to regulate the direction and speed of tiny DC motors. To regulate the motion of wheels or other mechanical components, it is frequently used in robotics and do-it yourself projects. The module typically comprises an H bridge circuit that, depending on the input signal, enables the current to flow through the motor in either direction. It normally contains a power supply input, two input pins for regulating the motor's speed, and one input pin for controlling the motor's orientation. Programming motors using C++ and Python is simple thanks to the I29 motor driver module's compatibility with many microcontrollers, including Arduino and Raspberry Pi. Overall, engineers and hobbyists who need to control the motion of DC motors in their projects will find the I29 motor driver module to be a helpful and adaptable tool. 15v DC battery, Double sided tape and few jumper wires. (Figure 3)

C. ESP32

The ESP32 is a low-cost, low-power microcontroller that includes Bluetooth and Wi-Fi. (Figure 4)

D. Motor driver L293D IC

It is the most popular way to use a computer to operate several DC Motors bi-directionally. The figure below shows an H-Bridge motor driver as an example. Two tiny motors can be controlled simultaneously and, in both directions, using the L293D circuit motor driver. It is capable of driving two DC motors simultaneously in both forward and backward motion. Pins 2 and 7 and pins 10 and 15 are, respectively, the input logic inputs for this operation.

Figure *1. 2WD Kit*

Figure *2. ESP32 Module*

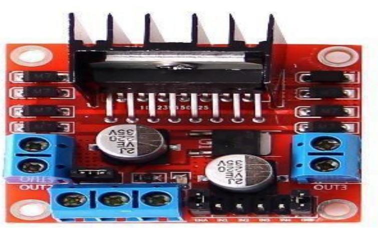

Figure *3. L29 Motor Driver Module*

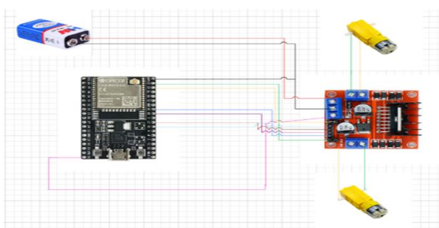

Figure *4. Circuit Diagram*

E. DC Motors

It is a basic motor that generates revolutions using power from a battery and a magnetic field. It consists of two opposite-polarity magnets and a coil that functions as an electromagnet. The magnets' electromagnetic forces of attraction and repulsion supply the torque needed to turn the DC motor. They are utilized as wheelchair wheels.

ESP is a single 40 nm TSMC power chip that combines 2.4GHz Wi-Fi and Bluetooth functionality. ESP32 is a line of inexpensive, low-power systems on a chip microcontroller that include built-in dual-mode Bluetooth and Wi-Fi.

F. Assembly

Firstly, we have assembled the car; we have soldered wires to gear motors to mount all gear motors on car chassis using connector and screw. Then we have attached the car-chassis plate using screws and we have made sure that it is tightened properly, so that we don't have any loose parts. Then we have joined red to red and black to black wires of DC-Motors on each side. Attach I298 and motor driver module on car chassis using double-sided tape.
We have connected the right side motor to the 1 and out 2 pins of the I298 motor driver module, then we have connected the left side motors to the 3 and out 4 pins of the motor driver modules. Then attached DC-battery power connectors to the motor driver module plus a 12-volt pin and Ground (GND) pin. Then we fixed the ESP-32 module on car-chass, using double sided tape. Now we have connected the I298 motor driver module to ESP32 pins. As per Table below.
We have taken plus 5 volts and Ground (GND) from I298 and the motor driver module and provided two ESP32 modules through 5volt and GND pins. After that, we attached the wheels to the car.
Coding Part: Firstly, we have installed ESP32 board using Arduino-Board manager for that, we have to go to file preferences and add ESP32 board link:
https://dl.espressif.com/dl/package_esp32_index.json
then select Tools, Board Manager, then look for and install ESP32.

TABLE I. PINS CONNECTION

ESP32 Pins	L298N Driver Pins	ESP32 Pins	L298N Driver Pins
IO22	enA	IO18	IN3
IO16	IN1	IO19	IN4
1017	IN2	IO23	enB

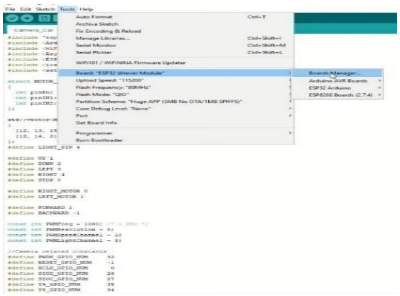

Figure 5. *Coding part 1*

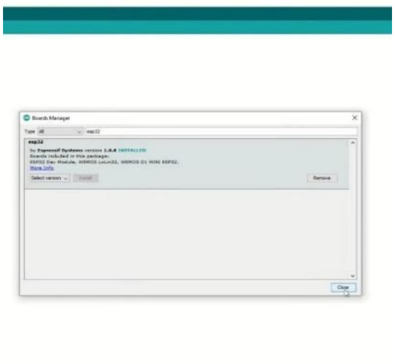

Figure 6. Coding part 2

Then we have installed the Dabble ESP32 library as well. For that, select Tools, Manage Libraries, then Search for and Install Dabble ESP32.

Now we have defined custom settings and included the terminal module, then we need to include the Dabble ESP32 library. We have designed the default motor speed as 200. We have also defined turning speed as 150, whose maximum value can be 255. Now we have assigned the right and left motor pins. We have set the PWM frequency resolution and channel for speed control. We also have created a variable to store the current speed of the car, we can change the car speed using voice commands. We have a car direction variable for the current direction. We have created a control with a voice function to control the car; inside this function, we will read the command sent for the mobile app over Bluetooth. We will read the command using the “dot read string” function, if the received command is forward, then it moves the car in forward direction by rotating both motors that too in forward direction. Similarly, if the command is received in reverse or backward direction then the other side motor moves in reverse direction, which makes the right turn

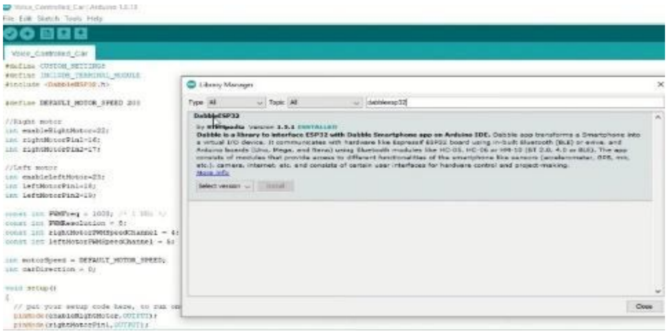

Figure 7. Coding part 3

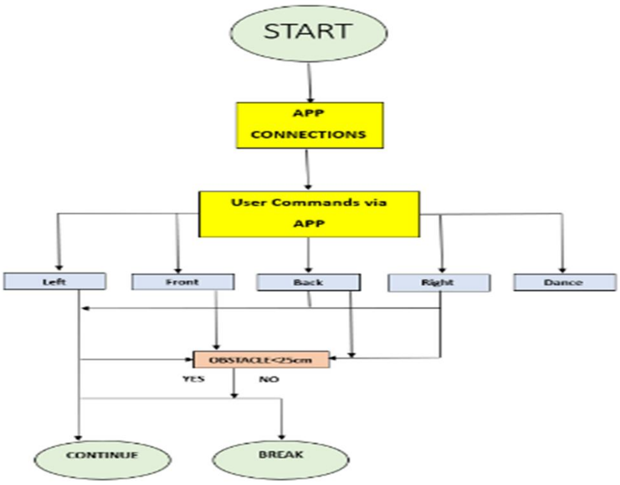

Figure 8. Flow Diagram

If the received command is left or states to turn in the left direction the car would rotate to the left. These commands are quick turn commands as, if the commands are rotated right or left, it will keep the car rotating continuously, unless and until the ‘stopped’ command is not given. If the command given is speed, the speed of the car is being set wherein the value of the speed of the car should be numerical. We can also make our car dance by giving a dance command. We have also created a rotate motor function which rotates the motor in a particular direction with particular speed given. Also, we have created a setup pin mode function to set up motor pins as output. It even sets the PWM channel for the speed control which initially stops all the motors inside. Then inside the loop function we need to call the dabble dot function to process the data, which is, it processes the input to receive the data. After these steps, we need to call control the voice function which controls the car.upload the code.

Now we connected the esp32 module to the laptop using a USB cable. then we select the esp32 Dev module and port. then hit upload. Now we connect the battery to the car.

At last, we need to download the dabble app for further use for commands. we need to go to the terminal module, connect it to our esp32 Bluetooth module which will be displayed as ‘my voice card’ in the Bluetooth device list. Now we can use this app to give voice commands.

The user must first integrate the model via the Dabble App before running in a wheelchair. The user will now be able to use their app to connect to the Bluetooth device with the name "MyVoiceCar" because we introduced the library DabbleESP32.h to the Arduino IDE. So, we can effectively connect our model with the app by adding Dabble.begin. The user will be able to send orders through the app, such as forward, backward, left, or right, after a successful connection. Wheels will rotate in accordance with the code, causing these orders to be carried out. If the wheelchair senses an obstruction less than 25 cm (9.84 in) away, it will halt automatically; otherwise, it will carry out the user's commands.

IV. RESULTS & DISCUSSION

The automated wheelchair system described provides users with a number of cutting-edge features and advantages. Since voice control is the foundation of its functioning, those with mobility issues can use it easily. Users may easily control the wheelchair's motions by speaking orders, which can substantially increase their independence and ease of movement. An ultrasonic sensor must be included as a vital safety element. The wheelchair is able to recognise obstacles in its route and, when spotting one, temporarily pauses to assess the situation and choose the best course of action for dodging the obstacle. The probability of crashes is greatly decreased and user safety is improved by this real-time obstacle identification and avoidance technique. By utilizing the Bluetooth capabilities of the ESP32 Microcontroller, the integration of the Dabble app provides users with a handy way to manage the wheelchair. Through the software, users can communicate with the wheelchair in a variety of ways by pressing buttons on the screen. Additionally, the system provides five instructions that let users carry out a variety of tasks, including moving ahead, carrying out prepared dance routines, turning right or left, and moving backward. These commands give users the flexibility to maneuver their wheelchair and modify it for various scenarios. The wheelchair's capacity to create power while in use is one of its unique features. The wheelchair can recharge its battery by using a dynamo to convert the wheel revolution into power. The wheelchair's operational range is increased thanks to this sustainable energy generation, which is also in line with environmental ideals. The electricity produced can also be used to recharge other electronic gadgets. The ability to recharge cell phones, tablets, and other necessary devices while using the wheelchair makes this function highly useful. Users are guaranteed constant access to their gadgets and connectivity throughout the day.

V. CONCLUSION

The suggested system's core component, the voice command, turns mobility for a physically impaired person into an autonomous endeavor and does away with the need for any type of outside support. By allowing the user to input voice commands to the ESP32 Microcontroller, which in turn controls the wheelchair, the "Dabble" app totally automates the procedure. Thus, the suggested solution is a voice-controlled wheelchair that also has a charging capability for mobile devices. The suggested approach introduces a fresh model to the already known automated wheelchair designs.

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Revolutionizing Shopping Experience: Smart Carts and Shelves

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***Abstract*— Efficient inventory management is essential for businesses to optimize their supply chain, reduce costs, and enhance operational efficiency. At the same time due to manual scanning at the checkout processes, customers have to wait for a long time in the queue. As a solution to these different problems, we have proposed a system using IoT. This research paper presents a novel approach to inventory management by integrating two cutting-edge technologies: Load Cell Sensor HX711 and Smart Cart System using Radio Frequency Identification (RFID) technology. By combining the capabilities of these technologies, the paper aims to automate inventory tracking, monitoring, and replenishment, providing real-time data for accurate inventory control and decision-making. The Smart Cart System enhances the customer satisfaction while the Smart Shelves increase efficiency of inventory management by automating the data capture process. It provides convenience by eliminating the need for manual scanning or checkout processes, and generating bill on webpage allowing customers to simply place items in the cart and proceed with their shopping. Also we present the machine learning aspect of our project aimed at revolutionizing the shopping experience using RFID technology and load cells. We explore the implementation of three prominent algorithms - Linear Regression, Random Forest, and XG Boost - to predict future sales.**

***Index Terms*— Smart shopping, smart cart, machine learning**

I. INTRODUCTION

Efficient inventory management is a critical aspect of successful businesses across various industries. It directly impacts operational efficiency, customer satisfaction, and profitability. Traditional inventory management methods often involve manual processes, which are time-consuming, prone to errors, and lack real-time visibility. As a result, businesses face challenges in accurately tracking inventory, preventing stockouts, optimizing replenishment, and enhancing overall operational efficiency. At the same time, the traditional shopping experience often involves manually selecting items, queuing up for checkout, and managing shopping carts laden with products. This process can be time-consuming, cumbersome, and prone to errors.
To address these challenges, this research project proposes a system by integration of two cutting-edge technologies: Load Cell Sensor HX711 and Smart Cart System using Radio Frequency Identification (RFID) technology. The combination of these technologies offers a comprehensive solution for automating and improving inventory management processes.

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In this system, IoT-enabled devices such as smart carts and shelves are equipped with RFID tags that communicate with readers and microcontrollers to track inventory levels and provide real-time data on product availability. This data is then analyzed using machine learning algorithms to optimize inventory management and reduce waste and also provides valuable insights into inventory levels, movement, and consumption patterns. Additionally, the use of microcontrollers enables retailers to automate processes such as checkout, payment, and restocking, leading to increased efficiency and reduced labor costs. This integration ensures accurate inventory counts, reduces manual errors, and provides insights into stock levels for proactive replenishment.

II. LITERATURE REVIEW

[1] The proposed idea involves providing customers with a trolley equipped with a barcode scanner and touch screen display, which can be used to scan products and display their information, cost, and the customer's total bill. Customers can then pay using digital payment methods like Paytm, UPI, Phone Pay, etc. This not only improves the customer experience but also reduces the need for human resources at billing counters. Such systems can also help in inventory tracking and personalized customer experiences, making them a transformative technology for the retail industry. [2] The retail industry faces the challenge of recovering shopping carts and arranging them in large supermarkets and shopping malls. This process requires significant financial and manpower resources and has low recovery efficiency. To address this challenge, an improvised algorithm has been proposed to achieve collision-free recovery and self-driving carts. The algorithm is based on the Rapidly-exploring Random Tree (RRT) algorithm, which incorporates an artificial potential field and node selection range to improve tree growth. Experiments have shown that the improved algorithm has high obstacle avoidance, short search time, and strong real-time capabilities. This innovation has the potential to revolutionize the retail industry by reducing labour costs and increasing efficiency in cart recovery and management.

[3] In this research paper, the authors utilize RFID technology to analyze production data in an IoT-enabled smart job-shop. In manufacturing environments, production and transparency are crucial for efficient operations. However, the increasing amount of production data can be difficult to use due to its discreteness and lack of correlation. To address this challenge, the authors develop an RFID-based production data model that formalizes and correlates the heterogeneous production data. By attaching RFID tags to Work in Progress (WIPs), the authors are able to create smart WIPs that aid in process command execution. This research has the potential to improve production efficiency and reduce errors in manufacturing environments.

[4] The research paper proposes an interactive shopping model that incorporates IoT and cloud computing to facilitate efficient access, ordering, and monitoring of products. The system aims to create an interactive shopping ecosystem that eliminates the need for customers to waste time searching for specific products. Instead, the system acts as a guide for the customers, providing them with a seamless shopping experience. By leveraging IoT and cloud computing, the system can enhance product inventory management and provide valuable data insights for retailers. Overall, the proposed system has the potential to revolutionize the retail industry and elevate the shopping experience for customers

[5 The literature review conducted by M. A. Al-Fuqaha et al. explores the potential benefits and challenges of smart retail systems using IoT and RFID technologies, including smart shelves. The authors highlight the potential of these technologies to revolutionize the retail industry by improving inventory management, enhancing the shopping experience, and providing valuable data insights. The study identifies challenges such as high installation and maintenance costs, cybersecurity concerns, and potential technical malfunctions that must be addressed to fully realize the benefits of these technologies. The authors also discuss potential solutions and future research directions to advance the application of IoT and RFID technologies in smart retail systems. [6] This paper provides an overview of IoT-based smart shelf systems for retail stores. The authors review various aspects of smart shelves, including design considerations, components, and implementation challenges. The paper also presents a case study of a smart shelf system developed by Intel, which uses RFID tags and sensors to manage inventory and monitor product expiration dates. [7] This paper provides a comprehensive review of smart shelf technologies for retail applications. The authors review various types of sensors, IoT devices, and data analytics tools used in smart shelves, and discuss their advantages and limitations. They also analyse the key features and benefits of smart shelves, such as inventory management, product tracking, and customer behaviour analysis. The paper concludes with a discussion of the challenges and opportunities in the field, and proposes future research directions.

[8] This paper presents a review of smart retail shelf systems, focusing on the integration of RFID tags, sensors, and IoT devices. The authors review various design considerations, such as the placement and orientation of the sensors and the communication protocols used in the system. They also discuss the advantages and limitations of smart retail shelf systems, such as improved inventory management, reduced waste, and enhanced customer

experience. The paper concludes with a discussion of future research directions in the field, such as the integration of AI and machine learning algorithms in smart shelves. [9] This paper provides a review of smart retail shelves, focusing on their potential applications and benefits in the retail industry. The authors review various features and components of smart shelves, such as RFID tags, sensors, and IoT devices, and discuss their advantages and limitations. They also analyze the potential benefits of smart shelves, such as improved inventory management, reduced labor costs, and enhanced customer experience. The paper concludes with a discussion of future research directions in the field, such as the development of real-time inventory management systems and the integration of predictive analytics tools in smart shelves. [10] This paper provides a comprehensive review of smart retail shelf systems, focusing on their design and implementation using IoT technologies. The authors review various components and technologies used in smart shelves, such as RFID tags, sensors, and IoT devices, and discuss their integration into a coherent system. They also analyze the potential benefits of smart retail shelf systems, such as improved inventory management, reduced waste, and enhanced customer experience. The paper concludes with a discussion of future research directions in the field, such as the development of advanced analytics tools and the integration of machine learning algorithms for predictive analytics in smart shelves.

III. METHODOLOGY

The proposed system in this project is an integrated smart retail system that combines Smart Cart and Smart Shelves using IoT technology. The system aims to revolutionize the traditional retail experience by leveraging IoT capabilities to streamline inventory management, enhance customer experience, and optimize operational efficiency. The Smart Cart is equipped with IoT sensors, such as RFID sensors to enable automatic item detection and tracking. As customers place items in the cart, the RFID tags attached to the products are scanned, and the bill is updated in real-time on the webpage. The following steps are followed to implement the system.

A. Hardware Setup

Install an RFID reader module on the Smart Cart to enable automatic item detection. Ensure proper wiring and connectivity between the RFID reader and the microcontroller or processing unit of the cart. Test the hardware components for functionality and compatibility.

B. RFID Tag Integration

Attach RFID tags to each product or item to be used with the Smart Cart system. Encode the RFID tags with unique identification numbers corresponding to each product. Link these identification numbers to their respective prices and other relevant information in the database.

C. Web-Based Billing System

Develop a web-based billing system that receives the transmitted product information from the Smart Cart. Implement the necessary backend functionalities to generate the bill based on the received data. Ensure that the web page is user-friendly and provides accurate and real-time billing information.

D. Testing and Validation

Test the Smart Cart system in a controlled environment. Verify the accuracy of RFID tag detection, data capture, and data transmission. Perform thorough testing of the web-based billing system to ensure correct bill generation based on the received product information.

E. Data Analysis and Optimization

Analyze the collected data and feedback to evaluate the performance of the Smart Cart system. Measure metrics such as RFID tag detection accuracy, bill generation speed, and user satisfaction. Identify areas for optimization and refinement based on the analysis.

F. Iterative Refinement and Documentation

Based on the analysis and user feedback, make necessary refinements and improvements to the Smart Cart system and the web-based billing system

Smart shelves using load cell sensors are an innovative solution that leverages the power of IoT and weight measurement technology to provide real-time inventory tracking and management. By integrating load cell sensors into the shelves, these intelligent systems can accurately monitor the weight of items placed on them. This enables automated inventory updates, precise stock level tracking, and timely replenishment notifications. Determine the desired functionalities, such as accurate weight measurement, real-time inventory tracking, and compatibility with the overall IoT infrastructure.

G. Load Cell Selection

Research and select suitable load cells based on the requirements of the smart shelves system. Consider factors such as weight capacity, precision, and compatibility with the HX711 amplifier. Ensure the load cells are appropriate for the expected product weights and dimensions.

H. HX711 Amplifier Integration

Connect the load cells to the HX711 amplifier. Follow the manufacturer's guidelines and datasheet to ensure correct wiring and proper electrical connections. Calibrate the HX711 amplifier to achieve accurate weight measurements.

I. Shelf Design and Construction

Design and construct the shelves to accommodate the load cells and the items to be placed on them. Ensure that the shelves are sturdy and capable of withstanding the expected weight loads. Integrate the load cells into the shelves, providing proper support and alignment.

J. Load Cell Calibration

Calibrate the load cells to ensure accurate weight measurements. Use known weights or calibration masses to determine the calibration factors for each load cell. Follow the manufacturer's instructions for calibration procedures and take multiple readings to ensure accuracy.

K. Data Acquisition and Processing

Implement the software components necessary for data acquisition and processing. Connect the load cells to a microcontroller or processing unit capable of communicating with the IoT infrastructure. Develop algorithms to capture weight measurements from the load cells and process the data.

L. IoT Integration

Integrate the smart shelves system with the IoT infrastructure. Establish a communication link between the microcontroller or processing unit and the central database or backend system. Utilize wireless technologies like Wi-Fi or Bluetooth to transmit the weight data to the central server.

M. Real-Time Inventory Tracking

Develop software functionalities to enable real-time inventory tracking. Ensure that the weight data from the load cells is translated into accurate inventory information, such as item presence, quantity, and stock levels. Update the inventory database in real time based on the weight measurements.

N. User Interface and Visualization

Design a user interface to visualize the inventory information. Develop a web or mobile application that allows users to access the inventory data and monitor the stock levels on the smart shelves.

0. Testing and Validation

Test the functionality and performance of the smart shelves system in a controlled environment. Verify the accuracy of weight measurements, real-time inventory tracking, and data transmission. Conduct thorough testing to ensure the system meets the desired requirements.

P. Testing and Validation

Test the functionality and performance of the smart shelves system in a controlled environment. Verify the accuracy of weight measurements, real-time inventory tracking, and data transmission. Conduct thorough testing to ensure the system meets the desired requirements. By leveraging load cell sensors and IoT integration, smart shelves offer a transformative solution for retailers seeking to enhance their inventory management practices. The machine learning models in this project are employed to predict future sales using RFID technology, load cell data, and historical sales records. The specified approach involves the following steps:

Q. Data Collection

Relevant data is collected from various sources, including RFID sensors that track customer movement and interactions with products, load cells that measure changes in product weight, historical sales data to understand past buying patterns, product information, and customer demographics.

R. Data Preprocessing

The collected data undergoes preprocessing steps to clean and transform it into a suitable format for machine learning. This process involves handling missing values, outlier detection, and normalization or scaling of features.

S. Feature Engineering

Domain knowledge and insights are utilized to engineer meaningful features that have a strong impact on sales prediction. These features may include time-based patterns, product attributes, customer preferences, and seasonality effects.

T. Data Splitting

The dataset is divided into two parts: a training set and a validation set. The training set is used to train the machine learning models, while the validation set is used to evaluate their performance.

U. Model Selection

Three machine learning algorithms - Linear Regression, Random Forest, and XG Boost - are selected for the prediction task. These algorithms are chosen due to their suitability for regression problems and their varying complexities.

V. Hyper parameter Tuning

For each algorithm, hyperparameters are optimized to find the best combination that yields the most accurate predictions. This is typically done through techniques like grid search or random search.

W. Model Training

The selected algorithms are trained on the training set using the optimized hyperparameters. During training, the models learn patterns and relationships within the data to make accurate predictions.

X. Performance Evaluation

The trained models are evaluated on the validation set using performance metrics such as Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE). These metrics measure the difference between the actual sales and the predicted sales, allowing us to assess the models' accuracy.

Y. Results Analysis

The performance of each model is analyzed and compared to determine which algorithm performs the best in predicting future sales. The results are used to draw insights into the effectiveness of the machine learning approach for sales prediction in the context of the project.

Z. Interpretation and Application

The insights gained from the best-performing model, most likely XG Boost, are applied to optimize inventory management, product placement, and personalized customer experiences. These predictions help retailers stay proactive in meeting customer demands and improving overall shopping experiences.

IV. WORKING

A.Smart_cart

The smart cart system using RFID and IoT with billing generation operates seamlessly by integrating hardware components, capturing and processing data, and generating web-based bills. As a customer place an RFID-tagged product into the smart cart, the RFID reader integrated into the cart detects the tag and captures its unique identification number. The captured identification number is wirelessly transmitted to the IoT infrastructure through communication technologies like Wi-Fi or Bluetooth. Within the IoT infrastructure, the identification number is processed to retrieve the corresponding product information from the database, including the item name, price, and stock availability. In real-time, the system calculates the total bill as the customer adds more items to the cart, retrieving the prices from the database based on their respective identification numbers.

The unwanted product removing process from the cart can be facilitated with the help of a 4-pin tactile switch. When the customer decides to remove an item, they press the tactile switch integrated into the smart cart system.

Once the tactile switch is activated, the smart cart system verifies the removal request by cross-referencing the activation with the product's RFID tag. This ensures that the correct item is being removed from the cart. Upon verification, the smart cart system updates the billing information in real-time. The system deducts the removed item's price from the accumulated bill, ensuring that the customer is not charged for unwanted items.

The calculated bill and item details are then transmitted from the smart cart to the web-based billing system, which generates the final bill based on the accumulated item prices. In the billing system of the smart cart, after the final bill is generated based on the accumulated item prices, additional functionalities are incorporated to facilitate a smooth and convenient checkout process.

B. Smart Shelves

Smart shelves using load cells and HX711 operate by integrating load cells within the shelves to measure the weight of the products placed on them. The load cells are connected to an HX711 amplifier, which amplifies the electrical signals produced by the load cells. These amplified signals are then processed by a microcontroller.

When a product is placed on a smart shelf, the load cell within that shelf detects the weight of the product and converts it into electrical signals. These signals are amplified by the HX711 amplifier and sent to the microcontroller or CPU for processing. The microcontroller applies calibration factors and performs necessary calculations to obtain the precise weight measurement of the product.

It provides visual representations, notifications, and alerts for low stock or restocking needs. Real-time monitoring and alerts are implemented through connectivity option like Wi-Fi allowing the system to generate notifications for low stock levels.

A user interface provides access to the smart shelf system, displaying the weight of each shelf, and inventory status, and generating reports or analytics based on the collected data. By employing load cells and HX711 amplifiers, smart shelves can accurately measure the weight of products placed on them. This enables efficient inventory management, minimizes stockouts, enhances theft prevention measures, and provides valuable data for analysis and decision-making in retail environments.

C. Machine Learning

For the machine learning component of our project, we focused on predicting future sales to enhance the shopping experience through RFID technology and load cells. Firstly, we collected relevant data from multiple sources, including RFID data, load cell readings, historical sales records, product information, and customer data. Next, we performed data preprocessing and feature engineering to prepare the dataset for training. Three machine learning algorithms were chosen for the prediction task: Linear Regression, Random Forest, and XG Boost. We divided the dataset into training and validation sets, and hyper parameter tuning was conducted for each algorithm. Performance evaluation was based on metrics such as Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE). The results offer valuable insights into future sales patterns, enabling improved inventory management and a more personalized shopping experience for customers.

V. Results And Discussion

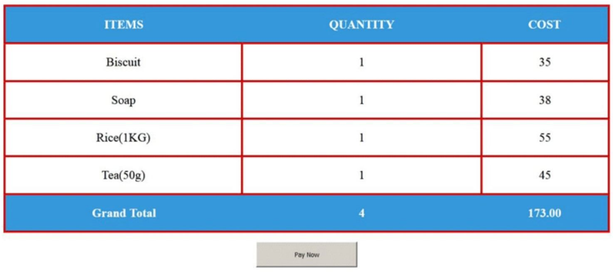
The project involved the design and implementation of a smart cart system using RFID technology, along with a web-based bill generation feature. Additionally, a smart shelves system using load cell technology was incorporated into the project. The results of implementing the smart cart system using RFID technology and the smart shelves system using load cell technology were promising. The integration of RFID technology in the smart cart system enhanced product tracking. The convenience offered to customers through automatic billing and personalized shopping experiences improved customer satisfaction.

A. Smart Cart

Accurate Product Tracking: The RFID technology successfully enabled accurate and real-time tracking of products as they were placed or removed from the cart. This feature enhanced inventory management and reduced errors in product tracking.

Convenient Shopping Experience: Customers found the smart cart system convenient, as they no longer needed to manually scan each item at the checkout counter. The automatic tracking of selected products and the generation of digital bills on the webpage streamlined the shopping process.

Real-time Data Analysis: The collected RFID data provided valuable insights into consumer behavior, product preferences, and shopping patterns. Retailers were able to analyze this data to personalize marketing strategies, optimize product placements, and enhance customer satisfaction.



ITEMS	QUANTITY	COST
Biscuit	1	35
Soap	1	38
Rice(1KG)	1	55
Tea(50g)	1	45
Grand Total	4	173.00

Pay Now

Fig1. Billing web page

B. Smart Shelves System Using Load Cell

Accurate Weight Measurement: The integration of load cells within the shelves provided accurate weight measurements of the products placed on them. This enabled precise inventory management and real-time stock tracking. Inventory Optimization: The load cell-based smart shelves system improved inventory management by providing accurate and up-to-date information on stock levels. This allowed retailers to optimize their stock replenishment processes, minimizing stock outs and overstocking. Real-time Monitoring and Alerts: The connectivity options in the smart shelves system facilitated real-time monitoring. Alerts were generated when stock levels were low or when unusual weight changes were detected, enabling prompt action to be taken. Enhanced *Efficiency*: The implementation of the smart shelves system increased the overall efficiency of the store operations. The automation of weight measurements and stock tracking reduced manual efforts and improved productivity. The smart shelves system using load cell technology proved effective in accurately measuring the weight of products on the shelves. This led to improved inventory management, theft prevention, and real-time stock tracking. The integration of connectivity options facilitated real-time monitoring and alerts, further enhancing the efficiency of store operations.

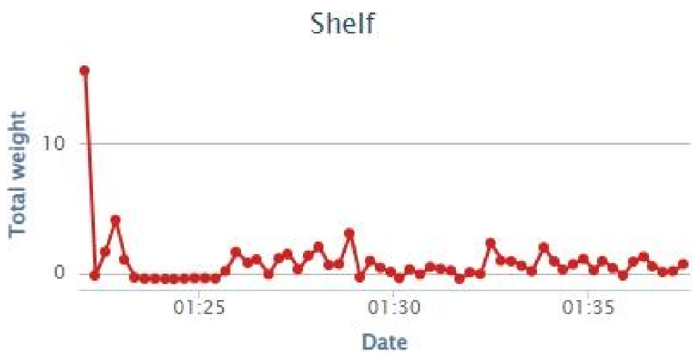


Fig1.Graph of monitoring weight on the shelf

C. Machine Learning

The machine learning models were trained and evaluated on the dataset, and the performance metrics for each algorithm were recorded. The results showed that all three algorithms, Linear Regression, Random Forest, and XG Boost, achieved promising predictive capabilities for future sales. The evaluation metrics used to assess the models' performance were Root Mean Squared Error (RMSE). The RMSE accounts for the squared differences, penalizing larger errors more heavily.

TABLE 1: RESULT OF EXPERIMENTATION

Model Name	Mean Squared Error
Linear Regression	29480
Random Forest	13816
XG Boost	13739

Results of experimentation is shown in Table 1. The findings indicated that XG Boost consistently outperformed both Linear Regression and Random Forest in terms of RMSE. This result was not surprising, as XG Boost is known for its ability to handle complex relationships and nonlinearities in data. The ensemble nature of Random Forest also contributed to its competitive performance.

The implications of these results are significant for retailers seeking to optimize inventory management and enhance the shopping experience. The accurate predictions provided by XG Boost can aid in proactive inventory replenishment and stock allocation, minimizing product shortages and overstock situations. This, in turn, leads to reduced operational costs and improved customer satisfaction, as customers are more likely to find the products they desire on the shelves.

```
Linear regression predicted Sales after 1 month: 81906.49621212122
Mean Squared Error: 294800273.4848606
Random forest Predicted Sales after 1 month: 82185.48204761902
Mean Squared Error: 138164645.17385694
XG boost Predicted Sales after 1 month: 81325.2421875
Mean Squared Error: 137391644.52090558
As smallest Mean square error is 137391644.52090558 of Xgboost Model, we can consider it as most accurate model
```

Fig3.Output of future sale prediction

V. CONCLUSION

In conclusion, the project successfully implemented a smart cart system using RFID technology and a smart shelves system using load cell technology, along with web-based bill generation. These systems have demonstrated numerous benefits for retailers and customers alike. Customers experienced a convenient shopping process with automatic billing on the webpage, reducing checkout time and enhancing overall satisfaction. The smart shelves system enhanced real-time monitoring and alerts allowed for proactive stock management and increased operational efficiency. The integration of RFID and load cell technologies in the smart cart and smart shelves systems has laid the foundation for a more advanced and connected retail ecosystem, offering valuable insights and opportunities for retailers to stay competitive in the ever-evolving market.

Despite the successes, the project also faced challenges. Data quality, availability, and generalization were crucial concerns in training the machine learning models. The interpretability of complex algorithms like XG Boost raised questions about the transparency of predictions and the potential for biases. Addressing these challenges requires ongoing efforts to collect high-quality data, enhance model interpretability, and employ fairness-aware approaches to mitigate biases.

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Grenze International Journal of Engineering and Technology, Jan Issue

Secured Information System for Healthcare in Cloud with Dual Access Control using Blockchain

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***Abstract*— It is crucial to implement security measures and to make sure that vulnerabilities are solved to completely safeguard the health services. To protect the exchange of EMRs between various organizations participating the adaptive healthcare system this research will explore such difficulties in more detail and place a greater emphasis on security issues. Four different types of smart contracts to overcome the security issues: Verifying the identity of the user, authorizing access, detecting misconduct, and revoking access. There are challenges regarding data sharing and access control brought up by the existing Electronic Medical Record (EMR) management system utilized by healthcare organizations. Dual Access Control Framework, a security and privacy management system for blockchain-based EMR, to allay these worries.**

***Index Terms*— EMR, electronic medical records, centralized blockchains, EHR Electronic health record self-Executing contracts, computerized transaction protocols, Elliptic curve cryptography.**

I. INTRODUCTION

By comparing a user's generated content to the data authorization server or in a database of legitimate user, authentication technology limits access to systems. Authentication by itself is insufficient to protect data. A further layer known as authorization is required, to consider if an individual should really be offered access to the info or perform the transaction they're attempting. Most security experts are aware of how important access control is to their company. On how access control should be used, nevertheless, many perspectives exist. In an environment that is fluid and devoid of defined limits, access control demands the establishment of enduring regulations.

Large databases that store data on servers made of cutting-edge hardware are used to do this. These servers can frequently be established by utilizing many computers, supplying the processing power and storage space required to enable more users to look at the database at one time. A spreadsheet or database may be available to anyone, but they are usually owned by a company and managed by a single person who has total control over their functionality and the data they contain.

Crowley contends that authentication by itself is woefully inadequate to safeguard data. Adding yet another layer known as authorization is required to determine whether A visitor should really be capable of accessing the information or execute the operation they are trying to carry out.

II. RELATED WORKS

Researchers suggested numerous strategies to increase the data's scalability and security in the cloud environment. According to J. Sun et al have proposed the system "The Electronic Health Record (EHR)". It frequently engages in cross-organizational or cross-domain collaboration for essential and excellent patient care [3]. Since cross-

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domain cooperation invariably entails the exchange and sharing of related sensitive and very confidential patient data, rigorousentrusting process design is required as a advises that new (N. Fatema et al.,2014). The delegation mechanism allows for and limits a bandingpartner's access rights. Patients won't use the EHR system unless they are assured that their health information will be used and disclosed properly (E. B. D. Hussein et al.,2017); this cannot be done without good access control and pass authentication (J. Sun et al.,2009). The delegated powers during the collaboration should be revocable at any point. When working together, sensitive patient data must be shared securely to ensure patient privacy. An electronic clinical recordthat would be encrypted is suggested in this work (L. J. Kish et al,2015).In addition to fundamental authenticated key agreement provided by the use of outsourcing methodology and the fundamental repudiation mechanism, our electronic clinical record system includes advanced techniques for fine-grained access restriction and termination on demand (R. S. Sandhu et al.,1994). There seem to be two kinds of entry monitoring systems that have beenemployed: attribute-based and needed access control (V. C. Hu et al.,2015).

The network hashes communications into a hash-based proof-of-work timestamps are created continuously, because of which a document cannot be altered without repeating the conclusive evidence. The largest line demonstrates this, it was the first to emerge from the largest CPU power pool and that the events happened in the order theywere observed (M. A. Khan et al,2018). Mankind's primary concern has always been health protection. Despiteplaying a crucial social function, present healthcare data management systems are cumbersome, inefficient, occasionally expensive, and prone to misunderstandings and human mistake (J. Priisalu et al,2017).By using blockchain technology as a platform, the medical chainproject appears to have the ability to set a new standard for monitoring health records in the healthcare industry (Rallies et al.,2017). According to Rallies et al, “For maintaining and storing registered patients' electronic health records (EHR), a novel approach based on a permissioned blockchain is suggested.”. This approach guarantees efficiency for both doctors and patients and, ideally, preserves faith in the public health system. It does so by ensuring openness and, more importantly, fixity, which are vital for secure administration and preservation (J. Priisalu et al.,2017).To implement widespread and reliable control of accession to Interconnected devices (S. Ravidas et al.,2019), For each subject-object pair, each ACC offers a single access control mechanism that carries out both confirmation of inactive access rights based on predeterminedpolicies and Validation of changing access through employing dynamic analysis (A. Ouaddah et al., 2017).

A. Difficulty Faced By Users

- Centralized data security
- Time constraint, Event driven approach.
- High cost, Privacy breaches.
- Existing system follows a centralized data storage of E-healthrecords, which makes it less scalable and difficult to maintain.
- Additionally, they are centralized and liable to a single spot ofcollapse.

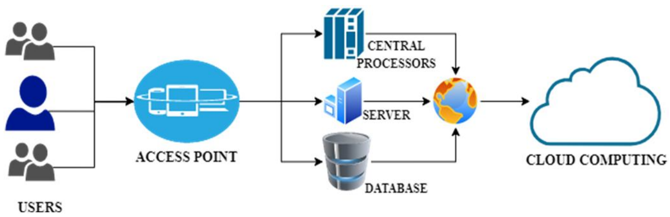

Figure 1 cloud computing architecture

III. SYSTEM MODEL

To ensure the safe sharing of electronic clinical record between different stakeholders in the automated healthcare sector, the current approach intends to create a smart contracts-based user access framework, which are established over through the shared databases. To achieve this, we encourage the use of four distinct kinds of smart contracts: account identification, approval for entry, spotting of misconduct, and Denial of access. In this framework, the electronic clinical records are saved using cryptographic techniques in the cloud using Elliptic Curve Cryptography (ECC). Their congruent hashes aresimultaneously stored in blockchain. Using a private performanceevaluation.

Contrarily, the approach we propose considers the scenario of complete medical tracks, which primarily involves three distinct kinds of entries:Patients, hospitals, and smart medical technology with computational supervision made possible by the Internet of Things. We have begun utilizing cloud storage to prevent crowding and lower overhead on theblockchain network. In other words, the blockchain stores the relevantindex number and hash when an EMR is created, and it is encrypted and maintained in the cloud. The following benefit of the proposed system, because actions can be predefined, this autonomous behaviors grow thanks to smart contracts based on the blockchain. Such ideasare simple to combine, which has numerous advantages.

- Since its inception a decade ago, big data analytics has analyzed enormous amounts of data to give users a wealth of business insight.
- Comparative analysis of the data collected and kept in the cloud can give the user insightful information that can lead to improvedproductivity and financial success.
- The usage of the cloud minimizes latency, which can be important in specific use cases.
- The majority of these can aid in improving user and device data processing as well as service quality.

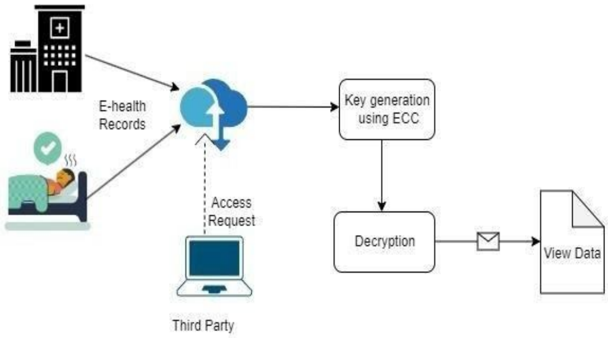

Figure 2 system architecture

A. E-Health Records

The next advancement in health care services that would improve patient- physician interactions is the adoption of electronic clinical records. Themetadata's accessibility and immediate nature will help doctors make more accurate diagnoses and treatments.

As an illustration, the EHR can improve patient care by

1. Increasing the fact of being accurate and readability of clinicalrecords to reduce the possibility of surgical mistakes.
2. Making the knowledge on health more broadly accessible, obviatingthe need for pointless testing, accelerating the pace of diagnosis, and enabling people to make conscious decisions.
3. Reducing clinical errors bymaking clinical records more precise andfurthermore understandable.

B. Access Control

A security method is known as approval for entry limits the access to resources in the environment of computation. It is a vital protection measure. that lessens risk to the organization or group. Logical and physical regulation on entering is both available. The ability to view information, system files, and computer networks is restricted using conceptual security controls. Organizations use the system of electronic entry management to monitor staff access to protected areas such as data centers and other restricted corporate areas. These systems use user credentials, access card readers, auditing, and reports. Some of the technologies used to restrict access to buildings and rooms include alarms and access control panels.

IV. Result Analysis

A secured information system for health care using a dual access control framework by blockchain can provide robust security by allowing access to sensitive patient data only to authorized personnel. The use of blockchain technology can ensure that the system's data is tamper-proof and secure, and the dual access control framework can add an additional layer of security by requiring two-factor authentication.

The analysis of such a system would typically involve assessing itseffectiveness in preventing unauthorized access, detecting, and responding to security breaches, and mitigating potential vulnerabilities. Some key metrics that could beused to evaluate the system's performance include:

Blockchain security: Blockchain technology uses cryptographic algorithms to secure data and prevent tampering. An effective blockchain-based system for health care should demonstrate a high level of security against data breaches, hacking attempts, and other security threats.

- *Authentication success rate*: This metric measures the percentage ofsuccessful logins by authorized personnel using the two-factor authentication system. A high authentication success rate indicates that the systemis functioning effectively, and legitimate users are being granted access to the system.
- *Unauthorized access attempts*: This metric measures the number of unsuccessful login attempts made by unauthorized personnel. A high number of unauthorized access attempts could indicate that the system is being targeted by malicious actors or that the user credentials are being compromised.
- *Breach detection and response time*: This metric measures the timeit takes for the system to detect a security breach and initiate a response. A fast response time is critical in preventing further data loss or damage.
- *Vulnerability assessment*: This involves regularly evaluating thesystem's security posture to identify potential vulnerabilities andprioritize remediation efforts.

Overall, an effective secured information system for health careusing a dual access control framework by blockchain should demonstrate a high level of security.

Figure 3 result page

V. STATISTICAL DATA

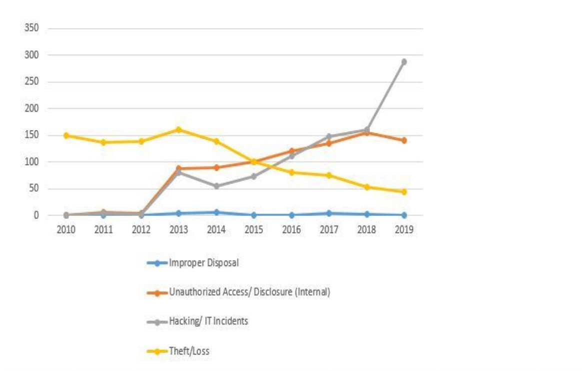

Figure 4 Graphical Presentation of Different Data Disclosure Types

According to the graph above, illegal access occurrences and hacking/IT incidents have increased in frequency while theft/loss and inappropriate disposal incidents have reduced. Notably, during the past few years, there has been a sharp rise in IT and hacking instances. The locations of information breaches and the sources from which sensitive health information has been exposed are covered in the sections that come next.

On the other hand, improper disposal and theft/loss have clearly decreased over the past four years. Only 257 theft/loss instances out of 1077 total incidents, or 23.86% of the total, were recorded in the last four years. Additionally, only 34 instances of waste that were inappropriate out of a total of 90 cases—or 37.77% of the total—were recorded in the previous four years. These findings demonstrate that the healthcare sector is far less negatively impacted by theft/loss and inappropriate disposal.

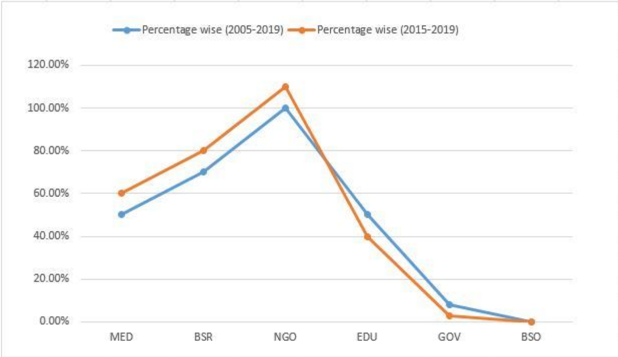

FIGURE 5 Representation of Data Breach Incidents.

The graph's slope in each sector has decreased in the second scenario (2015-2019), except for the MED sector, which was followed by the BSF sector, according to the figure. The graph shows that due to the important commercial value of electronic health records (E the healthcare sector is the main target of attackers.

VI. Future Scope

Future work proposes to combine the AES encryption mechanism withan innovative encryption methodology to address these problems. In this work, the owner of the data and PHR manager can securely swap their public keys and generate the secret by employing an ECC-DH keyexchange method. The following are this paper's main contributions.

Improve access permission by granting access to a variety of people sothat they can view various categories of files based on their PHR responsibilities.

VII. Discussion

The implementation of a secured information system for healthcare in the cloud with dual access control using blockchain technology represents a significant advancement in healthcare data management and security. In this section, we will discuss the key findings and implications of this system.

1. *Enhanced Security*: Blockchain technology provides an immutable and decentralized ledger for storing healthcare data, which significantly enhances security. With dual access control, only authorized personnel can access sensitive patient information, reducing the risk of data breaches.
2. *Data Integrity*: Blockchain ensures the integrity of healthcare data. Any changes made to the data are recorded in a transparent and tamper-proof manner, making it easy to track and verify the authenticity of records.
3. *Patient Privacy*: Dual access control ensures that both healthcare providers and patients have control over who can access their data. This empowers patients to maintain their privacy and control over their medical records.
4. *Interoperability:* The use of blockchain can improve interoperability among different healthcare systems.
5. *Reduced Costs*: Storing healthcare data in the cloud can reduce infrastructure costs for healthcare organizations.

VIII. Conclusion

In conclusion, the implementation of a secured information system for healthcare in the cloud with dual access control using blockchain technology offers a robust solution to the pressing challenges of data security and privacy in the healthcare industry. By leveraging blockchain's immutability and decentralization, along with dual access control mechanisms, this system not only ensures the confidentiality and integrity of patient data but also empowers patients to have greater control over their own health information.

Furthermore, the system aligns with regulatory requirements and provides a foundation for improved interoperability and data sharing among healthcare providers. While it represents a significant step forward, it's essential to consider the practical implementation challenges, such as the need for robust identity management and the integration of legacy systems.

In the future, as blockchain technology continues to evolve, it is likely that such systems will become even more sophisticated, offering healthcare organizations even greater security and efficiency in managing patient data.

Overall, this system holds great promise in revolutionizing healthcare data management in a secure, efficient, and patient-centric manner.

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Analysis of Decoupler Controlled Three Input Multiport Boost Converter for Hybrid Electric Vehicle

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***Abstract*— In recent years, in quest of clean energy as a energy source for vehicles to replace fossil fuels has become important to reduce environmental pollution. Hybrid Electric Vehicles, powered by pure renewable energy sources like solar cells and fuel cells, are expected to revolutionize the transportation industry. This paper introduces an improved non-isolated three-input multiport boost converter for the Hybrid Electric Vehicles. The converter features three ports out of this , two port is supplied with the input power sources and one port with a battery, all formed into a single structure. The new converter use inverted decoupler feedback controller. Major benefit of using this controller is the cross coupling between the input variable parameters can be mitigated. The proposed system was simulated and the steady state transient performance of the closed loop analyzed .The results validated with the hardware setp.The efficiency, voltage regulation and dynamic response was improved.**

***Index Terms*— Hybrid Electric Vehicle, MISO converter, decoupler.**

I. INTRODUCTION

There is a growing push for the adoption of green technology to combat pollution and promote the integration of various renewable energy sources. Electric vehicles (EVs) have become increasingly popular due to their environmentally friendly characteristics. According to the International Energy Agency (IEA) report, the profit projected for the EV market will reach $457.60 billion by 2023. Additionally, the consumer base is expected to increase to 16.21 million users by 2027 [4].The existing Electric Vehicles (EVs) have the problem of using fossil fuel and producing non-zero carbon emissions. To solve this issue, researchers are focusing on the development of Hybrid Renewable Energy Vehicles (HREVs). These types of vehicles utilize a hybrid combination of solar cells, fuel cells, biomass, and other renewable energy sources. As a result, zero carbon emissions can be achieved. Renewable sources of energy are known for their intermittent nature. To ensure a smooth and continuous power supply to loads, energy storage elements are required in stand-alone renewable power systems. Traditionally, multi stage DC-DC converters are used in these applications [1], [2]. However, this approach may suffer from drawbacks of high cost and low efficiency.

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In recent times, Multi Port Converters (MPCs) have gained significant research interest as they offer a more promising solution. MPCs have the capability to interface and control multiple power terminals synergistically. They possess several merits, including low cost, high power density, high efficiency, and a compact structure [3]-[21]. By utilizing MPCs, it becomes possible to interface and manage various renewable power sources simultaneously, such as multichannel PV panels, hybrid PV systems, and wind turbines[8-11].
With the integration of MPCs into renewable energy systems, the issues of high cost and low efficiency associated with conventional multiple-stage conversion approaches can be addressed [11-12]. This advancement can lead to more efficient and cost-effective renewable power systems, helping to foster the widespread adoption of renewable energy sources and promoting a sustainable energy future.
Major problem faced by the multiport converter implementation is a proper control strategy. Since the system has to deal with the more than one source the chance for coupling of various parameters are high. As result the performance of the system will be descend. Multivariable control strategy will be a promising solution to this issue. The available multivariable control strategies are Model Predictive Control (MPC), decentralized control, decoupler control etc. In this decoupler control is the populated one due the simplicity and accuracy. The decoupler control is of static model and dynamic model are available. When a practical scenario is considered dynamic decoupler is preferred. In the realm of dynamic decouplers, there are three main types available: the ideal decoupler, the simplified decoupler, and the inverted decoupler. In their study [15], the researchers extensively discussed ideal and simplified decoupling techniques, ultimately concluding that the simplified technique outperforms the ideal method, offering better performance. Additionally, in a separate study [16], the author detailed that the inverted decoupler surpasses the simplified decoupler in terms of efficiency. The inverted decoupler was found to produce more accurate results in control applications. Notably, a growing number of researchers [12-20] have shown a recent interest in the application of inverted decoupler techniques in their work, indicating a trend toward its adoption in various research projects.
This paper proposes an inverted decoupler control for a three input port MPC. This MPC has a solar PV source ,fuel cell and battery. The converter is mathematically modelled and transfer function determined. The proposed inverted decoupler control technique enhances the dynamic performance of the MPC converter by reducing cross-coupling effects among inductor current, source current, and load voltage. Furthermore, the converter is highly efficient in minimizing current ripples.

II. Proposed Converter Topology

The new converter is integrated with three input sources, including a fuel cell .PV cell, a, and a battery. The operation mode of the converter is determined by the battery performance. To incorporate nonlinear elements, an inductor and an internal resistance are connected to the source.

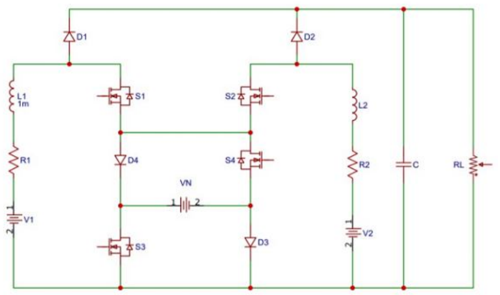

Fig.1 Circuit diagram of three input multiport boost converter

The converter operates in three distinct operating modes, each characterized by specific switching periods. The duration of these switching intervals is determined by the duty ratio of the semiconductor switches. To maximize power extraction, this model incorporates Maximum Power Point Tracking (MPPT). The regulation of power extraction is influenced by the duty ratio of the switches.

$$D_1 + D_2 + D_3 + D_4 + D_5 = 1 \tag{1}$$

$$V_O = \frac{V_{PV} + D_4 V_{Bat}}{1 - D_1 - D_4} \tag{2}$$

$$V_O = \frac{V_{FC} - D_3 V_{bat}}{1 - D_2 - D_3} \tag{3}$$

$$P_{Bat} = D_3 I_{FC} V_{Bat} - D_4 I_{PV} V_{Bat} \tag{4}$$

Where,

D_1-Duty ratio of switch1:D_2-Duty ratio of switch 2:D_3-Duty ratio of switch 3:D_4-Duty ratio of switch 4:
V_O-Regulated output voltage of converter: V_{BAT}-Battery voltage: V_{FC}-Fuel cell voltage : P_{Bat}-Battery power level:
I_{FC}-Fuel cell current : I_{pv}-Solar cell current:

The eqn. (1-4) define the working of the duty ratio working for the regulation of the converter, Eqn. (2-4) explain the relationship of battery voltage , fuel cell current and duty ratios. From equation (2) it can be understood that the PV power can be controlled by adjusting D_1. D_3 controls the Battery charging performance.

$$v_{L_1} = d_4 T\left(v_1 - r_1 i_{L_1} + v_B\right) + (d_1 - d_4)T\left(v_1 - r_1 i_{L_1}\right) + T(1 - d_1)\left(v_1 - r_1 i_{L_1} + v_0\right) \qquad (5)$$

$$v_{L_2} = d_4 T\left(v_2 - r_2 i_{L_2} + v_B\right) + (d_2 - d_4)T\left(v_2 - r_2 i_{L_2}\right) + T(1 - d_2)\left(v_2 - r_2 i_{L_2} + v_0\right) \qquad (6)$$

Where,

d_1,d_2,d_3,d_4-Duty ratio of switches 1,2,3 and 4 small signal model is considered:
v_{L_1}, v_{L_2} – voltage across inductors L_1 and L_2: I_{L_1}, I_{L_2} – current through inductors L_1 and L_2:

Eqn. 5 and 6 represent mathematical equations describing the behaviour of the inductor voltage. The gating pulses are generated from the saw tooth pulses produced by the inverted decoupler. The overall operation is determined by the control of duty ratios during the five switching intervals.

III Simulation-Results

MATLAB simulations analyse the converter model functioning in n using the proposed inverted decoupler control strategy. Different modes of operation in simulation are specified by varying the PV power and load conditions. The hybrid model includes the maximum power of 1 kW and 0.85 kW of average power is given to the load side. The rating of the input sources are set to P_{PV}^{max} = 1.5kW, P_{FC}^{max} = 1kW, and $P_{battery}^{max}$= +1.5kW. The regulated voltage for the closed loop MPC is 220V.The ripple content is measured for the input source current.

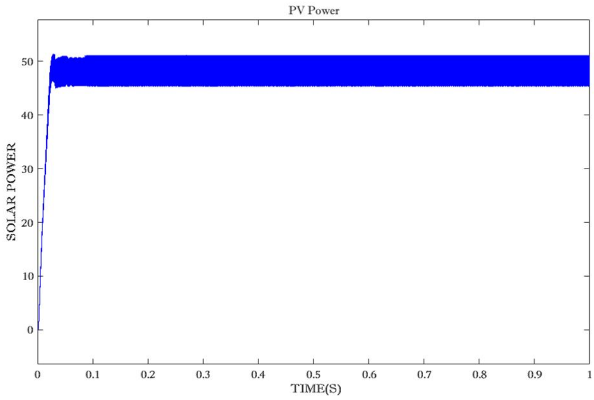

Fig.2 The waveform shows the solar power extraction using the MPPT control

Fig.2 shows the solar power extracted from the panel. The main source for the converter is solar power. Due to the irradiance variation the power will be varying in nature .A perturbation and observation MPPT algorithm is used to obtain the maximum power from the source.

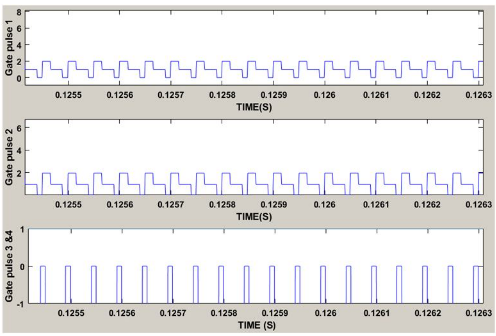

Fig.3 Gate pulses applied for the semiconductor switches

Fig. 3 illustrates the switching pulses provided to the four switches in the proposed converter. The duty ratio varies across different switching periods. Table I presents a comparison of the closed-loop performance of the proposed converter. The converter was simulated using an existing PID controller, but for this MPC converter, three PID controller loops are required.

TABLE I -COMPARISON OF CLOSED LOOP PERFORMANCE OF THE PID CONTROL AND INVERTED DECOUPLER CONTROL

Feedback Controller type	Rating	Percentage Overshoot(%)	Settling time (ms)
Three loop PID controller	220V,1kW	4.3	80
Decoupled control converter	220V,1kW	0.92	45

The simulation results demonstrate a robust dynamic response for the double boost MPC with an inverted-decoupler controller, even in the presence of input disturbances. The closed-loop performance has been significantly improved when compared to the existing feedback controller, as evidenced by the reduced peak overshoot and settling time.

IV. HARDWARE IMPLEMENTATION

To validate the efficacy of the proposed converter, a laboratory prototype was constructed, as illustrated in Figure 4. The prototype of the proposed converter is designed with the following specifications: a rated power of 30 W, input source voltage 20-40 V, and a120V regulated output voltage. The switching frequency is configured to operate at 70 kHz

Fig.4 Experimental setup for the proposed converter

Figure 5 illustrates the impact of the inverted decoupler control, which was activated at 1 second. The response clearly indicates that the input current waveform becomes distorted when using PID controllers. The glitches observed are a result of the interaction between the inductor current and load current. However, with the implementation of the decoupler, the current response becomes smooth, and the closed-loop performance improves, achieving a settling time of 40 ms.

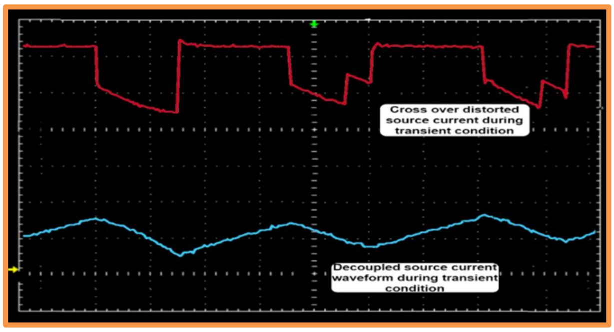

Fig.5 Waveform of the distorted source current and the decoupled output

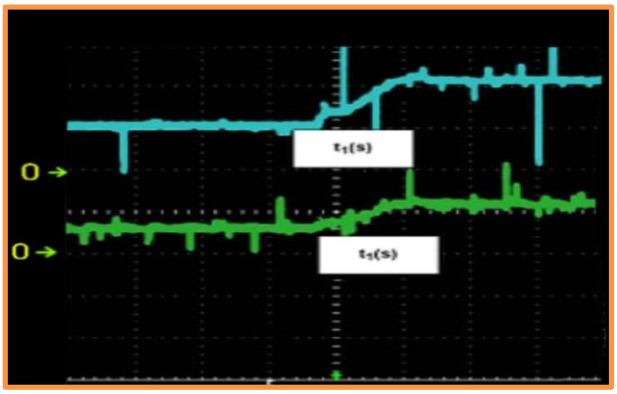

Fig.6 load voltage and current response for the proposed converter

Figure 6 displays the responses of the load voltage and current for the converter. The load voltage response reaches the steady-state value within a 40 ms interval, while the load current takes 55 ms to reach its steady-state value. The improvement in closed-loop performance can be clearly observed from these waveforms.

TABLE II-COMPARISON OF THE PID CONTROLLER AND DECOUPLER CONTROLLER FOR THE NEW CONVERTER PERFORMANCE

	Control strategy	Change for the reference value	Settling time for regulated voltage	Efficiency
simulation	PID Controller[27]	33%	2s	78.25%
	Inverted decoupler	5.2%	35ms	91.2%
Hardware	Inverted decoupler	9.8%	40ms	85.04%

V. CONCLUSION

In this paper, an inverted decoupler control strategy for non-isolated double boost MISO converters is proposed. The MPC is a hybrid model incorporating three different renewable energy sources: a PV cell, a Fuel cell, and a Battery. A power control algorithm, known as perturbation and observation, is employed to achieve maximum power extraction. This algorithm ensures the balanced delivery of energy from the sources to the load. The converter utilizes four independent switches and four duty ratios to manage power flow between the two input sources and the load. Analysis demonstrates that the MPC with the proposed control strategy yields stable closed-loop responses even in the face of reference parameter variations. This method offers several advantages:

- The decoupled system is entirely free from coupling elements, as evidenced by the analysis of the diagonal elements of the decoupler matrix, which consistently equals one.
- The controller effectively mitigates cross-coupling between variables, reducing power source current ripples to 2.6% within IEEE standard limits.
- It regulates the output voltage to 220V while remaining immune to disturbances.
- The control strategy enhances closed loop dynamic response with a regulated voltage settling time of 40ms, an overshoot of only 0.96%, and a rise time of 50ms.

This novel control approach minimizes interactions among different control loops and demonstrates strong dynamic performance.

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A Review on Forecasting of Renewable Sources of Energy with Solar and Wind for Improved Sustainability

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***Abstract*— Sustainability of the earth depends on renewable energy. Forecasting the output of renewable energy has a big impact on how we operate and manage our power networks. To guarantee grid dependability and permanence and to lower the danger and expense of the energy market and systems, accurate forecasting of renewable energy output is essential. Researchers have been drawn to this topic by deep learning's recent success in a variety of applications, and its bright future is shown in the variety of proposed approaches and the rising number of publications. This paper reviews deep learning-based solar and wind energy forecasting research that has been published over the past five years, covering in-depth topics such as the data and datasets used in the reviewed works, data pre-processing techniques, deterministic and probabilistic techniques, and evaluation and comparison methods. To facilitate methodological comparisons, the key traits of all the reviewed publications are compiled in tabular form. The field's existing difficulties and potential areas for future research are described. According to trends, recurrent neural network models, including those with long short-term memories and gated recurrent units, are second most frequently utilized in this sector behind hybrid forecasting models, with convolutional neural networks coming in third. We also observe an increase in interest in probabilistic and multistep forecasting techniques. Using the important learnings from this thorough study, we also create a comprehensive taxonomy of the research, which will, in our opinion, be essential for comprehending the cutting-edge and promoting innovation in this area.**

***Index Terms*— Sustainability, energy, networks, datasets, techniques, models, innovation**

I. INTRODUCTION

Numerous academics have turned their attention to this area as a result of the growing global interest in renewable energy sources and the growth of integrating such sources into the electrical grid [1-3]. Load forecasting, forecasting the output of renewable energy sources, energy pricing, detecting power quality disruptions, and defect detection on power systems and equipment are all common applications of smart energy systems. Forecasting the output of renewable energy sources, particularly wind and solar energy, has received a lot of attention recently due to its enormous influence on decisions about the operation and management of power networks. To assure grid dependability, permanence, and reduce risk, accurate forecasting of renewable energy output is essential. Writing partner. Deep learning and renewable energy are two of the most important and promising technologies for the

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future. This paper reviews recent deep learning-based research on solar and wind energy forecasting, covering the data and datasets used in the reviewed works, data pre-processing techniques, deterministic and probabilistic techniques, as well as evaluation and comparison techniques. To allow for methodological comparisons, the key traits of all the reviewed publications are compiled in tabular form. There is a suggested general taxonomy for the research. Hybrid models are the most popular architectures, followed by recurrent neural network models, such as the Long Short-Term Memory model and Gated Recurrent Unit, and then Convolutional Neural Networks, which come in third. Data decomposition techniques and feature selection approaches make up the majority of strategies used in combination with deep learning models. The results of all the experiments in the included studies show that deep learning-based forecasting models consistently outperform other machine learning models and statistical techniques in terms of accuracy and generalization ability, especially when they are combined with other algorithms to create hybrid models. Without comprehensive testing using datasets from various climates and topographies that contain information on all seasons and weather conditions, it is impossible to pinpoint the forecaster that performs the best.

II. LITERATURE REVIEW

Afshin et. al. (2023) states that solar energy is a widely accessible, clean, and sustainable energy source. Solar power harvesting in order to generate electricity on smart grids is essential in light of the present global energy crisis. However, the highly variable nature of solar radiation poses unique challenges for accurately predicting solar photovoltaic (PV) power generation. Factors such as cloud cover, atmospheric conditions, and seasonal variations significantly impact the amount of solar energy available for conversion into electricity. In addition, RFR and LSTM demonstrate their capability to capture the intricate patterns and complex relationships inherent in solar power generation data. The developed machine learning models can aid solar PV investors in streamlining their processes and improving their planning for the production of solar energy. [1]

Louis et. al. (2022) states that reducing carbon emissions and electricity costs in industry is a major challenge to ensure competitiveness and compliance with new climate policies. Photovoltaic power offers a promising solution but also brings considerable uncertainties and risks that may endanger the continuity and quality of supply. From an operational point of view, large-scale integration of solar power could result in unmet demand, electrical instabilities and equipment damage. The performance and lifetime of conventional fossil equipment are likely to be altered by repeated transient operations, making it necessary to adopt specific modelling tools. [2]

Moon-Soo et. al. (2022) mentioned that heavy snowfall is a natural disaster that causes extensive damage in South Korea. Therefore, it is crucial to predict snowfall occurrence and establish countermeasures to reduce the damage caused by heavy snowfall. In this study, the meteorological and geographic data of the past 30 years were collected, and four machine learning algorithms were used: multiple linear regression (MLR), support vector regression (SVR), random forest regressor (RFR), and eXtreme gradient boosting (XGB). Subsequently, the performances of the machine learning algorithms were compared. Machine-learning algorithms were selected as regression models to predict heavy snowfall. Additionally, grid search and five-fold cross-validation techniques were used to improve learning performance. Model performance was evaluated by comparing the observed and predicted data. It was observed that the RFR model accurately predicted the occurrence of snowfall (R2=0.64) compared with other models with various statistical criteria. [3]

Altaf et. al. (2022) states that for efficient energy distribution, microgrids (MG) provide significant assistance to main grids and act as a bridge between the power generation and consumption. Renewable energy generation resources, particularly photovoltaics (PVs), are considered as a clean source of energy but are highly complex, volatile, and intermittent in nature making their forecasting challenging us a reliable, optimized, and a robust forecasting method deployed at MG objectifies these challenges by providing accurate renewable energy production forecasting and establishing a precise power generation and consumption matching at MG. [4]

Zhigang et. al. (2022) states that the prediction of time series is of great significance for rational planning and risk prevention. However, time series data in various natural and artificial systems are nonstationary and complex, which makes them difficult to predict. An improved deep prediction method is proposed herein based on the dual variational mode decomposition of a nonstationary time series. First, criteria were determined based on information entropy and frequency statistics to determine the quantity of components in the variational mode decomposition, including the number of subsequences and the conditions for dual decomposition. Second, a deep prediction model was built for the subsequences obtained after the dual decomposition. Third, a general framework was proposed to integrate the data decomposition and deep prediction models. [5]

Haoyin et. al. (2022) states that the physical prediction method refers to a technology that excavates the factors related to PV power generation from the principle and then creates a physical model. Specifically, physical method modelling is based on numerical weather prediction (NWP) by utilizing atmospheric physical data including wind speed, temperature, rainfall, humidity, length of day, and cloud image via a total sky imager or satellite. Besides, it can be further classified as a simple physical model method and a complex physical model method. A simple physical model needs power system parameters, weather data, satellite observations, and so on. [6]

III. Proposed System

Since its very difficult to identify the exact issues associated for forecasting of solar and wind energy due to lack of information in a systematic way pr may be due to less parameter's comparison with certain deep learning techniques. This emerges the urgent need for a study of deep learning-based forecasting studies for renewable energy sources. This paper reviews recent deep learning-based research on solar and wind energy forecasting. It discusses in detail the data and datasets used in the reviewed works, data pre-processing techniques, deterministic and probabilistic techniques, as well as evaluation and comparison techniques. It took a lot of work to compile a comprehensive list of all the examined works' essential traits and present them in tabular formats. the most recent developments in the field and has also enabled us to put up a comprehensive taxonomy for deep learning-based research on solar and wind energy forecasting. Although there was no such comprehensive taxonomy of deep learning-based research on solar and wind energy forecasting, we believe that it will be crucial for identifying and comparing works on the subject, eventually fostering innovation in this area. Our suggested approaches serve to clarify the fact that the current methods for predicting the amount of wind and solar energy are insufficient to determine the outcome. So, by comparing more than 2 techniques helps to identify the flaws in the previous system or may increase the accuracy of forecasting.

IV. Objectives Of Proposed System

Following are the objectives which will be achieved:

- To forecast the renewable energy in market data by using machine learning regression algorithms
- To compare various algorithm and techniques by the use of relevant dataset
- To process linear regression and ridge regression to provide better sustainability solution
- To evaluate the performance such as mae,mse,rmse and mape

V. Need Of The Study

Due to the variable nature of weather, there will always be instability of the energy output from solar and wind energies. Thus, their output prediction is difficult and requires advanced methods. The techniques used for this task can be classified into four categories: physical methods, statistical models, artificial intelligence techniques, and their hybrid methods. Physical methods or Numerical Weather Prediction (NWP) models are mathematical models that simulate the atmospheric dynamics according to physical and mechanical principles. Since they depend on computer simulation, they require extensive computer resources and thus are used for long term forecasting horizon. This extensive review provides key insights into the state-of-the-art on the topic and has also allowed us to propose a broad taxonomy of deep learning-based solar and wind energy forecasting research. The forecast horizon includes four categories: ultra-short-term, short-term, medium-term, and long-term. The forecasting approach could be deterministic or probabilistic targeting the next time step or multi-steps. The data used for forecasting might be spatial, time series, or sky images. It could be the historical values of the wind speed or wind power for wind energy forecasting and solar power or solar irradiance for solar energy forecasting. This data could be used with or with- out other meteorological data. Data preprocessing methods include data normalization, data imputation, outlier treatment, changing data resolution, data transformation, data augmentation, correlation analysis, data clustering, data modelling as a graph or grid, data decomposition, and features selection.

VI. Research Methodology

Deterministic forecasting models developed for solar and wind energies are divided into six categories according to the used architectures that are as follows:

A. Data normalization and denormalization

Normalization is an essential step when numerical values have different scales, which is the case with forecasting inputs. Ignoring this step, especially with gradient descent-based algorithms, hinders their learning process, and slow up their convergence speed towards the minima, thus, distort the performance results. Forty-four papers included in this review reported using normalization. It might have been used in the remaining papers, but not mentioned. The normalization technique used in almost all the papers is Min-Max scaling, which transfers the data into a range between 0 and 1.

B. Handling wrong or missing values and outliers

In most of the papers, it is mentioned that records contained wrong values or outliers were removed. However, replacing wrong values that are beyond the limit with the maximum value of that input variable is reported. Also, missing values in this paper were filled using the linear interpolation method, in which an estimation of the value is calculated using the previous and the next value.

C. Data clustering

Clustering might be involved in renewable energy data pre- processing for dividing the dataset into different seasons or weather conditions. According to some researchers, the fuzzy c-mean clustering algorithm is recommended for this task. Historical PV power data was clustered into different groups to identify the daily pattern label. The k-means algorithm is used to cluster solar irradiance data into five clusters, which represent five types of sky conditions.

D. Linear Regression

The statistical method for linear regression needs to collect a large number of data related to the power output of the PV power generation system to regress some unknown constants and further obtain the functional relationship between the output power and the measurable unknown. According to the number of unknowns, the statistical method can be divided into the unary linear regression method, multiple linear regression method, and nonlinear regression method. Because there are many factors affecting PV system power generation, the prediction result is not satisfactory by using the unary linear regression method. The multiple linear regression method adopted that solar radiation intensity and ambient temperature as two main factors to build a multiple linear regression model of the PV system and finally obtains the linear function relation of the output power on six unknowns, including radiation intensity and temperature. By using this linear function, the output power of the PV power generation system can be predicted as long as the value of corresponding solar radiation and ambient temperature is obtained. Some researcher employs the support vector machine (SVM) to design a regression algorithm of the solar farm power prediction model. Because the SVM is based on the principle of risk minimization and has a strong ability of generalization, the error of solving results is relatively smaller even though there are fewer training samples.

E. Ridge Regression

The field of solar and photovoltaic (PV) forecasting is rapidly evolving. The electricity system in India faces several challenges as the energy demand is expected to grow significantly within the next decades while the domestic energy resources in terms of fossil fuels are limited. Hence it becomes important to get more dependent upon Renewable Energy to meet the future requirements. This project report provides state of the art of this dynamic research area, focusing on solar and PV forecast of next dates with given weather data. Diverse resources are used to generate solar and PV forecasts, ranging from measured weather and PV system data to satellite and sky imagery observations of clouds which form the basis of modern weather forecasting. Electric utility companies need accurate forecasts of energy production in order to have the right balance of renewable and fossil fuels available. Errors in the forecast could lead to large expenses for the utility from excess fuel consumption or emergency purchases of electricity from neighboring utilities. Power forecasts typically are derived from numerical weather prediction models, but statistical and machine learning techniques are increasingly being used in conjunction with the numerical models to produce more accurate forecasts. Forecasting methods can be broadly characterized as physical or statistical. The physical approach uses solar and PV models to generate PV forecasts, whereas the statistical approach relies primarily on past data to “train” models, with little or no reliance on solar and PV models.

VII. CONCLUSION

In this way renewable energy is necessary for the planet to remain sustainable is one of the important aspects that we understand from the above review. And we try to manage our power networks in significant manner so as to forecast the output of renewable energy in precise manner. Accurate forecasting of renewable energy generation is crucial to ensuring grid dependability and permanence and to reducing the risk and cost of the energy market and infrastructure became the research area for the new aspirants. Deep learning's recent success in a number of applications has attracted researchers' attention to this subject, and the range of proposed methodologies and the growing number of papers reflect deep learning's promising future.

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Design and Implementation of Hybrid Charging of EV

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***Abstract*— Hybrid charging for Electric Vehicles (EVs) has been developed and put into use to increase the efficiency and sustainability of EV charging infrastructure. This paper proposes a solution that combines photovoltaic (PV) solar panels and the electrical grid to charge EV batteries. The major objective is to employ renewable energy sources as much as possible while still ensuring dependable charging.**

The suggested hybrid charging system employs intelligent control algorithms to manage the energy flow between the PV system and the grid. Under optimal sunny conditions, electricity from the PV panels is produced to charge the EV battery. By consuming the extra energy generated by the PV system, which is also delivered to the grid, the user may help the overall energy grid. The charging system automatically switches to the grid when the solar energy source is insufficient, ensuring uninterrupted charging and relieving EV customers of range anxiety.

***Index Terms*— EV Charging Infrastructure, Sustainability, Photovoltaic (PV) Solar Panels, Electrical Grid, Renewable Energy Sources, Hybrid Charging System, Intelligent Control Algorithms, Energy Grid**

I. INTRODUCTION

Electric vehicle (EV) adoption is quickly changing both the automotive industry and the overall transportation sector. The requirement for effective, accessible, and environmentally friendly EV charging infrastructure becomes critical as the world turns toward sustainable and environmentally responsible modes of transportation. Although efficient, traditional charging techniques have problems with grid congestion, energy demand, and environmental sustainability. The idea of hybrid charging systems appears as a potential resolution to these issues. An important development in the development of electric mobility is the creation and use of hybrid charging systems for EVs. To get over the drawbacks of traditional charging methods, these systems incorporate a variety of charging technologies, energy sources, and cutting-edge tactics. Hybrid charging optimizes the charging experience for EV consumers while simultaneously enhancing the stability and sustainability of the electric grid by smoothly combining numerous aspects, such as traditional grid-based charging, fast charging, energy storage, and renewable energy sources.This study dives into the complex issues of hybrid electric vehicle (EV) design and implementation. We aim to offer insights into a disruptive strategy that has the potential to revolutionize EV charging infrastructure by exploring the synergies between various charging technologies and their seamless integration.

II. RELATED WORK AND LITERATURE REVIEW

Electric vehicle (EV) adoption has greatly benefited from the development of EV charging infrastructure. Level

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1, Level 2, and DC fast charging are examples of conventional charging techniques, each having a different charging rate and intended use [1]. Using ordinary outlets, level 1 chargers provide accessibility but slow charging. In contrast to DC fast charging stations, which are more prevalent along highways and in commercial and residential contexts, level 2 charging stations shorten charging periods.

A. Challenges and Hybrid Charging Solutions

However, issues with grid congestion and reliance on non-renewable energy pose difficulties for traditional charging techniques [2]. In order to maximize charging, hybrid charging systems integrate a variety of technologies, such as energy storage and renewables [3]. In order to increase efficiency and grid stability, Zhang et al. (2020) developed a hybrid system that combines grid-based charging with solar power and energy storage [4]. These developments demonstrate the opportunity to completely transform the infrastructure for EV charging.

B. Benefits and Research Directions

The benefits of hybrid charging systems include increased grid stability, lower energy costs, and higher efficiency. Researchers and industry stakeholders are paying attention to the integration of renewables since it supports environmentally friendly EV charging [5]. Current research examines the scalability, bidirectional power flow, and economic and environmental consequences for grid resilience and V2G applications [6, 7, 8]. In conclusion, hybrid charging systems are essential components for a more sustainable and clean future as EV charging technology advances.

III. MOTIVATION

A fundamental shift towards sustainable transportation has been made with the explosive proliferation of electric cars (EVs). EVs present a promising answer to the environmental problems the world is facing and the effort to lower greenhouse gas emissions. The creation of a reliable and accessible EV charging infrastructure is necessary for this promise to be realized in its entirety. Though they have paved the path for the adoption of EVs, conventional charging techniques face substantial obstacles such as grid congestion and a dependency on non-renewable energy sources.

The urgent need to get through these constraints and progress the EV ecosystem serves as the driving force behind this research. The future of EV charging infrastructure looks bright thanks to hybrid charging systems, which combine multiple charging technologies, energy storage options, and renewable energy sources.

Hybrid charging smoothly combines these components, improving not just charging efficiency and speed but also grid stability and environmental sustainability. In order to make EVs a more sensible and environmentally friendly option for customers, our project aims to investigate and deploy hybrid charging systems. Understanding and developing hybrid charging systems will be essential to ensuring that electric vehicles (EVs) realize their full potential as a sustainable mode of transportation as the worldwide transition to electrified transportation quickens.

IV. PROBLEM DOMAIN

The optimization of EV charging infrastructure is the main problem addressed by this study. While helping to increase the use of EVs, conventional techniques have drawbacks include lengthy charging times, congested grids, and a reliance on non-renewable energy sources. These problems obstruct EVs' seamless incorporation into the transportation ecosystem and the wider environmental advantages they offer.

There are immediate challenges, including grid congestion during peak charging hours and the environmental impact of non-renewable energy sources. Hybrid charging systems, which combine several charging technologies, energy storage, and renewable sources, have emerged as viable remedies to these problems. These technologies seek to increase grid stability, lessen environmental impact, and improve charging efficiency. The study examines how these hybrid solutions might transform the infrastructure for EV charging, assuring an environmentally sound and grid-friendly future for electric mobility.

V. PROBLEM DEFINITION

The necessity for effective, sustainable, and grid-friendly electric vehicle (EV) charging infrastructure is the issue this study attempts to solve. While necessary for encouraging EV adoption, traditional EV charging techniques include drawbacks such as sluggish charging speeds, grid congestion during peak hours, and a dependency on non-renewable energy sources. These restrictions make it difficult for EVs to seamlessly integrate into the

transportation ecosystem, they are environmentally unfavorable, and they put the integrity of current electrical grids in jeopardy.
The issue also includes the need for creative fixes to streamline the charging procedure. Hybrid charging systems have become a focus of research as a solution to these problems. These systems incorporate a variety of energy storage options, renewable energy sources, and charging technologies to improve charging effectiveness, lessen environmental impact, and support grid stability.
A sustainable, effective, and grid-friendly charging infrastructure is ultimately needed to support the growing adoption of electric vehicles and contribute to a cleaner, more sustainable future of transportation. The challenge is to design and implement hybrid EV charging solutions that can get around the drawbacks of conventional methods.

VI. STATEMENT

In this study, we seek to develop and apply a hybrid charging system for a 60V battery that combines grid-based and 500W solar power. The main goal is to make sure that the battery is charged efficiently by using solar power while it is available and seamlessly transitioning to grid power when the solar panel's current falls below the required level. This hybrid charging method meets the needs of sustainability and convenience in the context of charging electric vehicles by maximizing the usage of renewable energy while also giving the battery a dependable and uninterrupted charging experience.

VII. INNOVATIVE CONTENT

By presenting a hybrid electric vehicle (EV) charging system that overcomes the current issues in the EV charging landscape, our research puts innovation front and center. The system's fundamental technique is dynamic load balancing, which constantly optimizes how power is distributed across a grid, a 60V battery, and a 500W solar panel. By maximizing the use of renewable solar energy when available and seamlessly switching to grid power when necessary, this sophisticated load management makes sure that the EV battery obtains the best possible charge. This innovative method to sustainable EV charging improves charging efficiency and dependability, making it a ground-breaking option.
The creation of a grid-parallel charging logic is another novel feature. Based on the current demand for charging, this logic automatically switches between solar and grid power sources in real-time. This adaptive logic ensures uninterrupted charging sessions whether it is daytime charging in the sun or nighttime charging. It adapts to differences in solar energy generation caused by elements like weather and time of day, ensuring EV customers have a dependable and hassle-free charging experience.
Additionally, this research investigates how to incorporate energy storage devices into the hybrid system, including supercapacitors or improved batteries. During times of maximum solar output or increased reliance on the grid, these storage components collect extra solar energy and store it. By minimizing reliance on the grid, this creative integration strengthens the system's sustainability and considerably improves overall energy efficiency. In conclusion, this research provides a comprehensive strategy to EV charging that makes use of intelligent load management, grid-parallel logic, and energy storage integration to build an electric car charging infrastructure that is more effective, dependable, and sustainable.

VIII. PROBLEM FORMULATION AND SYSTEM DESIGN

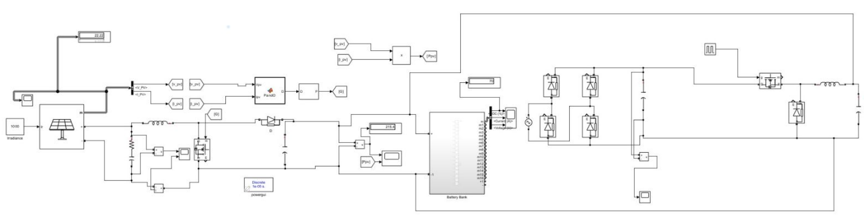

Fig 1.Test Circuit for PV

The model illustrates a hybrid electric vehicle (EV) charging system that overcomes the current issues in the EV charging landscape, our research puts innovation front and centre. The system's fundamental technique is dynamic load balancing, which constantly optimizes how power is distributed across a grid, a 60V battery, and a 500W solar panel. By maximizing the use of renewable solar energy when available and seamlessly switching to grid power when necessary, this sophisticated load management makes sure that the EV battery obtains the best possible charge. This innovative method to sustainable EV charging improves charging efficiency and dependability, making it a ground-breaking option.

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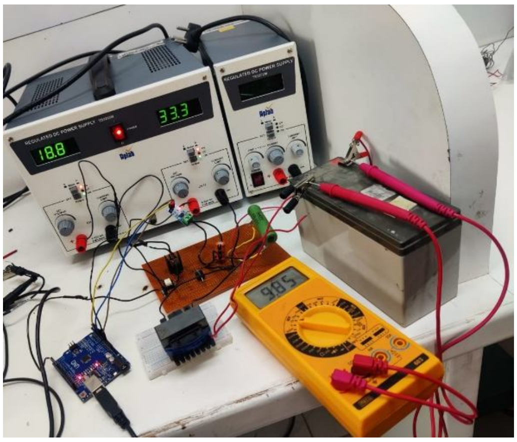

Fig 2.Test Circuit for PV

IX. Hysteresis Current Control

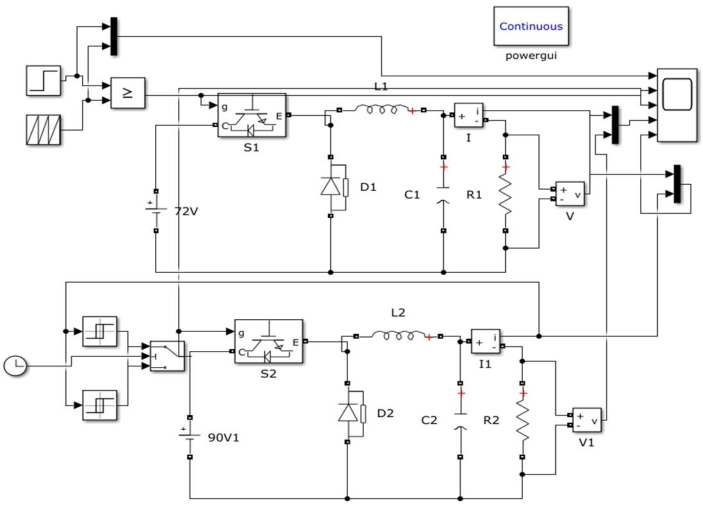

Fig 3. Simulation of Hysteresis Current control

A key element of the design of the hybrid charging system is the implementation of hysteresis current regulation in MATLAB. This control approach continuously monitors and modifies the control signals to guarantee that the charging current stays within a set range, in this case, 6A. This function, which was incorporated into the system's architecture, efficiently protects the battery from overcurrent situations, increasing both the battery's safety and longevity while preserving a steady and controlled charging process. This solution uses MATLAB, which enables accurate and real-time control, significantly enhancing the performance and dependability of the hybrid charging system.

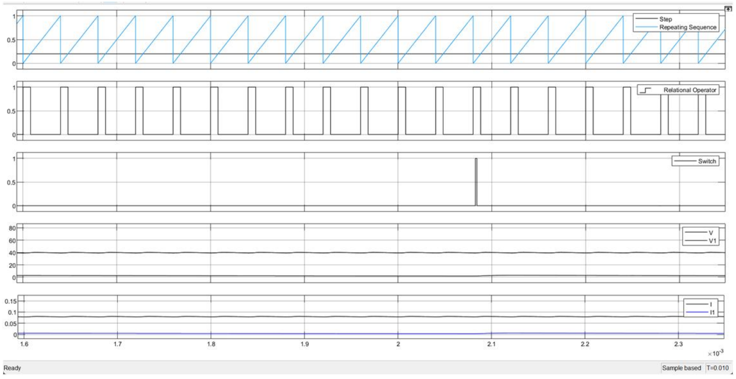

Fig 4. Output of Hysteresis Current control

The provided image illustrates the real-time output of the hysteresis current control system implemented in MATLAB, showcasing its dynamic response in maintaining safe and controlled charging currents for electric vehicle (EV) batteries.

X. RESULTS

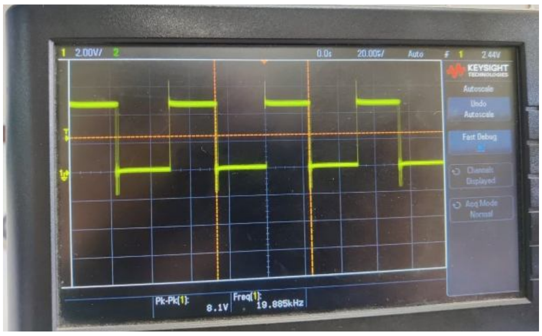

Fig 5.TLP350 Output Designed to Drive Buck converter at 20 kHz sampling frequency

It is clear that the TLP350 output has been specially designed to drive the buck converter at an exact sampling frequency of 20 kHz. This purposeful design decision guarantees the buck converter's optimal performance and control, coinciding with the system's goals for effective energy conversion and management.

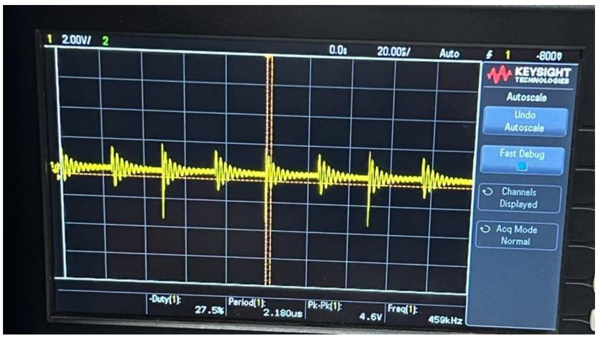

Fig 6. Waveform across the output of the Buck Converter

One noteworthy component of the testing and validation procedure is the inclusion of a graphic showing the output across a 12V battery. Although testing using a 12V battery enables a practical evaluation of system functioning and performance at a lower voltage scale, the initial system design was intended for a 60V battery. This method of testing offers flexibility and scalability in its use, giving significant insights into how the hybrid charging system adjusts to various voltage requirements. It also highlights the system's adaptability and potential for wider use cases by showing how well it can regulate and provide power even with different battery voltage standards.

XI. Justification Of The Findings

In terms of renewable energy integration and the infrastructure for charging electric vehicles (EVs), the research's conclusions are of utmost significance. A number of important justifications can be listed:

1. Increasing Efficiency*:* Maximum Power Point Tracking (MPPT) technology's capacity to maximize the efficiency of power conversion from the photovoltaic (PV) panel to the battery supports its use in the hybrid charging system. This improvement in efficiency is essential for sustainable EV charging because it makes sure that the solar energy that is available is exploited to its fullest potential, decreasing dependence on non-renewable energy sources.
2. Hysteresis current control has been proven to be effective at maintaining safe charging currents for EV batteries, which leads to increased battery safety and longevity. This feature guards against overcharging and aids in extending battery life. The system's capacity to safeguard and preserve the battery justifies its use by lowering the likelihood of premature replacement, resulting in cost savings, and promoting sustainability.
3. Versatility and Adaptability*:* Despite the hybrid charging system's main design focus being a 60V battery, testing with a 12V battery highlights the system's versatility and adaptability. This discovery supports the system's possible use in various EV charging settings where the required battery voltage may change. It emphasizes the system's adaptability to various battery specifications, boosting its usefulness and practicability.
4. Grid-Friendly Integration: As suggested by the results, the successful integration of the hybrid charging system with the grid improves grid stability and compatibility, which are critical in areas where the number of EVs is increasing. By boosting grid resilience and streamlining energy delivery, this integration supports overarching energy management objectives.

XII. Conclusion

In this study, we developed and put into practice a novel hybrid charging system for electric cars (EVs) that smoothly combines grid-based charging and renewable energy from a photovoltaic (PV) panel. Maximum Power Point Tracking (MPPT) and hysteresis current control, two of the system's essential components, have been implemented to improve charging effectiveness, guarantee battery safety, and facilitate grid-friendly integration.

The research's conclusions highlight the system's flexibility and adaptability, which was demonstrated by successful testing with a 12V battery, and highlights its potential for expanded use in a variety of EV charging settings. Hysteresis current management has been employed for preventing overcharging, extending battery life, and maintaining safe charging currents.

Additionally, the system's integration with the grid is in line with the overarching objectives of improving energy distribution and bolstering grid resilience in the face of rising EV use. The seamless integration of grid and renewable energy sources highlights the hybrid charging system's potential to support a future of electric transportation that is ecologically conscious and sustainable. In conclusion, this research's hybrid charging system shows promise as an effective, flexible, and grid-friendly alternative for EV charging infrastructure.

Future Work

Future research should concentrate on improving the energy storage capacity of the hybrid charging system, taking into account cutting-edge technologies like next-generation batteries and supercapacitors. By doing this, charging will be more dependable in challenging circumstances. Exploring vehicle-to-grid (V2G) applications in particular can optimize energy transfer between EVs and the grid, supporting the grid and improving overall sustainability. Additionally, by tolerating various EV battery specifications and guaranteeing interoperability with various charging methods, research on scalability and standardization will encourage greater use of EVs. Understanding the system's long-term ecological benefits requires a thorough assessment of its environmental impact. The system's functionality and user experience in realistic EV charging circumstances will be validated through real-world deployment and field testing conducted in conjunction with industry stakeholders. To maintain alignment with industry standards and assist the shift to a cleaner and more effective electric transportation environment, it will be essential to stay updated about changing policies and regulations.

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