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Chairman's Message

It is my distinct honor and privilege to welcome you to the International Conference on Sustainable Solutions in Engineering and Technology, hosted by Basaveshwar Engineering College. This prestigious event brings together thought leaders, researchers, and practitioners from around the globe to explore innovative solutions that address the critical challenges of sustainability in engineering and technology.

Our Sangha is deeply committed to fostering an environment of academic excellence and innovation. We believe that the interdisciplinary exchange of knowledge and ideas at this conference will lead to meaningful collaborations and impactful solutions. The topics covered here, ranging from renewable energy to sustainable infrastructure, are crucial for building a resilient and sustainable world.

The themes and discussions of this conference are more pertinent than ever as we face the dual imperatives of advancing technology and preserving our environment. I am confident that the insights and solutions that emerge from this conference will make significant contributions to our shared mission of sustainability.

I extend my heartfelt thanks to all the keynote speakers and participants for making this event successful. I congratulate the organizers for their hard work and dedication.

Dr. Veeranna C. Charantimath
Chairman,
B. V. V. Sangha, Bagalkote

Secretary's Message

As we navigate the complexities of modern development, it is imperative that we integrate sustainable practices into every facet of our technological advancements. This conference provides a vital platform for researchers, practitioners, and innovators to share their insights, discoveries, and strategies for creating sustainable solutions that will shape our future.

At Basaveshwar Engineering College, we are deeply committed to fostering an environment of academic excellence and innovation. Our goal is to drive forward the boundaries of knowledge and practice in ways that are sustainable and beneficial for society as a whole. This conference is a testament to our dedication to these principles and our belief in the power of collaborative effort.

Shri. Mahesh Athani
Hon. Secretary
B. V. V. Sangha, Bagalkote

Technical Director's Message

I am particularly excited about the innovative solutions and cutting-edge research that will be presented during this conference. The intersection of engineering and sustainability presents unique challenges and opportunities, and it is through gatherings like this that we can share knowledge, inspire innovation, and collaborate on projects that will have a profound impact on our world.

Our commitment to sustainability is not just a goal but a guiding principle that influences all aspects of our work. This conference is an ideal platform to explore new ideas, methodologies, and technologies that can lead to sustainable growth and development. The diverse array of topics and the expertise of our participants promise a rich and enlightening experience for all.

I extend my heartfelt thanks to all the participants, keynote speakers, and organizing committee members for their dedication and hard work in making this conference a reality. Your contributions are invaluable to the success of this event and to the advancement of sustainable engineering and technology.

Dr. R. N. Herkal
Director of Technical Institutes
B. V. V. Sangha, Bagalkote

Principal's Message

Dear Collegues & Researchers

I feel happy to organize International Conference titled "Sustainable Solutions in Engineering and Technology" in Basaveshwar Engineering College, Bagalkote. This prestigious event, promises to be a landmark occasion, bringing together leading experts, researchers, and innovators from around the globe.

Focus of this conference will be on exploring cutting-edge approaches and technologies that address the pressing challenges of sustainability in engineering and technology. With a diverse array of topics ranging from renewable energy solutions and sustainable materials to smart infrastructure and green manufacturing, we aim to foster collaboration and inspire breakthrough ideas. Researchers from all disciplines gather here to explore the multidisciplinary approaches in designing and implementing systems that meet present needs without compromising the needs of future generations.

Our institution is honored to be the venue for this significant event and is committed to providing an enriching experience for all participants. We are confident that the key notes from experts, presentations from researchers will lead to valuable insights and partnerships that will drive forward the agenda of sustainable development.

I extend my deepest gratitude to Management for their continued support. I thank all the Keynote speakers, participants and orgnaising committee members for their continued support and engagement in this crucial event.

Dr. Veena Soraganvi
Principal
BEC, Bagalkote

Dean (R & D)'s Message

Dear Esteemed Colleagues and Participants,

It is with great pleasure and pride that I welcome you to the International Conference on Sustainable Solutions in Engineering and Technology. This conference is a testament to our collective commitment to advancing research and innovation in ways that are both technologically forward-thinking and environmentally sustainable.

Our institution has long been at the forefront of fostering research that addresses global challenges. This conference serves as a crucial platform for sharing knowledge, exchanging ideas, and forging collaborations that can lead to sustainable advancements. The contributions from our distinguished speakers and participants are essential for driving forward the agenda of sustainable development in engineering and technology.

I extend my deepest appreciation to all the researchers, practitioners, and organizers who have worked tirelessly to make this conference a success. Your dedication and expertise is the cornerstone of this event, and your contributions are instrumental in shaping a sustainable future.

Let us seize this opportunity to collaborate, innovate, and inspire one another as we work towards sustainable solutions that will benefit not only our generation but those to come.

Dr. Mahabaleshwar S. K.
Dean (R & D) and ICT
BEC, Bagalkote

CONTENT

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27. Anti-Sinking Airbag and Indicating System for Vehicle during Flood

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Abstract:

Floods pose significant risks to vehicles, often leading to dangerous situations for occupants and complicating rescue operations. This paper introduces an innovative anti-sinking airbag and indicating system designed to enhance vehicle safety during floods. The proposed system automatically deploys airbags to buoy the vehicle when floodwater reaches critical levels, preventing it from submerging. Simultaneously, an integrated indicating system alerts occupants and emergency services about the vehicle's status and location, facilitating prompt rescue efforts. The anti-sinking airbag system is equipped with advanced sensors and deployment algorithms to ensure rapid and effective response during flooding. The indicating system utilizes communication protocols to provide real-time updates on the vehicle's condition, thereby improving the coordination of emergency services. This dual-function system not only enhances occupant safety but also contributes to more efficient and effective emergency responses during flood events. This paper details the design, functionality, and integration of the anti-sinking airbag and indicating system, highlighting its potential impact on vehicular safety standards. By addressing a critical gap in existing vehicle safety technologies, this research aims to pave the way for the development of more resilient transportation solutions capable of withstanding the challenges posed by severe flooding.

Keywords:

Anti-sinking airbag, Flood safety, Vehicle safety systems, Emergency response, Buoyancy, Sensor integration, Real-time communication, Automotive safety technology, Disaster management.

I Introduction:

Floods are among the most devastating natural disasters, causing extensive damage to infrastructure and posing significant risks to human life. Vehicles, which are essential for daily transportation, are particularly vulnerable during floods, often becoming immobilized and leading to dangerous situations for occupants. Traditional vehicle safety systems primarily focus on accident prevention and occupant protection during collisions, but they fall short in addressing scenarios where vehicles encounter sudden flooding [1-3].

In recent years, there has been a growing interest in developing innovative solutions to enhance vehicle safety during floods. This paper presents a novel approach: an anti-sinking airbag and indicating system designed specifically to mitigate the risks associated with vehicular flooding. The proposed system aims to provide an automatic response mechanism to prevent vehicles from sinking when exposed to floodwaters, thereby increasing the chances of occupant survival and vehicle recovery [4-7].

The anti-sinking airbag system is engineered to deploy when the vehicle detects a significant rise in water levels, buoying the vehicle and preventing it from submerging. Concurrently, the indicating system alerts occupants and emergency services about the vehicle's status and location, facilitating timely rescue operations. This dual approach not only enhances the immediate safety of the vehicle's occupants but also contributes to a more efficient and coordinated emergency response.

This paper will delve into the design and functionality of the anti-sinking airbag and indicating system, exploring the underlying mechanisms and technologies involved. It will also discuss the integration of sensors, deployment algorithms, and communication protocols essential for the system's effectiveness. Furthermore, the paper will analyze the potential impact of this technology on vehicular safety standards and its implications for future automotive designs. By addressing a critical gap in current vehicle safety systems, this research aims to contribute to the development of more resilient transportation solutions capable of withstanding the challenges posed by increasingly frequent and severe flooding events.

II Literature Review:

The increasing frequency and severity of floods due to climate change have necessitated the development of innovative safety measures for vehicles. Traditional vehicle safety systems, which primarily focus on collision prevention and occupant protection, are inadequate in addressing the unique challenges posed by flood scenarios. This literature review explores existing research and technologies related to vehicular flood safety, highlighting gaps that the proposed anti-sinking airbag and indicating system aims to address.

Studies have shown that vehicles are particularly vulnerable during floods, often leading to life-threatening situations for occupants. According to research carried out by author, many flood-related fatalities occur in vehicles, with individuals attempting to drive through floodwaters. Traditional vehicle designs lack the mechanisms to prevent sinking or provide adequate alerts to occupants in such conditions [8].

Current flood mitigation technologies for vehicles are limited. Some advancement has been made in the area of water-resistant vehicle designs and elevated vehicle structures. However, these solutions primarily focus on minimizing water ingress rather than preventing vehicles from submerging. For instance, the development of water-resistant electronic components discussed in this paper has improved vehicle performance in wet conditions but does not address the issue of vehicle buoyancy during severe floods [9].

Airbags have been a crucial component of vehicle safety systems for decades, primarily used for occupant protection during collisions. Research by authors indicated the potential for adapting airbag technology for other safety applications. However, there is limited research on the use of airbags to enhance vehicle buoyancy. The concept of deploying airbags to prevent vehicles from sinking is relatively novel and has not been extensively explored in existing literature [10].

Effective communication is vital for timely emergency response during flood events. Advances in vehicle communication systems, such as those discussed by Campolo, have enhanced real-time data transmission and vehicle-to-infrastructure communication. These technologies provide a foundation for developing indicating systems that can alert occupants and emergency services about a vehicle's status during floods. However, there is a need for integrated systems that combine buoyancy aids with real-time communication capabilities [11].

The integration of sensors and deployment algorithms is critical for the effectiveness of any advanced vehicle safety system. Studies by Wang, highlights the importance of sensor accuracy and rapid response times in safety-critical applications. While significant progress has been made in sensor technology, there is a need for research focused on sensors capable of detecting water levels and triggering safety mechanisms in real-time [12].

Despite advancements in vehicle safety and flood mitigation technologies, there remains a significant gap in comprehensive solutions that address the challenges of vehicle flooding. Most existing systems focus on either enhancing vehicle resilience to water ingress or improving communication during emergencies. The integration of buoyancy aids, such as airbags, with indicating systems that provide real-time alerts has not been extensively researched. The review of existing literature reveals a critical need for innovative solutions to enhance vehicle safety during floods. The proposed anti-sinking airbag and indicating system aims to fill this gap by providing a dual-function approach that prevents vehicles from submerging and facilitates timely emergency response. By leveraging advancements in airbag technology, sensor integration, and communication systems, this research seeks to contribute to the development of more resilient and safer vehicles capable of withstanding the challenges posed by flooding events.

III Proposed Methodology:

The anti-sinking air bag and indicating system is a systematic integration of electronic sensors, associated signal conditioning circuits, electronic controller unit, an airbag inflation system and an indicating unit. Figure 1 depicts the complete system showing the vital parts of it.

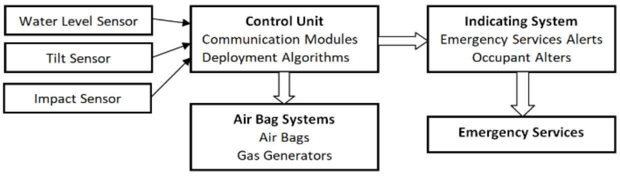

Figure 1: Block diagram of the system

The system consists of water level sensor, tilt sensor and impact sensor. Water level sensor is essential for measuring the water level around the vehicle. Tilt sensor provides the information about the tilt of a vehicle during flood conditions. Impact sensor provides the information regarding any accidents that may occur due to flood situations. These three-sensor data are collected by the control unit for data analysis. Based on these sensor data, the control unit will send the necessary information to indicating system and the air bag systems. The control unit is the heart of this system. After receiving the real time data from the sensors, the control unit processes and analyzes the data. Also, it decides when to inflate the airbags. The air bags are made up of nylon 66 so that it can provide buoyancy to the vehicle. Gas generators are also necessary to inflate the air bags quickly in the flood situation. Along with real time data processing, it has to manage GPS and wireless communication for sending alerts like emergency service alerts and occupant alerts. Occupant alerts are in the form of visual and auditory warnings. Also in emergency situations, the indicating system will provide the location and status information to emergency responders for the quick services.

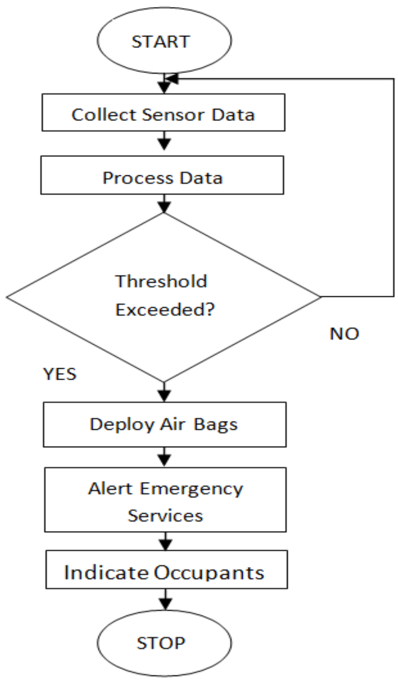

Figure 2: Flow chart of measurement and control

The structure and workflow of the system highlighting the integration and interaction between various subsystems to ensure vehicle safety during floods are shown in this block diagram.

The flow chart for the system is shown in Figure 2. Initially the sensors used in the system will measure the data. A water level sensor is a device designed to detect the level of water in a given environment and provide an output signal indicating the water level. It can be used in various applications, including flood detection systems, industrial processes, and household appliances. The sensor monitors the presence and level of water. It does so using various detection mechanisms such as conductivity, pressure, optical, and ultrasonic methods. The sensor converts the detected water level into an electrical signal. The sensor sends the processed signal to a control unit and display system, which can trigger actions like alerts, pump activation and in this system deploying the air bags.

A tilt sensor is a device that measures the tilt or inclination of an object with respect to gravity. It detects the orientation and motion of an object and converts the tilt into an electrical signal that can be read by a microcontroller or processing unit. Tilt sensors are widely used in various applications, including automotive safety systems, mobile devices, and industrial machinery. Tilt sensors typically use accelerometers, liquid-filled tubes, or mercury switches to detect changes in orientation. The sensor converts the detected tilt into an electrical signal. The sensor sends the processed signal to a control unit, which can trigger actions like alerts or adjustments.

An impact sensor is a device designed to detect and measure sudden forces or shocks exerted on an object. These sensors are crucial in various applications, including automotive safety systems, industrial machinery, and consumer electronics, where they help in detecting collisions, falls, or any sudden impacts. Sensing Mechanism: Impact sensors detect sudden changes in force or acceleration. They can use various technologies such as piezoelectric materials, accelerometers, or strain gauges. The sensor converts the detected impact into an electrical signal. The sensor sends the processed signal to a control unit, which can trigger actions such as alerts, system shutdowns, or safety mechanisms.

These sensors are crucial for ensuring vehicle safety, especially in dynamic environments such as during a flood. Their integration into safety systems helps detect potential hazards and trigger necessary actions to protect the vehicle and its occupants. The control unit is the microcontroller which can take decisions based on the real time data received from sensors. A threshold values are defined and if the measured sensor values are more than the threshold, the control unit will perform two tasks: it sends the emergency alert messages using GPS and GSM technologies and also the activation signal is provided to air bag system to deploy air bags.

Using these, the system is able to provide safety to the vehicle and occupants.

IV Discussion and Conclusion:

Flooding is a significant issue worldwide, particularly during the monsoon season in India. Flood risks affect both human life and vehicles, necessitating proper management of parked vehicles in flood-prone areas. To address this, an innovative system has been proposed to enhance vehicle safety during floods, which includes an anti-sinking airbag and an indicating system. Advanced sensors embedded in the vehicle bottom detect rising water level. An algorithm in the electronic controller ensures rapid and effective airbag inflation. When floodwater reaches critical levels, airbag is inflated to buoy the vehicle, preventing it from submerging. The system has multiple advantages: Ensures enhanced safety of vehicle occupants, real-time updates and alerts to improve the effectiveness of emergency services and minimizes flood-related vehicle damage.

Designing and developing an intelligent system to buoy the vehicles during floods is a crucial application that integrates sensors, electronic systems, and airbags. This innovative system aims to provide significant technological support for rescuing vehicles and alerting rescue management personnel, thereby enhancing rescue operations during floods. The proposed dual-function system, comprising an anti-sinking airbag and an indicating system, offers a significant improvement in vehicle safety during floods. By ensuring rapid response and effective communication, this system not only protects vehicle occupants but also contributes to more efficient emergency management during flood events.

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28. Combined Effect of Noise Reduction and Multiband Frequency Compression for Improving Speech Perception in Monaural Hearing Aids on Source Localization

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Abstract:

People with sensorineural hearing loss have wider auditory filters. The wider auditory filters have relatively smooth spectrum representations. This induces spectral masking, which impairs hearing-impaired people's ability to understand speech. The speech becomes less understandable when there is background noise, too. Therefore, it is important to select the best hearing aid algorithms like frequency lowering, frequency transposition, and frequency compression to minimize the effects of spectral masking. In order to enhance speech perception, it is therefore imperative to use noise reduction techniques in conjunction with hearing aid algorithms, but typically, these parts are created and evaluated separately. Therefore, the goal of the current study is to evaluate the combined effect of multiband frequency compression and noise reduction techniques on sound source localization for improving speech perception in monaural hearing aids. In the present work, we have investigated the impact of this approach on source localization with a compression factor of 0.6. The listening tests conducted for 7 different azimuth angles (-90°, -60°, -30°, 0°, 30°, 60°, and 90°) on 6 listeners with normal hearing under various signal to noise ratio (SNR) situations and on 6 listeners with mild sensorineural hearing loss (SNHL) showed that there is no detrimental effect on localization.

Keywords:

Hearing aids, multi-band frequency compression, Noise reduction, Sensorineural hearing loss, Source localization.

I Introduction:

Humans deal with localization of sound on every day: when crossing a roadway, it is necessary to know if an automobile will be coming or not, this is done either through visualization or with the sound source localization. A person must also identify the direction of sound source when someone shouts their name. To do all this brain is required to pinpoint the location of an event's source position hundreds of times every day. But how humans are doing it? The fact that people have two ears is the essential factor. This feature, together with the unique structure of the outer ear (pinna), contributes to humans' incredible ability to locate sound sources is discussed in thesis [1]. Numerous technical applications, such as locating an active speaker or enhancing the signal to noise ratio in hearing aids, depend on localization.

Intermural time difference (ITD), intermural level difference (ILD), and spectral cues are three acoustic cues that must be perceptually integrated in order to localize a sound source [2] - [6]. In order to locate sources in the horizontal plane, ITD and ILD are the most essential signals. ILD is significant at higher frequencies, whereas ITD is significant at lower frequencies, based on the "duplex" concept of binaural localization [7]. When locating in the vertical plane and differentiating between the rear and the front, spectral hints of the high frequency (> 5 kHz) signals produced by sound diffraction by the pinna are important. ITD varies with the distance between the two ears, ranging from a minimum value of 0 for a sound originating from directly ahead to a value of around 690 μs for a sound coming from a source directly across from one ear. ILD ranges from 0 to 20 dB [8], [9].

Over the years, many attempts have been made to determine the relationship between the location of a sound source in space and the sound pressure that source generates at a listener's eardrums. Traditionally, this link has been shown using the head related transfer function, or HRTF [10], [11].

Compared to individuals who can hear properly, hearing-impaired people have a wider auditory filter. Frequency selectivity decreases due to increased masking effects. Speech perception is often impaired by sensorineural hearing loss due to increased hearing levels, intensity recruitment, a lower dynamic range, and raised temporal and spectral masking [12]. Automated gain control, frequency selective gain, and multichannel dynamic range compression with customizable release time, number of channels, attack time, and compression ratios are features found in many hearing aids [13], [14]. In order to further enhance speech perception, many techniques have been suggested to lessen the effects of maximum intra speech spectral masking brought on by broadening of auditory filters [15] - [17]. By studying all these techniques in this work we have come up with combined effect of noise reduction and multiband frequency compression for improving speech perception in monaural hearing aids on source localization.

The frequency compression technique is built on the basis of auditory critical bands [18] - [20]. With this technique, the voice signal was pushed into the middle of every significant band along the frequency axis. FFT was calculated for very frame after the input voice was separated into segments using a Hamming window. It was compressed in the range of 0.1 and 0.9. After piecewise frequency compression, the magnitude spectrum and the original phase spectrum were combined.

The new voice signal was created using the overlap-add technique. Participants with hearing impairments took part in listening tests fifty vowel-consonant-vowel (VCV) syllables were used as the test material from a male speaker. With compression between 0.2 and 0.4, the recognition percentage went from 35.4% to 38.3% for the unprocessed set to the greatest performance.

A comparison of horizontal localization and speech perception in noise with and without digital noise reduction (DNR) activation in hearing aids with and without an ear to ear synchronization is given in [21]. Participants were 25 listeners with mild to moderate bilateral sensorineural hearing loss, ranging in age from 18 to 55 years. A root-mean-square degree of inaccuracy was used to assess each participant's ability to locate horizontal sound sources. The signal-to-noise ratio needed to get a 50% recognition score (SNR-50) for voice recognition in the presence of speech babble noise was calculated. Additionally, SNR-50 was assessed using noise sources coming from four distinct angles, and it was recorded under four assisted scenarios both with and without the independent activation of wireless links and DNR. According to the results of the current study, hearing aids with wireless synchronization and DNR turned on performed better across all of the metrics. Nevertheless, depending on the direction of noise and speech, the increase in scores may or may not be advantageous to the listener. The subsequent sections present the proposed work, tests, results and conclusion.

II Proposed Method:

A coordinate system, as shown in Figure 1, must be provided in order to describe localization in the three-dimensional space.

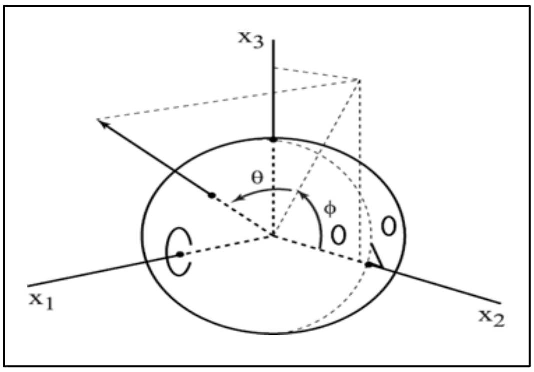

Figure 1: Coordinate system relative to the head with azimuth θ and elevation φ

Azimuth (θ), which also refers to the horizontal plane that determines the left-to-right direction, is a term used to describe how the sound source is positioned in relation to the head. Elevation (ϕ) refers to the vertical surface that indicates the direction of upward and downward motion. The horizontal surface is represented by the x_1 and x_2-axes in Figure 1, while the vertical surface is represented by the x_2 and x_3-axes. Although sound enters both ears, the brain distinguishes between information obtained from binaural signals and information obtained from monaural signals. Information concerning the interaural time difference (ITD) and interaural level (intensity) difference (ILD, IID) is sent by the signals that reach the left and right ears. This indicates that the incident sound wave reaches our ears at various times and volumes. One ear receives the sound before the other as long as the source is not directly in front of the head. Both ears signals are used to retrieve this information. The term "binaural cues" is used to describe them. Since ILD and ITD are the same for the left and right ears, sound sources that come directly in front of or behind a person do not provide them. Monaural signals are significant in this situation. The spectral structuring of the incident sound waves by the head, shoulders, torso, and, most importantly, the pinna, is represented by monaural cues, which are retrieved from the signal of one ear.

Elevation, azimuth and time all influence the head related impulse response 'h'. HRIR is sampled in the data files both temporally and spatially. The discrete indices naz, nel, and nt are used to specify azimuth, elevation, and time, respectively. A 3D array having dimensions of (25*50*200) is an HRIR h (naz, nel, nt). HRIR values are given for 25 different azimuths, 50 different elevations and 200 instants in time [22]. The azimuth is the angle between a vector to the sound source and the midsagittal or vertical median plane and varies from -90° to +90°. The elevation is the angle from the horizontal plane to the projection of the source into the midsagittal plane and varies from -90° and +270°. The azimuth index naz is related to the azimuth angle θ as follows

naz	θ	naz	θ	naz	θ	naz	θ	naz	θ
1	-80º	6	-35º	11	-10º	16	15º	21	40º
2	-65º	7	-30º	12	-5º	17	20º	22	45º
3	-55º	8	-25º	13	0º	18	25º	23	55º
4	-45º	9	-20º	14	5º	19	30º	24	65º

In MATLAB, the azimuth angle corresponding to naz is the naz-th element of the vector

Azimuths= [-80, -65, -55, -45: 5: 45, 55, 65, 80].

Both elevation and time are uniformly sampled. Elevations range from -45º to 230.625º in steps of 5.625º. In MATLAB, the elevation angle corresponding to nel is the nel-th element of the vector

Elevations= -45 + 5.625 *(0:49)

In the inter aural polar coordinate system, Table 1 shows the range of azimuth and elevation angle values for various places.

Table I: Azimuth and Elevation Directions in 3d Space

Azimuth	Elevation	Direction in 3D space
0º	0º	Ahead
0º	90º	Overhead
0º	180º	Behind
0º	270º	Below

Azimuth	Elevation	Direction in 3D space
90º	0º	To the right
-90º	0º	To the left

III Tests and Results:

The present work aims to evaluate the effects of multiband frequency compression and cascaded noise reduction on source localization in order to enhance speech perception for monaural hearing aids. During the experiment, two HRTFs were used to produce spatial sounds. The public domain CIPIC HRTF database provides HRTFs for various azimuth and elevation configurations, as well as a detailed explanation of the method used to quantify HRTFs and anthropometric features [23]. The HRTFs from this database for Subject 3, a KEMAR manikin participant, were used in the current experiment. They were for elevation angle of 0° and the frontal azimuth angles ranging from -90° (left) to +90° (right).

Six individuals who had normal hearing in the face of broad band masking noise and six individuals with mild sensorineural loss underwent hearing tests to study source localization. Broad-band random noise was used as a masker to the processed stimuli for participants with normal hearing. It was administered for a brief (10 ms) period of time at six SNR values: ∞, 6, 3, 0, -3, and -6dB. Without utilizing broad-band masking noise, hearing-impaired subjects were evaluated. Every time a test was administered, participants were given the option to choose their level of comfort with the binaurally presented sounds.

The aim of present work was to compare direction identification outcomes in processed and unprocessed conditions. The initial hearing tests were performed on 6 normal subjects while they were subjected to a broadband masking noise. Six SNR values were utilized to induce the noise: ∞ (no noise), 6, 3, 0, -3, and -6dB. Six subjects with modest bilateral sensorineural loss underwent the second round of testing without the use of masking noise. In both experiments, sounds were processed using HRTFs with 0º elevation and 0º, ±30º, ±60º, and ±90º azimuth angles. The participant was presented with a chart that detailed these directions, as shown in Fig.2. The stimuli that are processed for the various angles are delivered in a random sequence and 5 times every angle is repeated. One of these seven angles was recognized by the person as the direction of the source. Each perceived angle's mean was computed using the responses as columns in a stimulus response matrix.

Broad band noise and the sound of breaking glass as an ambient sound served as the test stimuli in the experiment with individuals who had normal hearing. All that was used as the test stimuli for the masking noise experiment was the sound of breaking glass. Therefore, each subject received a total of 210 presentations with masking noise (7 angles x 5 repetitions x 6 SNR values) and 35 presentations with no noise (7 angles x 5 repetitions). The stimulus-response matrix for the sound of breaking glass is depicted in Table 2 with responses from all six normal hearing participants combined. In an experiment with hearing impaired subjects, the sound of breaking glass served as one of the test stimuli. Each person received a total of 35 presentations (7 angles x 5 repetitions). Table 3 displays the stimulus-response matrix for the sound of breaking glass with the responses from all six hearing-impaired participants combined.

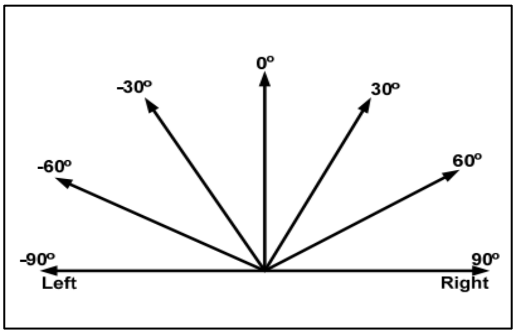

Figure 2: Azimuth Perception Test Reference Chart

Using wiener filters as a noise reduction approach, the suggested scheme processes the speech data to get the angle determination score (%) that is displayed in Figure 3. Six individuals with hearing impairments took part in the experiment. Based on these figures, we can see that there were no negative impacts on source localization according to the subjective evaluation of seven different azimuth angles conducted on six listeners with hearing impairment.

A. Graphical Analysis:

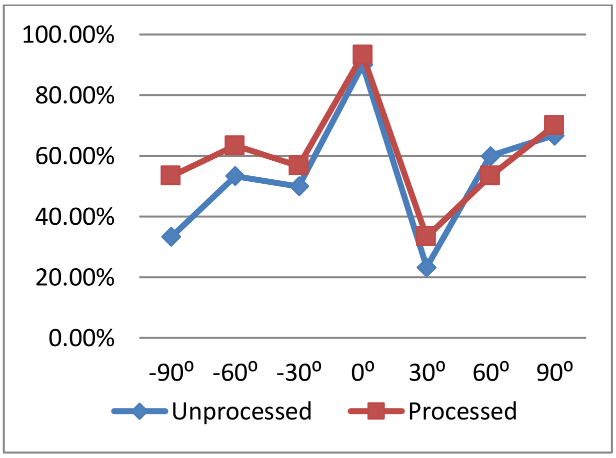

Figure 3: Angle determination score (%) in unprocessed & processed scenarios for 6 Hearing Impaired participants

B. Spectrographic Analysis:

Figures 4 and 5 below depict the hearing-impaired individuals left ear, right ear and wide band spectrogram of the unprocessed and processed glass breaking speech signal at a 90-degree angle. Figures 6 and 7 below depict normal hearing persons left ear, right ear and wide band spectrogram of the unprocessed and processed glass breaking speech signal spectra at a 90-degree angle and -6 dB. Sound spectrograms that have been processed indicate that background noise has been mostly eliminated and that the harmonic structure is unaffected by speech compression.

In case of normal hearing people unprocessed speech is the input speech with different SNR's and processed speech is the output from cascaded structure of noise reduction followed multiband frequency compression. In case of hearing impaired people unprocessed speech is the clean input speech and processed speech is the output from cascaded structure of noise reduction followed multiband frequency compression.

For unprocessed and processed speech with noise reduction and multiband frequency compression at several SNR levels and a compression ratio of 0.6, the average source direction identification by six participants with normal hearing is shown in Table 2. In comparison to raw voice at SNR values of ∞ dB, +6 dB, +3 dB, 0 dB, -3 dB, and -6 dB, respectively, the mean of processed speech values improved to 1.14, 4.14, 6.15, 5, 7.71, and 8.57 in the sound source direction identification. Additionally, it has been found that at lower SNR values, improvements in the ability to localize sound sources are considerable. The findings indicate that the individuals were able to perceive the source direction by utilizing ITD and ILD signals from different bands. For six hearing-impaired participants, Table 4 compares their percentages of angle recognition scores under unprocessed and processed situations using the stimulus of glass breaking sound. The percentage of the average stimulus-response matrix that has not been processed for the six hearing-impaired participants is 33.3%, 53.3%, 50%, 90%, 23.3%, 60%, and 66.7% at azimuth angles of -90°, -60°, -30°, 0°, 30°, 60° and 90° respectively. We can find that the localization performance is only up to 53.8% from the unprocessed stimulus-response matrix produced by performing listening tests. The percentage of the average stimulus-response matrix that has been processed among six hearing-impaired participants is 53.3%, 63.3%, 56.7%, 93.3%, 33.3%, 53.3%, and 70%, respectively, for azimuth angles of -90°, -60°, -30°, 0°, 30°, 60° and 90°. According to the processed stimulus-response matrix that was acquired from the listening tests, the localization performance was only up to 60.46%.

The subjective assessment for 7 separate azimuth angles on 6 listeners with normal hearing under different signal-to-noise ratio circumstances and 6 listeners with hearing impairment found no detrimental effects on source localization

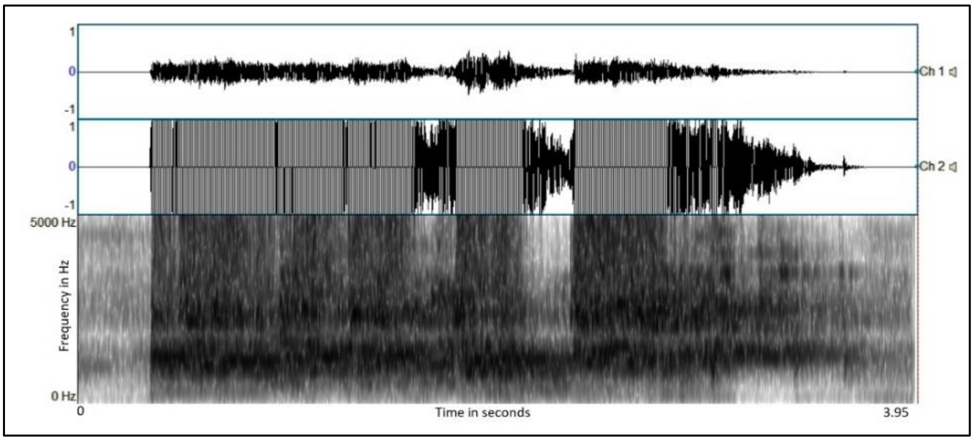

Figure 4: Hearing Impaired People Left Ear, Right Ear and Wide Band Spectrogram of Unprocessed Glass Breaking Speech Signal for 90-Degree Angle

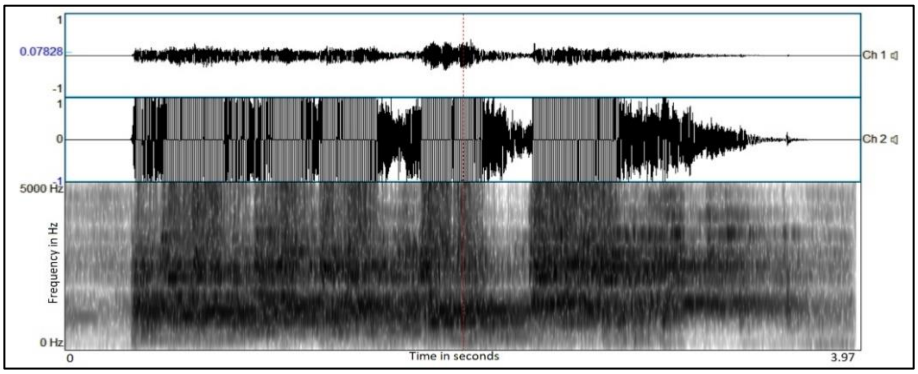

Figure 5: Hearing Impaired People Left ear, Right ear and Wide Band Spectrogram of processed glass breaking speech signal for 90-degree angle

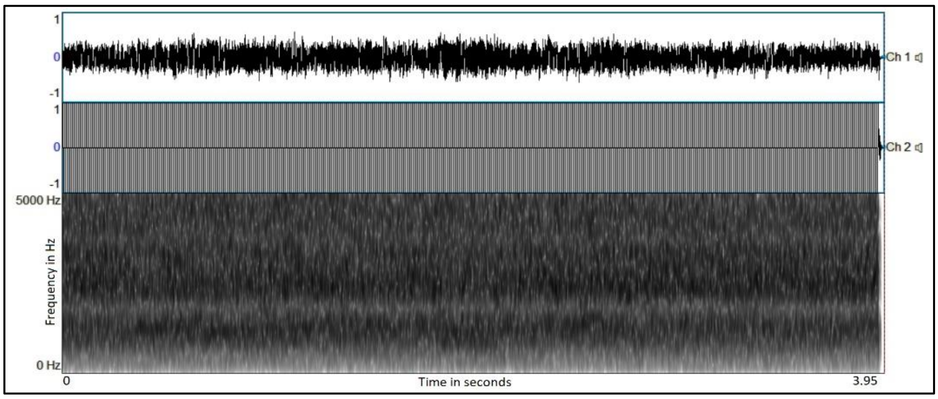

Figure 6: Normal hearing people Left ear, Right ear and Wide band Spectrogram of unprocessed glass breaking speech signal for -6 dB at 90 degree angle

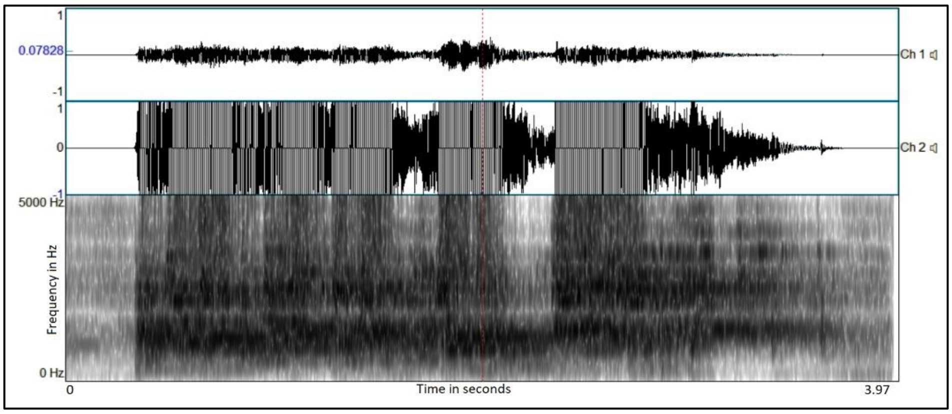

Figure 7: Normal hearing people Left ear, Right ear and Wide Band Spectrogram of processed glass breaking speech signal for -6 dB at 90-degree angle

Table II: Average Source Localization Values for Processed and Unprocessed Speech for The Six Normal Hearing Individuals at Various Snr Levels with The Sound of Breaking Glass

Angle (deg)	SNR (dB)											
	∞		6		3		0		-3		-6	
	Un processed	Processed	Un processed	Processed	Un processed	Processed	Un processed	Processed	Un processed	Processed	Un processed	Processed
-90°	20	22	21	26	15	25	20	26	17	29	14	26
-60°	16	17	17	22	14	24	15	21	14	24	12	21
-30°	14	16	13	17	17	20	14	18	12	20	10	19
0°	30	30	30	30	30	30	30	30	30	30	30	30
30°	15	16	14	20	13	21	12	19	14	19	11	20
60°	16	17	20	23	15	20	15	23	13	24	12	22
90°	**21**	**22**	**21**	**27**	**20**	**27**	**21**	**25**	**21**	**29**	**16**	**27**
Mean	18.86	20	19.43	23.57	17.71	23.86	18.14	23.14	17.29	25	15	23.57
Improvement	1.14		4.14		6.15		5		7.71		8.57	

Table III: Source Localization Scores for Presentation Angle Versus Perceived Angle in Hearing-Impaired Individuals. There Are a Total of 30 Presentations (5 Presentations X 6 Subjects) For Each Angle. Glass Breaking Sound Is the Test Material

Presented Azimuth angle(deg.)	Unprocessed Speech							Processed Speech						
	Perceived angle (deg.)							Perceived angle (deg.)						
	-90°	-60°	-30°	0°	30°	60°	90°	-90°	-60°	-30°	0°	30°	60°	90°
-90°	**10**	12	8	0	0	0	0	**16**	10	4	0	0	0	0
-60°	5	**16**	9	0	0	0	0	7	**19**	4	0	0	0	0
-30°	6	9	**15**	0	0	0	0	3	10	**17**	0	0	0	0
0°	0	0	2	**27**	1	0	0	0	0	2	**28**	0	0	0
30°	0	0	0	0	**7**	15	8	0	0	0	3	**10**	13	4
60°	0	0	0	0	3	**18**	9	0	0	0	0	6	**16**	8
90°	0	0	0	0	0	10	**20**	0	0	0	0	1	8	**21**

Table IV: Angle Determination Score (%) In Unprocessed and Processed Scenarios for Six Hearing-Impaired Participants

Presented Azimuth angle (deg.)	Unprocessed Speech							Processed Speech						
	Perceived angle (deg.)							Perceived angle (deg.)						
	-90°	-60°	-30°	0°	30°	60°	90°	-90°	-60°	-30°	0°	30°	60°	90°
-90°	**33.3%**	40%	26.7%	0%	0%	0%	0%	**53.3%**	33.3%	13.3%	0%	0%	0%	0%
-60°	16.7%	**53.3%**	30%	0%	0%	0%	0%	23.3%	**63.3%**	13.3%	0%	0%	0%	0%
-30°	20%	30%	**50%**	0%	0%	0%	0%	10%	33.3%	**56.7%**	0%	0%	0%	0%
0°	0%	0%	6.67%	**90%**	3.33%	0%	0%	0%	0%	6.67%	**93.3%**	0%	0%	0%
30°	0%	0%	0%	0%	**23.3%**	50%	26.7%	0%	0%	0%	10%	**33.3%**	43.3%	13.3%
60°	0%	0%	0%	0%	10%	**60%**	30%	0%	0%	0%	0%	20%	**53.3%**	26.7%
90°	0%	0%	0%	0%	0%	33.3%	**66.7%**	0%	0%	0%	0%	3.33%	26.7%	**70%**

IV Conclusion:

Based on previous studies and the findings from the current investigation, we can conclude that the issue of noise suppression, localization, and concerns particular to sensorineural hearing loss peoples, such as lower dynamic range, spectral and temporal masking, have received a substantial amount of attention for hearing aids. So, in addition to addressing the negative consequences of SNHL, a method that lowers background noise should also be included. In the current work, we have taken into account a cascaded structural mechanism that takes into account both the noise suppression and sensorineural hearing loss issues, namely a decreased dynamic range and spectral masking to study their impact on source localization. Comparing our previous work [24] on effect of multiband frequency compression for enhancing speech perception in monaural hearing aids on source localization with the current work (Noise minimization and Multi-band frequency compression), there is a little change over the source localization score of about 5.24% for processed speech in the latter one. Therefore, cascading structure of noise suppression and multiple-band frequency compression plays important role in improving speech perception in monaural hearing aids. If this method is applied to the analysis of speech signals in hearing aids, people with moderate sensorineural loss may be able to hear speech more clearly. To determine how effectively this strategy enhances speech perception and how noise reduction techniques impact source localization has to be evaluated with a larger number of subjects and a variety of test materials in the future work.

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29. Data Management in Edge Computing: Opportunities and Challenges

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Abstract:

In order to handle the enormous volumes of data produced by IoT and IIoT devices, edge computing has become an essential technological advancement. This review paper explores recent advancements in data management using edge computing, focusing on efficient data placement, retrieval, reduction mechanisms, privacy-preserving techniques, and energy-efficient scheduling. Additionally, the paper identifies existing gaps and challenges, offering insights into future research directions. Edge computing is a paradigm shift in data management, bringing computation and storage closer to the source. This article examines the introduction to edge computing, including its architecture, important advantages, problems, and real-world applications. The goal is to give a detailed overview of how edge computing can transform data management processes, improve performance, and overcome the constraints of standard cloud computing.

Keywords:

Edge computing, data management, data reduction, privacy-preserving, energy efficiency

I Introduction:

The explosion of IoT and IIoT devices has resulted in an unprecedented increase in data generation. Traditional cloud computing infrastructure is under pressure due to the exponential expansion of data created by Internet of Things (IoT) devices, mobile applications, and other digital services. The requirement for real-time data processing, low latency, and efficient bandwidth utilization has spurred the emergence of edge computing.

Traditional cloud computing infrastructures struggle to cope with this data influx, leading to latency issues, bandwidth constraints, and increased costs. By processing data closer to its source, edge computing offers a workable solution by lowering latency and speeding up reaction times.

A. Edge Computing Architecture:

Edge computing architecture involves several steps to ensure efficient processing of data close to the source. Here are the typical steps involved in designing and implementing an edge computing architecture:

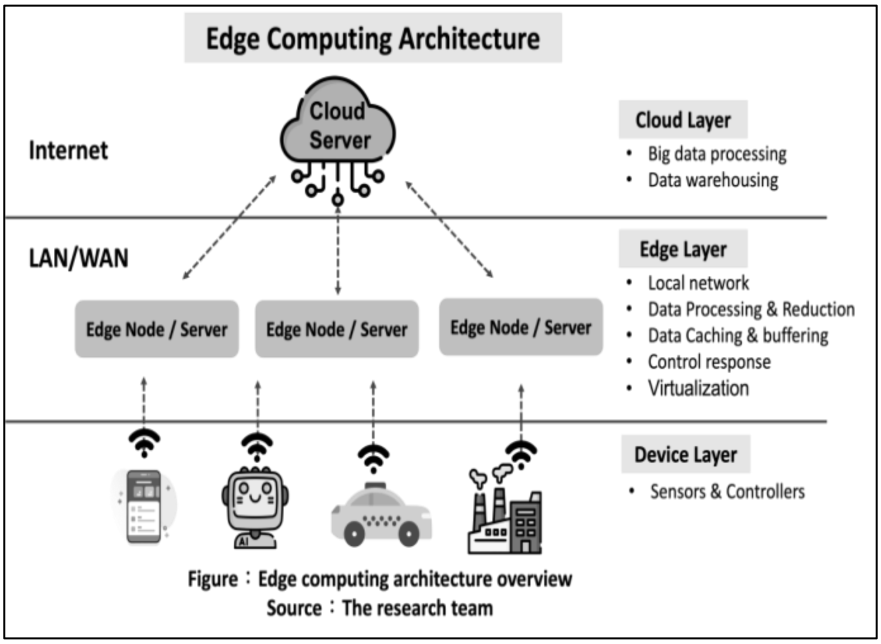

Figure 1: Edge Computing Architecture

Edge computing architecture comprises several key components:

1. **Edge Devices:** These include sensors, IoT devices, and other endpoints that generate data. Examples are smart thermostats, industrial sensors, and mobile devices.
2. **Edge Nodes:** Intermediate devices such as gateways, routers, and local servers that process and store data closer to the edge devices. These nodes perform preliminary data processing, filtering, and aggregation before sending relevant data to cloud servers if necessary.
3. **Edge Data Centers:** Smaller-scale data centers that provide additional processing and storage capabilities. They act as miniaturized versions of central data centers but are strategically located closer to the edge devices to reduce latency.
4. **Cloud Data Centers:** Centralized data centers that handle tasks that cannot be efficiently managed at the edge. They offer substantial computational power and storage capacity, supporting extensive data analysis, machine learning, and long-term storage.

B. Edge Computing Advantages Versus Cloud Computing:

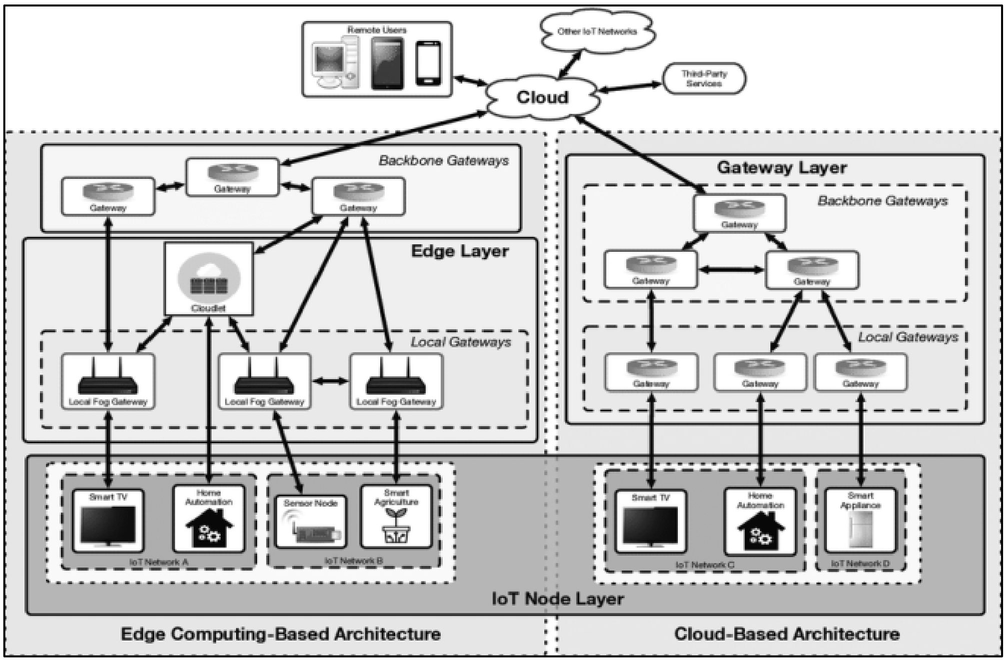

Figure 2: Edge Computing Advantages Versus Cloud Computing

1. **Closeness to Data Source:** By processing data locally, edge computing eliminates the need for data to travel vast distances to cloud data centers. Because data doesn't have to travel across the entire network to reach a central server, this close proximity improves speed and efficiency.
2. **Real-Time Processing:** Applications like driverless cars, industrial automation, and healthcare depend on real-time data processing and decision-making, which edge computing enables. Timely responses and actions are ensured via immediate data processing at the edge.
3. **Lower Latency:** Compared to cloud computing, edge computing offers faster response times by drastically lowering latency by shortening the distance data must travel. For latency-sensitive applications, where even little delays can have major repercussions, this is essential.
4. **Cost Savings:** By processing and storing data locally, edge computing can save expenses related to data transfer and cloud storage. Lowering the amount of data transferred to the cloud reduces the need for pricey cloud storage options as well as the cost of transmission.
5. **Improved Bandwidth Utilization:** By handling data processing at the edge, the strain on network bandwidth is reduced, leading to more efficient use of network resources. This is particularly important in environments with limited bandwidth or high data traffic.
6. **Improved Security:** By processing data locally, hazardous information is not as likely to be exposed when being transferred to and from cloud servers. The chance of illegal access and data breaches is reduced when data processing is done locally.

II Literature Survey:

A review of recent studies on data management in edge computing is presented in this section, with highlighting efficient data placement and retrieval, prediction-based data reduction, privacy-preserving methods, energy-efficient scheduling, Edge-Cloud Solutions for Big Data Analysis, Distributed Deep Learning and Offloading, Edge AI for Real-Time Processing, Deep Reinforcement Learning for Resource Allocation, Efficient Data Compression Techniques, and Efficient Data offloading etc. It also addresses current gaps and challenges in the field mentioned.

A. Edge-Cloud Solutions for Big Data Analysis:

Hybrid solutions for distributed machine learning and large data analysis are made possible by the combination of edge and cloud computing. Edge-cloud systems, which combine the low-latency benefits of edge computing with the processing capacity of the cloud, were covered by Loris Belcastro et al. [1]. The focus of their study is on the smooth synchronization of data across cloud and edge environments.

Gaps and Challenges:

- **Data Synchronization:** Guaranteeing effective and smooth data synchronization between cloud and edge systems.
- **Latency Issues:** Minimizing latency in hybrid edge-cloud environments.
- **Cost Management:** Managing costs associated with data transfer and storage between edge and cloud.

B. Edge AI for Real-Time Processing:

Real-time processing is made possible by Edge AI by allowing machine learning models to be deployed directly on edge devices. The use of AI models on edge devices, which greatly lowers latency and enhances real-time decision-making capabilities, is covered by Louis Frank [2]. Applications that demand quick reactions, like industrial automation and autonomous driving, benefit greatly from this strategy.

Gaps and Challenges:

- **Model Complexity:** Deploying complex AI models on resource-constrained edge devices is challenging.
- **Real-Time Processing:** Ensuring real-time processing while maintaining model accuracy and performance.
- **Energy Efficiency:** Balancing the computational load with energy consumption for AI processing on edge devices.

C. Prediction-Based Data Reduction:

Techniques for reducing data are essential for handling the enormous volumes of data that IIoT devices create. An effective edge data management paradigm using prediction-based data reduction methods was presented by Lei Yang et al. [4]. By predicting data trends and removing redundant data, this framework uses machine learning techniques to drastically lower storage needs and transmission expenses. Through selective edge processing of critical data, this strategy improves the overall IIoT system efficiency.

Gaps and Challenges:

- **Accuracy of Predictions:** The accuracy of predictive models can vary, leading to potential data loss or inaccuracies.
- **Resource Constraints:** Implementing sophisticated machine learning algorithms on resource-constrained edge devices is challenging.
- **Real-time Processing:** Achieving real-time data reduction while maintaining prediction accuracy is complex.

D. Privacy-Preserving Techniques:

Edge computing raises serious privacy issues, especially for sensitive applications like healthcare. Using edge computing, Lingbin Meng and Daofeng Li created a privacy-preserving method for smart healthcare systems [5]. By processing critical patient data locally at the edge, their approach minimizes exposure to external threats. Furthermore, a federated learning framework for privacy-preserving big data analysis in Internet of Medical Things (IoMT) was proposed by Akarsh K. Nair et al. This system ensures data privacy and security by enabling many edge devices to train machine learning models cooperatively without exchanging raw data [6].

Gaps and Challenges:

- **Data Security:** Ensuring robust data security measures at the edge is critical.
- **Communication Overhead:** Federated learning can introduce significant communication overhead.
- **Scalability:** Scaling privacy-preserving techniques to large networks of edge devices is challenging.

E. Energy-Efficient Scheduling:

Energy efficiency is a critical factor in the design of edge computing systems. Jing Liu et al. explored intelligent energy-efficient scheduling techniques using ant colony optimization for heterogeneous edge computing environments [7]. Their approach dynamically adjusts the scheduling of computational tasks based on real-time energy consumption metrics. Similarly, the study by Quy Vu Khanh et al. on sustainable smart cities proposes an efficient edge computing management mechanism, highlighting strategies for energy-efficient resource allocation and management [9].

Gaps and Challenges:

- **Resource Allocation:** Dynamic and efficient resource allocation is complex.

- **Energy Consumption:** Balancing energy consumption with performance remains a challenge.
- **Heterogeneous Environments:** Managing heterogeneous edge environments with diverse devices and capabilities is difficult.

F. Deep Reinforcement Learning for Resource Allocation:

Tongke Cui et al. investigated deep reinforcement learning-based resource allocation for content distribution in IoT-edge-cloud computing environments [8]. Their approach leverages reinforcement learning to dynamically allocate resources, ensuring optimal performance and resource utilization. This method is particularly effective in complex and dynamic environments where traditional static allocation strategies fall short. Nain et al. present a comprehensive study on resource optimization in edge computing integrated with Software-Defined Networking (SDN) [3]. This integration aims to enhance the efficiency, flexibility, and manageability of edge computing environments by leveraging SDN's centralized control and programmability features.

Gaps and Challenges:

- **Algorithm Complexity:** Managing the complexity of deep reinforcement learning algorithms.
- **Real-Time Adaptation:** Ensuring real-time adaptation of resource allocation strategies.
- **Scalability:** Scaling reinforcement learning-based approaches to large networks of edge devices.

G. Efficient Data Compression Techniques:

Another essential component of effectively managing data on edge devices is data compression. Nerea Gómez Larrakoetxea et al. suggested using data compression approaches to enable effective machine learning on edge computing [10] Their work focuses on data compression to make better use of edge computing capabilities by lowering transmission costs and storage requirements without sacrificing much information.

Gaps and Challenges:

- **Compression Algorithms:** Developing efficient compression algorithms that maintain data integrity.
- **Resource Constraints:** Implementing compression techniques on resource-limited edge devices.
- **Latency:** Minimizing the latency introduced by data compression and decompression processes.

H. Distributed Deep Learning and Offloading:

Computational offloading and distributed deep learning are essential for improving edge computing networks' capabilities. Distributed deep learning-based offloading strategies for mobile edge computing networks were studied by Liang Huang et al. Their method divides the processing burden among several edge devices [12]. Deep reinforcement learning-based resource allocation for content distribution in IoT-edge-cloud systems was investigated by Tongke Cui et al. [11].

Gaps and Challenges:

- **Workload Distribution:** Efficiently distributing workloads across multiple edge devices.
- **Network Stability:** Ensuring network stability and reliability during offloading.
- **Algorithm Complexity:** Managing the complexity of distributed deep learning algorithms.

I. Efficient Data Offloading:

Mingye Li et al. explored efficient data offloading using a Markovian decision process in edge computing. Their approach optimizes the decision-making process for offloading data from edge to cloud, considering factors such as network conditions, computational load, and energy consumption [10]. This ensures efficient utilization of resources while maintaining system performance.

Gaps and Challenges:

- **Decision Models:** Developing accurate and efficient decision models for data offloading.
- **Network Stability:** Ensuring network stability and reliability during offloading.
- **Resource Management:** Balancing the load between edge and cloud resources effectively.

J. Efficient Data Placement and Retrieval:

Optimizing edge computing performance requires efficient data insertion and retrieval. A system for effective data insertion and retrieval in edge contexts was presented by Junjie Xie et al. By distributing data among several edge nodes in a deliberate manner, their method reduces latency in data access and increases data availability [13]. The system ensures efficient data distribution and fast retrieval by using caching, replication, and partitioning algorithms.

Gaps and Challenges:

- **Dynamic Environments:** Existing models often assume static conditions, while real-world environments are dynamic.
- **Scalability:** Ensuring scalability while maintaining performance and reliability remains a challenge.
- **Data Consistency:** Maintaining data consistency across distributed edge nodes is complex.

III Real-World Applications:

- **Smart Cities:** Real-time data processing from cameras and sensors for environmental monitoring, public safety, and traffic control is made possible by edge computing. To improve security and traffic flow, for instance, local data analysis is possible with traffic signals and security cameras.
- **Healthcare:** By utilizing edge computing, medical sensors and wearable devices may instantly analyze health data and issue alerts. Improved patient outcomes and prompt treatments are made possible by local data processing and real-time vital sign monitoring.
- **Manufacturing:** Edge computing supports predictive maintenance and real-time monitoring of machinery and production lines. By analyzing data from industrial sensors locally, manufacturers can detect anomalies, predict equipment failures, and optimize production processes.
- **Retail:** Edge computing facilitates personalized customer experiences through real-time data analysis and inventory management. Retailers can analyze customer behavior locally to provide targeted promotions, manage inventory efficiently, and enhance the overall shopping experience.
- **Autonomous Vehicles:** Edge computing allows self-driving cars to process sensor data locally for faster decision-making. Real-time analysis of data from cameras, LiDAR, and other sensors enables autonomous vehicles to navigate safely and respond to changing road conditions.

IV Conclusion:

The reviewed studies highlight significant advancements in data management using edge computing. Efficient data placement and retrieval, prediction-based data reduction, privacy-preserving techniques, energy-efficient scheduling, and distributed deep learning are key areas where innovative solutions are being developed. However, several gaps and challenges remain, such as dynamic environment adaptation, scalability, data consistency, prediction accuracy, resource constraints, data security, communication overhead, resource allocation, energy consumption, and seamless integration of edge and cloud environments. Addressing these challenges is crucial for optimizing the performance, security, and energy efficiency of edge computing systems, paving the way for their widespread adoption in various IoT and IIoT applications.

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30. Development and Performance Testing of Automatic Seed Sowing Agri Robot

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ABSTRACT:

Agricultural development is one of the most powerful and vital sectors to end extreme poverty. It is an allied sector and also the major livelihood provider in the country. In this paper it is mainly focused on reducing the time taken for sowing the seeds and to minimize the work of a farmer with minimum time along with the technology that is more easily understood, implemented, and used by the farmers. Proposed model has a 4- 4-wheel robot system and an Arduino Uno board which will control entire system process. If the seed box is empty, then the ultrasonic sensor detects the level of the seed container and indicates its status on the LCD display. The seed sowing machine is developed to get at an affordable price. Also, the non-technical and unskilled farmer can also operate it very easily. The single-row seeding mechanism is very simple to use and the various adjustments are made with ease, which is maintenance-free. The system is powered with batteries, wheels are provided for the rotation and a dc motor is inbuilt with those wheels to carry out the seed sowing activity.

KEYWORDS:

Agriculture, Agri-robot, Arduino Uno, Grafana, Influx DBLCD Display, IR Sensor, Sowing machine, Ultrasonic Sensor.

I Introduction:

Agriculture contributes a significant figure level to our GDP. Sustainable changes are taking place in agriculture techniques such as seeding, soil loosening, fertilizing, ploughing and harvesting. Agriculture is crucial to our economic growth; hence it is very essential to maximize agricultural productivity with good quality yields. Automating the process of day-to-day seed plantation or seed sowing will minimize the farmer work and will be done errorless. The small and compact-sized robot performs well and is of lightweight which does not compact soil of the land [8].

A. Existing System:

The traditional way of showing the seed sowing is manual and faces plenty of the problems, traditional techniques largely depend upon manpower and takes more time required with more human efforts to accomplish the work. Humans cannot work for long hours so need to rest and also cannot work in environments which is hazardous. To complete one particular work in the agriculture sector, we need to have better manpower which is accomplished by an automated robot which does soil loosening and seed sowing task. The traditional way suffers from plenty of problems. So, the main aim of the proposed work is to minimize the human effort as well as the time requirement and to maximize the crop production with fine accuracy [2].

B. Proposed System:

The proposed system consists of a system that provides fast soil loosening, digging, seeding, and closing [2]. The robot is controlled by ATMEGA328PMicrocontroller with the help of a command received by the HC-05 Bluetooth Module robot which moves forward, backward, left, and right. The 12V adapter is used to energize the system. The Arduino Uno board is used to operate the complete system [9]. The three DC motors are used in robot applications whereas two motors are used as the wheel of the robot for the rotation of the robot and one DC motor for the seeding process where we can use the oneL293D motor driver motor to control two motors and another L293D motor driver is used to control the speed of seeding process. With the help of the Bluetooth module, agri-robot can operate as per user requirement to turn left, right, forward, and backward. The saw tooth mechanism set up is used to loosen the land soil and digging, and a mechanical setup are done for closing the soil.

II System Architecture:

The overall objective of the proposed work is represented in the block diagram which depicts how all different components are interconnected to each other to perform their own role to finish the particular work of this proposed work. Using a 12V adapter, the 12V supply is provided to the motor drive and for the Arduino Uno board a 9V battery is provided.

The code is written using 'Embedded C' language in the Arduino IDE Software which is given to Arduino as the input using a USB Arduino cable after that the Arduino Uno board is used to interface with all connected components such as L293D Motor Drive, Bluetooth module, Ultrasonic Sensor along with the display. An ultrasonic sensor is used to detect the availability of seed present in the container and the data will be displayed on the display screen.

A. Block Diagram:

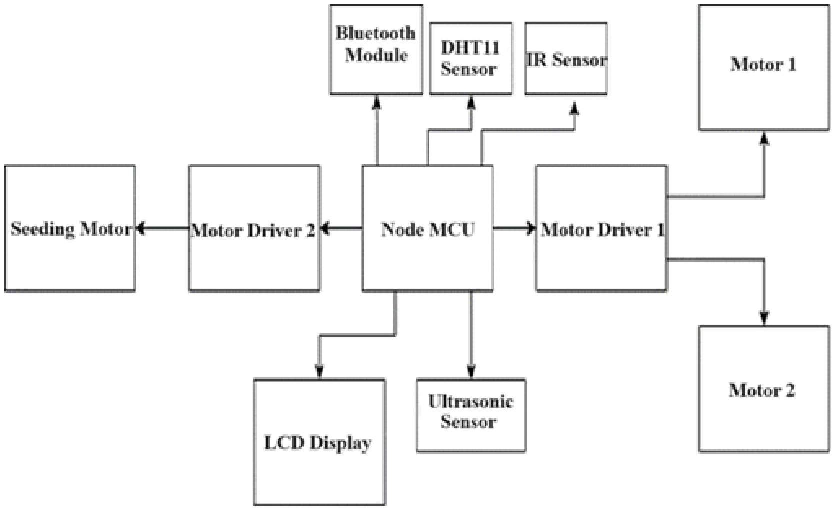

Figure 2.1: Block Diagram of the Proposed System.

Figure 2.1 represents the block diagram of the proposed model which consists of motors for different agriculture purpose, various sensors, Node MCU, Bluetooth module and LCD display.

B. Proposed Working Model:

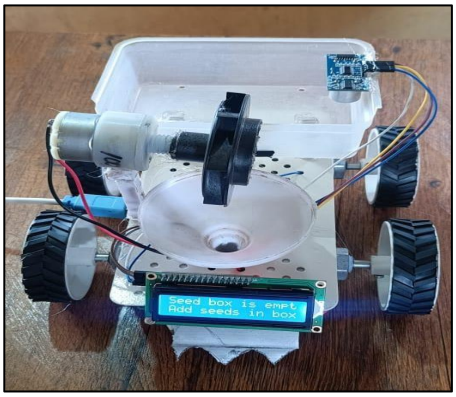

Figure 2.2: Robot Seed Boxis Empty

Figure 2.2 illustrates the working model with empty seed status which indicates to add the seeds in the box for sowing.

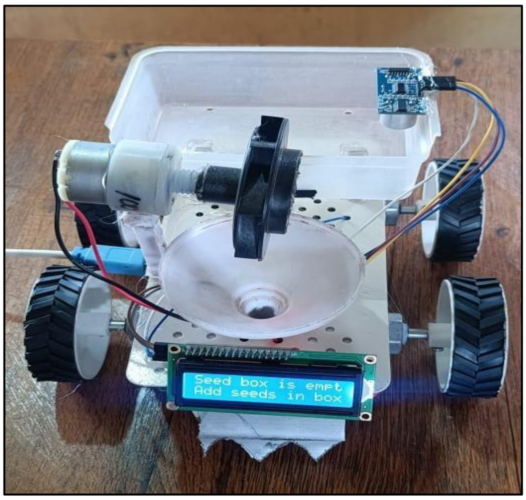

Figure 2.3: Robot Box has Seed

Figure 2.3 illustrates the working model with the status of loaded seed boxusing ultrasonic sensor for further sowing.

III Technology Used:

A. ESP8266 Module:

The ESP8266 module is a multifaceted and cost-effective microcontroller incorporating built-in Wi-Fi capabilities. Equipped with a TCP/IP stack, this module seamlessly connects to Wi-Fi networks and facilitates communication with other devices over the internet. Our utilization of the ESP8266 encompasses a wide range of functionalities, including sensor data collection, motor control, and bidirectional data exchange with databases and cloud services.

B. Arduino IDE Software:

The Arduino IDE (Integrated Development Environment) software incorporates essential components such as a compiler, a source code editor for scripting, a debugger, and a builder. This software is utilized for uploading code to any Arduino family board. It is also employed to establish a connection between the Arduino Uno board and a laptop or computer using a USB cable to upload a written program and to facilitate communication with it.

C. Ultrasonic Sensor:

The ultrasonic sensor is designed to measure distance and is utilized in this proposed project to detect the presence of seeds in the seed container. The sensor comprises two components: the TRIG and ECHO modules.

The TRIG module emits an ultrasound signal at a frequency of 40kHz, which then propagates through the air medium. When an object or obstacle obstructs its path, the signal reflects back to the module. The pin configuration of the Ultrasonic HC-SR04 features V_{CC}, GND, TRIG, and ECHO pins. The VCC pin is used to supply the necessary voltage, and the TRIG and ECHO pins can be connected to any available Digital I/O pin on the Arduino Uno board.

1. *Grafana*

Grafana is utilized as a central component of agri-robot model for monitoring and visualization process. Specifically, Grafana enables to aggregate and display real-time and historical data from the robot, including performance metrics and sensor readings. This allows to gain valuable insights and identify trends, ultimately aiding in informed decision-making and performance optimization. Additionally, the customizable nature of Grafana allows to tailor the visualizations to agri-robot requirements, ensuring a clear and meaningful representation of the data [11].

2. *Influx DB:*

Influx DB is a specialized time-series database designed to efficiently store and retrieve data that changes over time. It is specifically optimized for managing data points with timestamps, making it well-suited for system's requirements in tracking changes and trends over time. Influx DB is commonly utilized in monitoring and analytics scenarios, such as tracking sensor data, monitoring system performance metrics, or logging events in real time [12,13].

3. *I2C LCDD is play:*

The 16X2 LCD Display is connected to an I2C Module to transform it into a 16X2 I2C LCD Display. A notable distinction between the two displays is the reduced wiring requirement of the I2C Display, which necessitates only four wires: V_{CC}, GND, SCL, and SDA.

This display system is designed to indicate the presence of seeds within a container using an ultrasonic sensor and an Arduino Uno board. When seeds are detected, the display will show "Box Has Seed" and "Happy Sowing," whereas in the absence of seeds, it will display "Seed Box is Empty" and "Add Seeds in Box."

4. *L293D Motor Driver:*

In the proposed application, two motor drivers are used to regulate the speed and direction of the robot, as well as to control the seeding process. These motor drivers are operated using a +12V power supply and are equipped with the widely used L293 IC for seamless control of the connected motors.

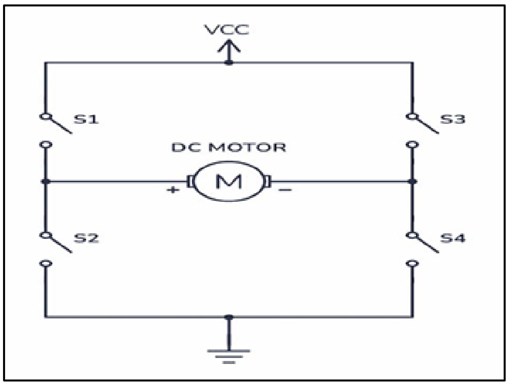

Figure 3.1: Illustration of Motor Direction change

The direction of the DC Motor can be controlled by the polarity of its input terminal or voltage. This technique is done using H-Bridge.

IV Flowchart of the Proposed System:

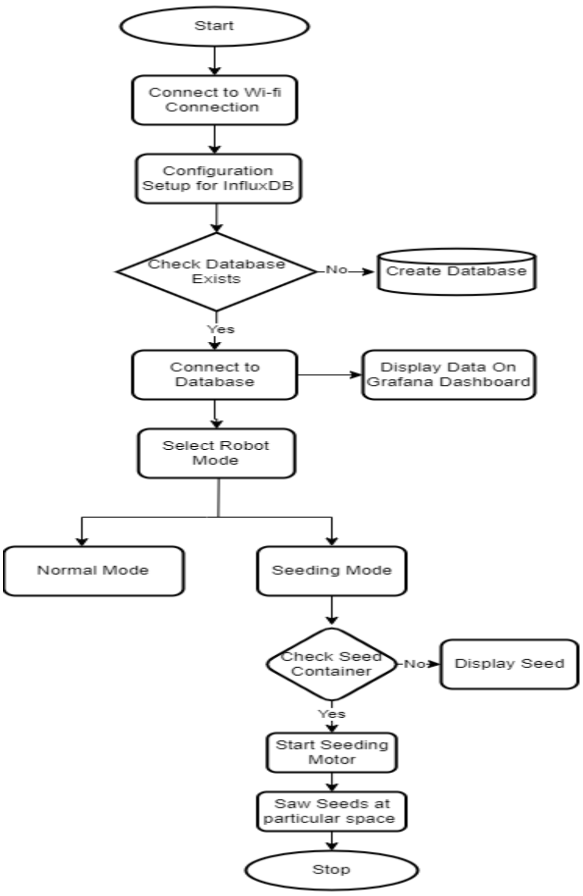

Figure 4.1: Flow Chart

The flow of operations for the robot begins with its initialization. Initially it establishes a connection to a Wi-Fi network to enable communication capabilities. Followed by this, it configures the Influx DB, a vital component which facilitates the linkage between robot and the cloud-based database. If the specified database does not already exist, the system proceeds to create it.

Subsequently, Grafana, a data visualization tool, establishes connectivity with the database. This enables the seamless display of all data collected by the robot in a user-friendly format.

The robot functions in two distinct modes: normal mode and seeding mode. In the normal mode, the robot operates analogous to a conventional vehicle without engaging in any seeding activities. Conversely, in seeding mode, the robot's cultivators descend to the ground, creating furrows at predefined intervals for sowing seeds. After completing this task, robot closes the dug portions, thereby completing the seeding process.

V Output:

Figure 5.1 and Figure 5.2 represents the output of the agri-robot. The spacing and depth between seed to seed varies from crop to crop.

Table 5.1: The distance between the two different seeds

Seeds	Distance
Soyabean	18cm
Groundnuts	15cm
Jawar	12cm

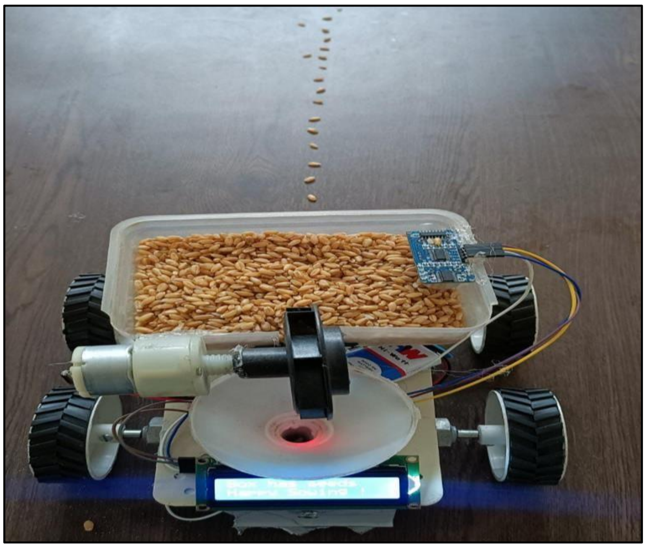

Figure 5.1: Robot Seeding Process

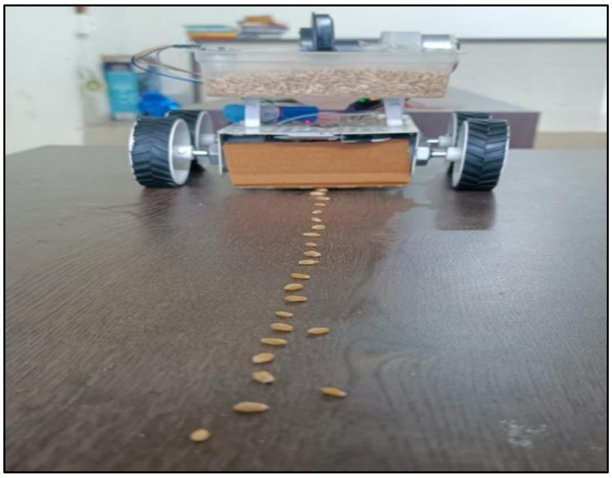

Figure 5.2: Robot Seeding Process Back View

VI Results:

Influx DB is used to store the entire data.

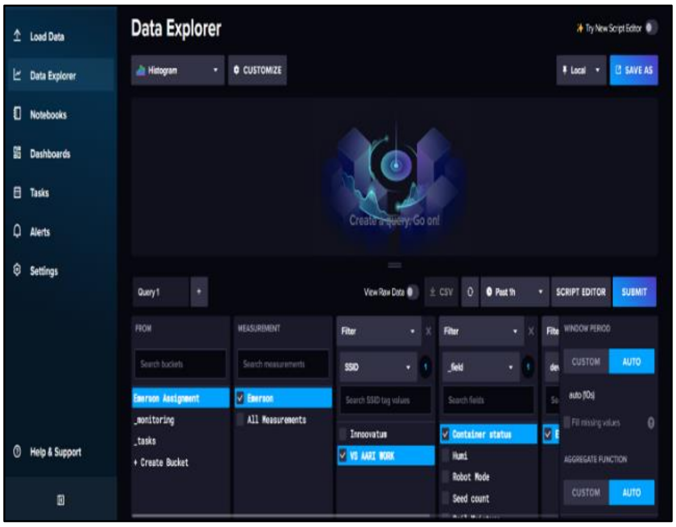

Figure 6.1: Influx DB Data Explorer

Figure 6.1 represents Influx DB window which is a powerful time-series database which is used to manage and store all the required data. Its optimized scheme and efficient design make it ideal for handling huge volumes of time-stamped information. With Influx DB, easy storage and retrieval of the data points can be done, it enables to visualize and analyze trends and time-based patterns effectively. Its adaptable query language and data model provides the freedom to arrange and retrieve data in accordance with user unique requirements. Influx DB's powerful features it has enabled to create scalable and reliable data storage system [12,13].

Figure 6.2: Grafana Dashboard

The illustration in Figure 6.2 depicts the seeding mode within Grafana, an advanced platform for data visualization and monitoring. Grafana is seamlessly integrated with Influx DB to deliver insightful visual representations of stored data. Through the combined capabilities of Grafana and InfluxDB, it has enabled to create dynamic, interactive dashboards that present both historical and real-time data. Grafana offers a diverse array of visualization options, including tables, graphs, and charts, enabling us to present data in a visually engaging and easily comprehensible manner [11].

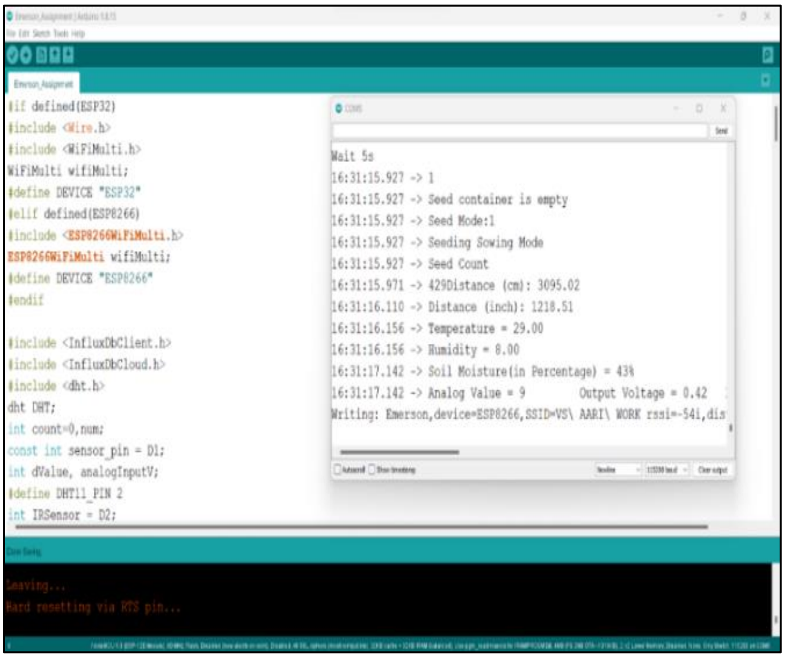

Figure 6.3: Output representation of all the connected sensors on the serial monitor of the Arduino IDE.

VII Conclusion:

An automatic seed sowing robot has been successfully developed to streamline various agricultural tasks and enhance overall efficiency. From soil preparation to seeding and monitoring, this technology aims to minimize human effort, reduce time constraints, and ultimately maximize crop production. The incorporation of advanced performance monitoring technology, such as Grafana for visualization, ensures comprehensive oversight and control. This Agri-robot marks a significant step forward in agricultural automation and the pursuit of sustainable, high-yield farming practices.

VIII Future Scope:

This proposed work can be upgraded with several seeding arms, which can be extended up to 4 to 6 rows in single time. This can furthermore reduce the time for the production of crops.

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31. Edge Computing Based Smart Health Care System

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ABSTRACT:

In the realm of emergency medical services, timely and accurate health data is crucial for ensuring the well-being of patients in transit to healthcare facilities. The proposed system integrates edge computing technologies to enable real-time data processing and analysis, facilitating swift decision-making and improved patient care. Our smart ambulance is equipped with various IoT sensors and medical devices that continuously monitor the patient's vital signs, transmitting critical data to health care providers instantly. This setup allows for early diagnosis and intervention, significantly improving patient outcomes. Additionally, the edge computing frame work ensures minimal latency in data transmission and processing, even in remote or bandwidth-limited areas. The proposed system's architecture, implementation details, and performance evaluation are thoroughly discussed, demonstrating its potential to revolutionize emergency medical services. Our findings suggest that Edge Computing-based Smart Ambulances can play a crucial role in modernizing emergency health care, offering a promising solution to the challenges faced in urgent medical scenarios.

KEYWORDS:

Smart Ambulance, Edge Computing, IoT Sensors.

I Introduction:

Medical emergencies demand rapid and efficient response systems to save lives and reduce the severity of injuries. Traditional ambulance services, while vital, often face challenges such as delays in diagnosis, limited real-time data access, and communication issues between the ambulance and health care facilities [1].

These limitation scan critically impact the quality of care provided to patient' senrouted to hospitals. Recent advancements in technology offer promising solutions to these challenges.

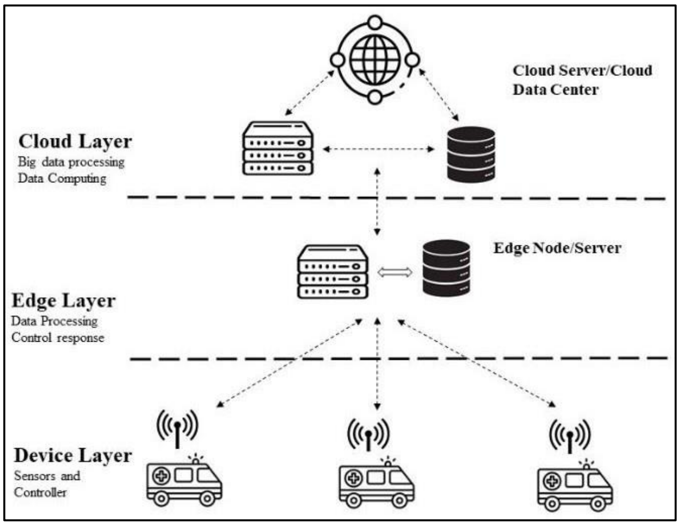

Figure 1: Edge Computing Architecture for Smart Ambulance

The figure 1 illustrates the architecture of the Edge Computing-based Smart Ambulance system, comprising three distinct layers: The Device Layer, the Edge Layer, and the Cloud Layer. At the Device Layer, ambulances are equipped with sensors and controllers that continuously monitor and collect patient data. This data is transmitted to the Edge Layer, where edge nodes or servers handle data processing and control response in real-time, ensuring low latency and immediate decision-making. The Edge Layer facilitates efficient communication between the ambulances and the cloud. The Cloud Layer, consisting of cloud servers and data centers, performs extensive data computing and big data processing, enabling advanced analytics and long-term data storage [2]. This layered approach ensures a robust, scalable, and responsive system capable of delivering timely medical interventions during emergencies. The proposed methodology delves into an innovative ambulance system tailored for swift response to emergencies, especially in scenarios with multiple injured patients like major accidents or natural disasters. It integrates cutting-edge edge computing technology, including machine learning algorithms and Raspberry Pi devices, to enhance speed and accuracy in collecting and analyzing patient data for prompt treatment suggestions. Cloud connectivity facilitates efficient resource management and long-term hospital planning. A prioritization mechanism ensures urgent cases receive immediate attention during transportation, supported by specialized training for ambulance staff to effectively handle high-stress situations.

II Literature Survey:

Integrating edge computing with smart ambulance systems offers significant benefits for patientcare and outcomes. By leveraging technologies like IoT and real-time data analytics [4], these systems enable the collection and transmission of vital patient data to healthcare providers, allowing for better preparedness and reduced treatment delays [4].

Additionally, the utilization of Multi-Access Edge Computing (MEC) enhances the efficiency of health care services by providing extremely low latency, substantial bandwidth, and optimized resource usage [5]. This integration facilitates continuous monitoring of emergency patients, addressing the lack of real-time risk assessment and dynamically providing necessary medical interventions [6]. Overall, the combination of edge computing with smart ambulance systems improves response times, enhances patient care, and ultimately contributes to better health outcomes in emergency situations.

Edge Computing Based Smart Ambulance systems can significantly optimize medical emergency response times in urban areas by integrating various technologies. These systems utilize RFID, GPS, LTE, IoT, and real-time data analytics to stream line ambulance transit and enhance emergency services [7]. By leveraging multi-sensor integration, including RFID sensors, cameras, and microphones, these smart ambulance scan communicate with traffic signals, detect congestion levels, and identify ambulance presence in traffic, enabling dynamic rerouting to less congested routes and triggering traffic signal adjustments for prioritized passage [8].

Additionally, IoT platforms like Blynk facilitate real-time tracking of ambulances, ensuring swift identification of the nearest hospital and enabling vital data transmission to healthcare providers before the patient's arrival [9]. Furthermore, the incorporation of IoT devices within ambulances allows for the collection and transmission of vital patient signs, preparing medical personnel in advance and reducing delays in treatment [10]. By combining these technologies, Edge Computing Based Smart Ambulance systems revolutionize emergency response, ensuring prompt and efficient medical care delivery in urban settings. Edge Computing Based Smart Ambulance services, as proposed in various research papers, significantly enhance patient outcomes in remote areas by leveraging IoT technologies for real-time monitoring and data transmission [11].

These services integrate wear able devices and IoT nodes to continuously monitor patients during transit, enabling immediate medical interventions based on real-time risk assessments [12]. Additionally, the incorporation of GPS systems in ambulances allows for swift identification of the nearest hospitals, ensuring timely access to necessary medical care [13]. The utilization of cutting-edge software features and Lab-On-Chip technology within Electric Ambulances further optimizes response times and facilitates on-the-spot health examinations, ultimately improving treatment efficacy and patient outcomes in emergency situations [14]. By enhancing communication between emergency responders and health care facilities through information technology, these smart ambulance systems streamline the decision-making process and improve overall rescue efficiency, especially in remote or rural areas [15]

III Methodology:

Following an extensive examination of various research papers, it has become clear that emergency response teams encounter numerous challenges during major accidents or natural disasters. One of the primary obstacles is the large number of injured individuals, which often exceeds the capacity of existing ambulance systems, resulting insignificant delays in providing urgent medical assistance.

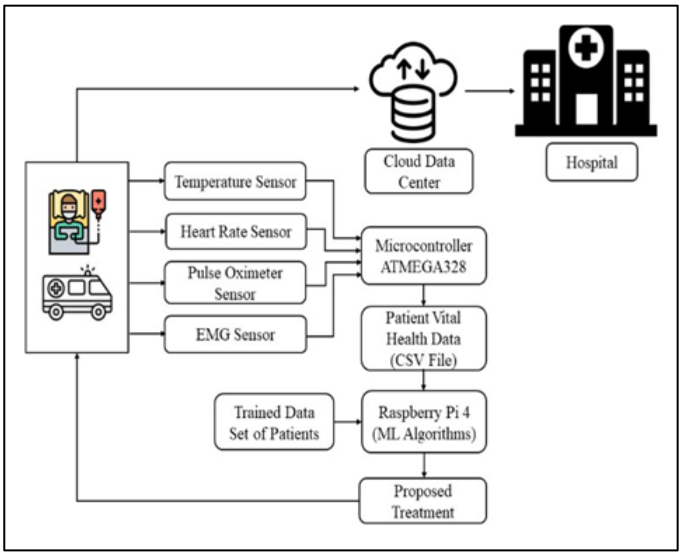

Figure 2: Block Diagram of Proposed Methodology

A. Workflow:

Figure 2 illustrates the work flow and components of the Edge Computing-based Smart Ambulance system.

Central to the system are various sensors with in the ambulance, including temperature sensors, heartrate sensors, pulse oximeter sensors, and EMG sensors, all of which monitor the patient's vital signs in real-time. The data collected by these sensors is processed by an ATM ega 328 micro controller, which compiles the information into a CSV file format for efficient handling and transmission. This patient vital health data is then sent to a Raspberry Pi4, which uses machine learning algorithms trained on a dataset of patient health records to analyze the data and propose potential treatments. The processed in formation and proposed treatments are forwarded to a cloud data center, enabling seamless communication and data storage. Simultaneously, the data is transmitted to the hospital, ensuring that medical personnel are well-informed about the patient's condition before arrival. This integration of real-time monitoring, edge computing, and machine learning with in the smart ambulance system enhances the ability to provide timely and accurate medical care during emergencies.

B. Sensors:

1. ***Temperature Sensor:*** The DS18B20 digital temperature sensor is renowned for its high accuracy and versatility. It operates within a broad temperature range of -55° C to + 125° C, with an impressive accuracy of ± 0.5°C from-10°C to +85°C. The sensor offers programmable resolution from 9 to12 bits, allowing for flexibility based on the application's precision requirements. It communicates via a1-Wire protocol, requiring only one data line for communication and power, and supports a supply voltage range of 3.0V to 5.5V.

2. ***Heart Rate Sensor:*** The Pulse Sensor, or heart rate sensor, is a highly efficient and accurate device designed to measure pulse rates using the photo plethysmography (PPG) method. Operating at a voltage range of 3.3V to 5V, it consumes less than 4m A of current, making it energy-efficient. It provides an analog output signal suitable for direct interface with microcontrollers. The sensor can measure heart rates ranging from 0 to 220 beats per minute (BPM) with an accuracy of ±2 BPM and a response time of less than100ms.
3. ***Pulse Oximeter Sensor:*** The MAX 30100 Pulse Oximeter Sensor is a highly integrated module designed for accurate measurement of oxygen saturation (SpO2) and heartrate. It operates at 1.8V for the core and 3.3V for I/O, with atypical current consumption of 600µ A in normal mode and just 0.7µA in shutdown mode, making it ideal for battery-powered applications. The sensor utilizes a reflective photoplethysmography (PPG) method with red (660 nm) and infrared (880 nm) LEDs, providing an SpO2 measurement range of 0% to 100% with an accuracy of ± 2% in the 70% to 100% range, and a heart rate range of 30 to 240 BPM with ± 1 BPM accuracy.
4. ***EMG Sensor:*** The electromyography (EMG) sensor's technical specifications include a frequency response range typically from 10 Hz to 1 kHz and a signal amplitude range of ± 1 mV to ±10 mV, ensuring accurate detection of muscle electrical activity. It features a high input impedance of over 10 MΩ and a dynamic range of 20-40 dB, which supports a signal-to-noise ratio of 60-80 dB for clear data acquisition. The sensor operates with a low power supply of 3-5 V DC and offers connectivity through analog or digital interfaces like USB or Bluetooth.

C. Microcontroller ATMEGA328:

The AT mega 328 microcontrollers also called Arduino, a popular member of the Atmel AVR family, is renowned for its efficiency and versatility in embedded systems. It features an 8-bit AVR RISC architecture with a clock speed of up to20MHz, providing a robust processing capability for various applications. The microcontroller includes 32 KB of flash memory for program storage, 1 KB of SRAM for dynamic data, and 2KB of EEPROM for non-volatile data retention. It offers 23I/Opins, which can be used for digital input/output, along with six analog-to-digital converter (ADC) channels with a10-bitresolution. The AT mega 328 also supports serial communication via USART, SPI, and I2C interfaces, and operates on a voltage range of 1.8V to 5.5V. Its low power consumption and broad range of features make it a popular choice for hobbyists and professionals alike, especially in Arduino-based projects.

D. Implementing ML Algorithm on Raspberry Pi 4:

The Raspberry Pi 4 Model B is a powerful single-board computer equipped with aqua core ARM Cortex – A 72 processor running at 1.5GHz, and it offers 2GB, 4GB, or 8GB of LPDDR4- 3200 SDRAM, depending on the model. It features dual HDMI ports for 4K video output, multiple USB 3.0 and USB 2.0 ports, and Gigabit Ethernet for high-speed network connectivity. Implementing machine learning (ML) algorithms on the Raspberry Pi 4 is feasible thanks to its enhanced processing power and RAM, allowing for the execution of light weight models and inference tasks.

In our proposed methodology we have leveraged popular libraries such as Tens or Flow Lite and PyTorch, which are optimized for edge devices, to deploy pre-trained models or perform on-device training. The Raspberry Pi 4's GPIO pins and extensive community support further enable integration with sensors and peripherals, making it a versatile platform for ML applications ranging from image recognition to predictive analytics in resource-constrained environments.

E. Trained Data Set and Patient Vital Data:

The trained data set refers to a collection of historical patient health records used to develop machine learning models. This data set typically includes, Demo graphic Information, Vital Signs, Medical Conditions, and Sensor Data. The purpose of this trained data set is to provide a comprehensive foundation for training machine learning algorithms. These algorithms learn patterns and correlations between the input features and the output labels. Once trained, the machine learning models can predict patient conditions and suggest appropriate treatments based on new patient data.

The patient vital health data captured in a CSV file includes real-time health metrics recorded by various sensors attached to the patient. The CSV file contains structured data such as, Time stamp, Temperature Readings, Heart Rate Readings, Oxygen Saturation Levels and EMG Readings.

This CSV file serves as the primary input for the machine learning models running on the Raspberry Pi 4. The data is processed and analyzed in real-time to detect anomalies, predict potential health issues, and propose personalized treatments. The system ensures that critical health data is continuously monitored, allowing for timely interventions and improved patient outcomes. Additionally, the data is uploaded to a cloud data center, enabling remote access and further analysis by healthcare professionals in a hospital setting.

F. Cloud Data Center:

The cloud data center serves as a centralized and secure repository for storing vast amounts of patient health data, enabling remote access and real-time monitoring by healthcare professionals. It provides scalable storage solutions, advanced data analytics capabilities, and supports the training and updating of machine learning models to ensure accurate and up-to-date health predictions. Additionally, the cloud data center facilitates seamless integration with hospital systems, robust security protocols, and compliance with healthcare regulations, enhancing the overall functionality and security of the healthcare system.

IV Result and Analysis:

In this section, we present the outcomes of our opposed system for monitoring patient vitals and suggesting treatment using machine learning algorithms. The system comprises multiple sensors, a microcontroller, and a Raspberry Pi for data processing, as illustrated in the figure 2.

A. Sensors Output:

The system employs various sensors (temperature, heartrate, pulse oximeter, and EMG) to collect patient vital signs. Data from these sensors is transmitted to the ATMEGA 328 microcontroller, which aggregates the readings and formats them into a CSV file for further processing. The following figure 3 shows the interfacing of the sensor with microcontroller.

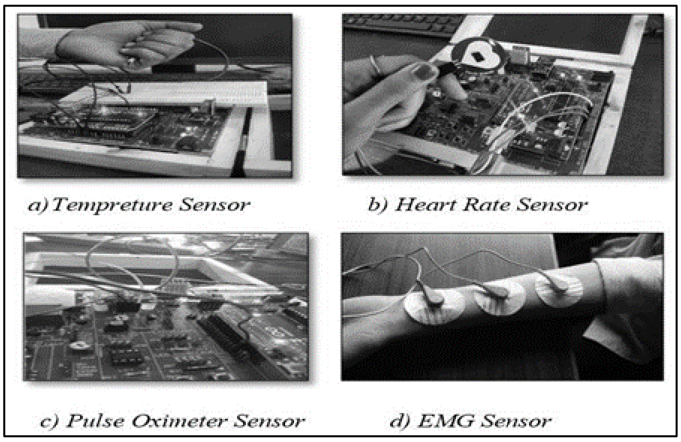

Figure 3: Interfacing All the Sensors to The Microcontroller

The following are steps to access sensor data from an Arduino and read it using a Raspberry Pi.

a) Arduino Side (Pseudocode):

Step1: Setup Serial Communication, initialize serial communication at 9600 baud rate and continuously read data from temperature, heart rate, pulse oximeter, and EMG sensors.

Step 2: Send data over serial, format the sensor data into a read able string and send the formatted string over the serial port.

Step 3: Send Data over Serial: Format the sensor data into are a dabble string. Send the for matted string over the serial port.

b) Raspberry Pi Side (Pseudocode):

Step1: First Setup Serial Connection, import necessary libraries and establish a serial connection to the Arduino.

Step 2: Read data from serial continuously check if data is available on the serial port. Read the incoming data line by line and Print or process the received data.

Step3: Store Data, open a CSV file for writing and Write the received data into the CSV file.

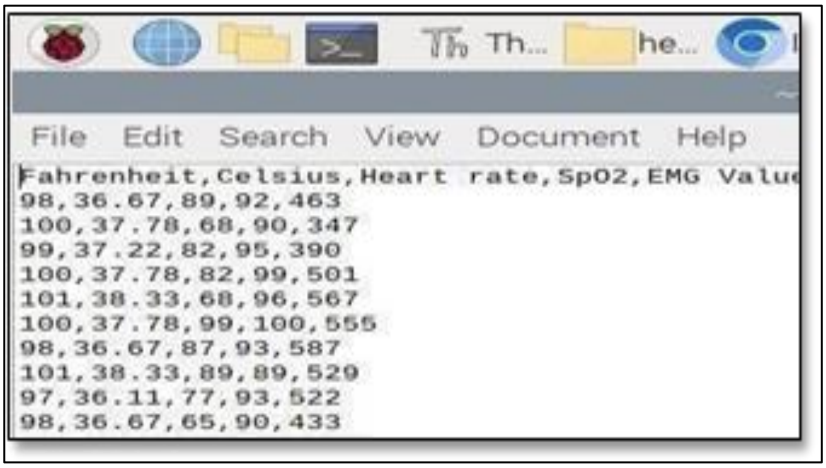

Figure 4: Sensor data from Raspberry Pi serial port

B. Predictive Analysis:

The dataset to be analyzed comprises various patient health parameters, including temperature, heart rate, oxygen level, and muscle strength. These parameters will be utilized for analysis and exploration in the study. The dataset to be trained is depicted below in table 1.

Table I: Training data Set

Sr. No	Temperature Data (°C)	Heart Rate (bpm)	SpO2 (%)	EMG Values (microvolts)	Prescribed Medicines
1	41.05	55	92	553	Suggested by doctors
2	45.25	53	90	571	Suggested by doctors
3	44.56	62	95	501	Suggested by doctors
4	44.64	70	96	595	Suggested by doctors
5	43.66	52	78	541	Suggested by doctors
	….	…	…	…	…
296	36.47	84	99	323	Suggested by doctors
297	36.37	52	80	336	Suggested by doctors
298	38.31	76	86	480	Suggested by doctors
299	38.48	82	73	353	Suggested by doctors
300	41.05	55	92	553	Suggested by doctors

Following is the evaluation of different machine learning algorithms including SVM (Support Vector Machine), Decision Tree, Logistic Regression, and Naïve Bayes, it was concluded that the Decision Tree algorithm exhibited the highest accuracy for the health dataset. The table 2 presents the different parameters used for calculating accuracy.

Table II: Performance Comparison of Various Machine Learning Algorithms Based On Accuracy Metrics

Feature	Decision Tree	Logistic Regression	KNN (k-nearest neighbor)	Random Forest
Accuracy	High	Moderate	Moderate	High
Interoperability	High	High	Moderate	Moderate
Overfitting	Low	Low	Moderate	Lower
Training Speed	Fast	Fast	Fast	Slower
Scalability	Good	Good	Limited	Good
Accuracy	High	Moderate	Moderate	High
Interoperability	High	High	Moderate	Moderate
Overfitting	Low	Low	Moderate	Lower
Training Speed	Fast	Faster	Fast	Slower
Scalability	Good	Good	Limited	Good
Accuracy	High	Moderate	Moderate	High

C. Running ML Applications on Raspberry Pi:

Running machine learning (ML) applications on a Raspberry Pi for the application shown in the figure 21. 2 involves several steps, including setting up the Raspberry Pi, collecting and preprocessing data, training a machine learning model, and deploying the model to make predictions. Following steps illustrate the running machine learning applications are Raspberry Pi.

Step1: Set Up Raspberry Pi - Ensure Raspberry Pi is running the latest version of the Raspbian OS. Update the system packages to the latest versions. Install Python and necessary libraries such as Num Py, pandas, scikit-learn, and others required form a chine learning tasks.

Step2: Collect and Prepare data -Interface all the sensors to Arduino board, using the USB cable connect the Arduino board to the Raspberry Pi. Write a script on the raspberry to read the serial data from the Arduinos and save it into CSV file. Load the collected data, clean it, and prepare it for training. This might involve normalizing or scaling the data, handling missing values, and splitting it into training and testing sets.

Step3: Train machine learning model - From the table 2, it is analyzed that decision tree algorithm performs very well for such application. After selecting appropriate machine learning algorithm, train the model using training data. Test the model on the testing set to evaluate its performance. Save the trained model for further preprocessing steps.

Step4: Deploy and Run ML model on Raspberry Pi -We have written python script to load the saved model on the raspberry pi. Continuously read the data from the sensors connected to the Arduino in real time. Trained models are used to make the prediction based on the real-time data. Display the proposed action in the ambulance.

Step5: Send data to cloud and hospital - Send data to the cloud data center for storage and further analysis. Also ensure that the data stored in the cloud is accessible to hospital system for monitoring and further analysis by medical professionals.

D. Cloud Connectivity:

First, vital health data collected from sensors and wear able devices is processed at the edge (on the ambulance) to reduce latency. The processed data is then securely transmitted to Ad fruit IO, a cloud-based IoT platform, where it is visualized on a real-time dashboard. This dashboard provides medical personnel and emergency responders with immediate access to critical health information. The dashboard's user-friendly interface and real- time updates enable a more effective response, ensuring that patients receive timely and appropriate care during emergencies. This integration of edge computing and Ad a fruit IO dashboard enhances the efficiency of ambulance services and ultimately improves patient outcomes. Figure 5 shows the

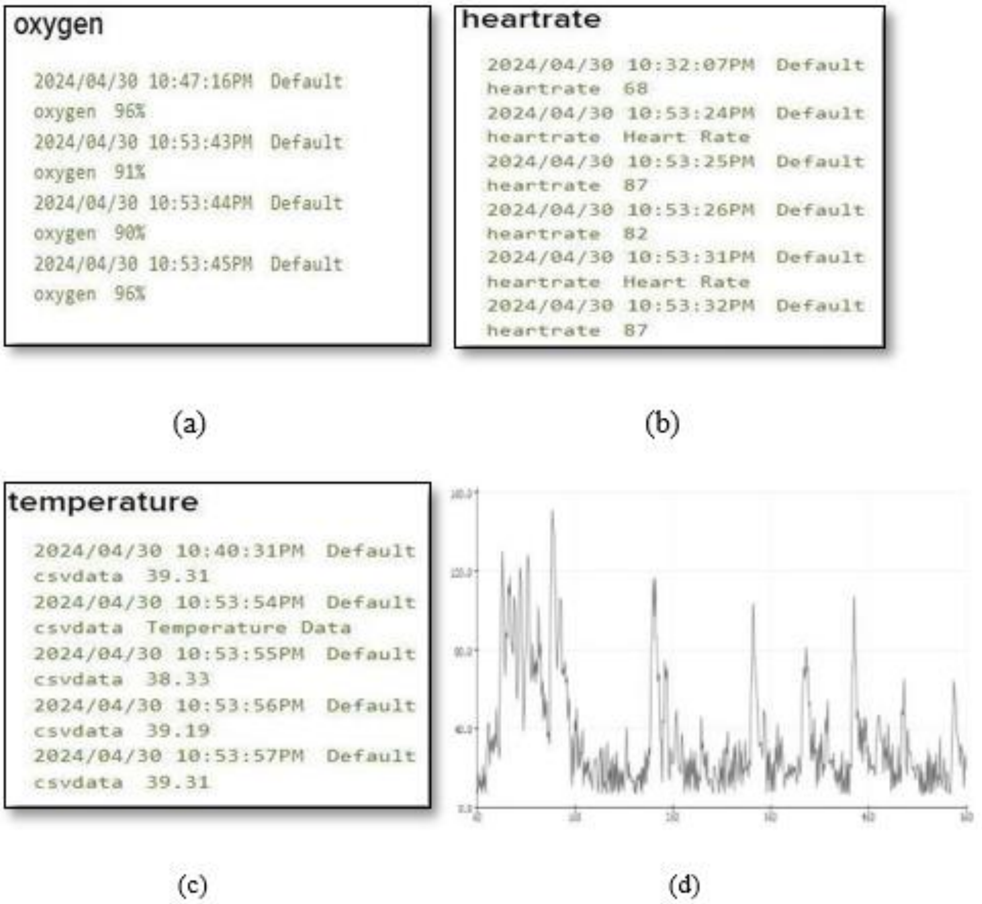

Figure 5: The above figure shows the IoT dashboard of Ad a fruit Cloud and it shows the streamed data of (a) Pulse oximeter sensor (b) Heart rate sensor (c) Temperature Sensor and (4) EMG Sensor

Future Scope:

Cloud capabilities provide centralized storage and extensive data analysis, supporting long-term trends and large-scale analytics. Edge computing, meanwhile, processes data locally, reducing latency and enabling real-time decisions, especially in time-sensitive situations. By balancing immediate, localized processing with large-scale cloud analysis, these technologies complement each other, offering both instant responses and comprehensive data insights. Enhancing data security through encryption and exploring blockchain will protect patient information, while user-friendly interfaces will improve system accessibility. Adopting interoperability standards will ensure continuous improvement and adaptability to various medical conditions, ultimately transforming patient monitoring and healthcare outcomes.

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32. Integrating Block chain in EV Charging Systems for Secure and Efficient Infrastructure

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ABSTRACT:

With the growing adoption of electric vehicles (EVs) and the pressing need for secure and efficient charging infrastructures, ensuring the security of communication protocols within EV charging management systems is crucial. This study applies Burrows–Abadi–Needham (BAN) Logic to analyse the security of a proposed protocol for EV charging management. The protocol facilitates mutual authentication between the EV, the charging station, and the backend management system, ensures that only authorized EVs can initiate charging sessions, and maintains the integrity and confidentiality of all exchanged messages. The BAN Logic analysis confirms the robustness and security of the protocol, highlighting its effectiveness in preventing common security threats such as replay attacks, impersonation, and unauthorized access. This formal verification underscores the importance of BAN Logic in enhancing the reliability and trustworthiness of EV charging infrastructures.

KEYWORDS:

Index Terms—Electric Vehicles (EVs); EV Charging Management System; Burrows–Abadi–Needham Logic (BAN)

I Introduction:

As electric vehicles (EVs) and the Internet of Things (IoT) continue to proliferate, their integration into smart grids offers a transformative approach to managing distributed energy and electricity generation [1]. This integration is manifested through various vehicular systems, including vehicular ad hoc networks (VANETs), vehicle-to-grid (V2G) systems, vehicle-to-vehicle (V2V) communications, and the Internet of Vehicles (IOV). These systems rely on a diverse array of communication and measurement sensors—such as speed detectors, GPS modules, Bluetooth, Wi-Fi, and on-board units (OBUs)—to gather and transmit critical data related to vehicle speed, location, identity, and movement.

However, the transmission of such sensitive data over public networks introduces significant security risks. The data is susceptible to interception, modification, and misuse by malicious actors. To mitigate these risks and ensure secure communication, robust mutual authentication and key agreement mechanisms are crucial.

Over the past decades, numerous authentication and key agreement schemes have been proposed to address these needs within vehicular IoT systems [2]. While these schemes aim to enhance privacy and operational efficiency, they often rely on trusted third parties to maintain high security levels. This reliance creates vulnerability: if the trusted third party is compromised, the entire security framework can be undermined. Therefore, there is an urgent need for authentication and key agreement solutions that do not depend on such third parties. These solutions must ensure the integrity, confidentiality, availability, and reliability of communications while accommodating the resource constraints inherent in many vehicular IoT devices.

The smart grid aims to deliver a reliable, sustainable, stable, and efficient electricity supply, with EV charging management being a critical component of this vision [3]. As the demand for EV charging services grows, addressing this need efficiently becomes paramount. Traditional smart grid systems that offer charging services often rely on third parties, which introduces vulnerabilities: if these third parties are compromised, users may lose access to essential EV charging services. Moreover, smart grid systems integrated with IoT devices must balance efficiency with the limited power and memory constraints of EV sensors like on-board units (OBUs). To overcome these security and efficiency challenges, recent studies have explored the potential of blockchain technology. Blockchain offers decentralization, verification, and data integrity, making it a promising solution for various fields including smart grids, healthcare, finance, and voting [4].

In blockchain systems, data is organized into blocks that contain transactions, with each transaction linking to previous ones through cryptographic hash functions [5]. Early blockchain implementations, such as Bitcoin and Ethereum, faced scalability issues, prompting the development of Hyperledger frameworks. Hyperledgersare designed to address these scalability challenges without involving cryptocurrency. Building on this foundation, a blockchain-based security model for EV charging management that utilizes smart contracts and the lightning network to enhance both security and efficiency within smart grid systems is proposed [6]. However, their model exhibits several inefficiencies, including the deposit problem, transaction generation issues, and transaction fees, and it lacks a guarantee of key security. To address these limitations, an improved secure charging system for EVs based on Hyper ledger technology is proposed [7].

The need for robust authentication and key agreement schemes in vehicular IoT systems has been a focus of numerous studies over the past decades [8]. Although these schemes aim to ensure privacy and improve efficiency, they often rely on trusted third parties to maintain high security levels. This reliance introduces vulnerabilities, such as susceptibility to distributed denial of service (DDoS) attacks and privileged insider threats. If the trusted third party is compromised, the entire security framework can fail. Therefore, it is essential to develop authentication and key agreement schemes that do not depend on trusted third parties, ensuring integrity, confidentiality, availability, and reliability, especially in resource-constrained environments.

II Related Works:

Several studies have explored the application of blockchain technology in the energy Internet architecture [9]. Authors examined the use of consortium blockchain for energy trading within industrial IoT environments, employing the Stackelberg game to ensure safe, fast, and reliable transactions. The concept of automating complex workflows in the energy IoT sector through smart contracts is introduced [10].

In addition to energy trading, research has increasingly focused on blockchain-based shared charging systems [11]. a blockchain system is developed that facilitates EV and charging station interactions without relying on a trusted third party, utilizing smart contracts for transactions. A consortium block chain to manage charging and discharging transactions between EVs, establishing a local aggregator as a service node, though without addressing user transactions across different aggregators is discussed [12]. Numerous studies also apply smart contracts to enhance shared charging systems. Decentralized security model that leverages the lightning network and smart contracts to bolster transaction security between EVs and charging points is explored [13]. A charging station deploy a smart meter equipped with a blockchain node to monitor power usage and interact with the blockchain through a smart contract communication module is proposed [14]. Several previous studies have focused on incentive mechanisms to enhance the quality and efficiency of charging services [15]. Various incentive strategies used in smart grids and applied a contract-theoretic approach to the energy trading process, aiming to optimize both service quality and operational efficiency is summarized.

A scheme utilizing a progressive two-price auction game to address large-scale EV charging cooperation, ensuring incentive compatibility within a constrained range is developed [16]. An evaluation mechanism for charging services that assesses charging stations based on user-provided credibility ratings and the endorsement experience values of charging station nodes is introduced [17].

III Propose Work:

A. Background:

The rapid adoption of Electric Vehicles (EVs) has led to a significant increase in the deployment of EV charging stations worldwide. As these systems collect vast amounts of data, including personal information, vehicle details, and payment information, robust data security mechanisms have become paramount. Traditional data management systems often face challenges related to data breaches, tampering, and unauthorized access. Blockchain technology, with its decentralized and immutable nature, offers a promising solution to these challenges, ensuring the security, integrity, and authenticity of IoT data in EV charging management.

B. Proposed Goals:

Utilizing block chain technology, Charge Guard aims to establish a secure platform for managing IoT data within EV charging systems. The proposed objectives are:

- **Authentication:** Ensure that the EV and the charging station authenticate each other.
- **Authorization:** Ensure that the EV is authorized to use the charging station.
- **Integrity and Confidentiality:** Ensure that the communication between entities is secure and tamper-proof.

C. Burrows–Abadi–Needham (BAN) Logic to an Electric Vehicle (EV) charging management system

Burrows–Abadi–Needham (BAN) Logic is a formal logic used to analyze and reason about the security of authentication protocols. Developed by Michael Burrows, Martín Abadi, and Roger Needham in the late 1980s, BAN logic helps to verify that a given protocol can establish certain security properties, such as mutual authentication or key agreement, between communicating parties. Applying Burrows–Abadi–Needham (BAN) Logic to an Electric Vehicle (EV) charging management system can help ensure secure communication between various entities involved, such as the EV, the charging station, and the backend management system. The different entities involved in the EV charging management system is EV (E): The electric vehicle, CS (C): The charging station and Backend Management System (BMS): The central system that manages charging sessions and billing. By applying BAN Logic, we can formally verify the security properties of the EV charging management system, ensuring that the protocol is robust against common security threats such as replay attacks, impersonation, and unauthorized access.

D. Burrows–Abadi–Needham (BAN) Logic protocol for initiating a charging session:

1. E → C**: {E_ID, N1}K_EC**
2. C → BMS**: {E_ID, N1, C_ID}K_CB**
3. BMS → C**: {N1, Authorization_Token, N2}K_CB**
4. C → E**: {Authorization_Token, N2}K_EC**

Where:

- **E_ID**: EV's unique identifier.
- **C_ID**: Charging station's unique identifier.
- **N1, N2**: Nonces generated by the EV and the BMS respectively.
- **K_EC**: Shared secret key between EV and charging station.
- **K_CB**: Shared secret key between charging station and BMS.
- **Authorization_Token**: Token generated by BMS to authorize the charging session.

1) BAN Logic Analysis:

a) Message 1: E → C: {E_ID, N1}K_EC

- **C ⊳ {E_ID, N1}K_EC**: The charging station sees the message.
- **C |≡ E ↔ C**: The charging station believes it shares a key with the EV.
- **C |≡ E |≡ N1**: The charging station believes that the EV believes N1 is fresh.

b) Message 2: C → BMS: {E_ID, N1, C_ID}K_CB

- **BMS ⊳ {E_ID, N1, C_ID}K_CB**: The BMS sees the message.
- **BMS |≡ C ↔ BMS**: The BMS believes it shares a key with the charging station.
- **BMS |≡ C |≡ N1**: The BMS believes that the charging station believes N1 is fresh.

c) Message 3: BMS → C: {N1, Authorization_Token, N2}K_CB

- **C ⊳ {N1, Authorization_Token, N2}K_CB**: The charging station sees the message.
- **C |≡ BMS ↔ C**: The charging station believes it shares a key with the BMS.
- **C |≡ BMS |≡ N1**: The charging station believes that the BMS believes N1 is fresh.
- **C |≡ BMS |≡ N2**: The charging station believes that the BMS believes N2 is fresh.
- **C |≡ BMS |≡ Authorization_Token**: The charging station believes that the BMS believes the authorization token is valid.

d) Message 4: C → E: {Authorization_Token, N2}K_EC

- **E ⊳ {Authorization_Token, N2}K_EC**: The EV sees the message.
- **E |≡ C ↔ E**: The EV believes it shares a key with the charging station.
- **E |≡ C |≡ N2**: The EV believes that the charging station believes N2 is fresh.
- **E |≡ C |≡ Authorization_Token**: The EV believes that the charging station believes the authorization token is valid.

The proposed protocol with BAN Logic ensures the following

Mutual Authentication: The EV and the charging station can authenticate each other using the shared key and nonces.

Authorization: The EV receives an authorization token from the BMS through the charging station, ensuring that only authorized EVs can use the charging station.

Integrity and Confidentiality: The use of shared keys and encrypted messages ensures that the communication is secure and tamper-proof.

IV Conclusion:

With the growing adoption of electric vehicles (EVs) and the critical need for secure and efficient charging infrastructures, ensuring the security of communication protocols within EV charging management systems is paramount. By applying Burrows–Abadi–Needham (BAN) Logic to the EV charging management system, we have demonstrated that the protocol effectively ensures mutual authentication, authorization, and the integrity and confidentiality of communications between the EV, the charging station, and the backend management system. The analysis confirms that the entities can securely authenticate each other, authorize charging sessions, and protect the exchanged messages against tampering and unauthorized access. Consequently, BAN Logic proves to be a valuable tool in verifying the robustness and security of protocols within EV charging infrastructures.

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33. IoT Enabled Infant Incubator for Healthcare Centers

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ABSTRACT:

Newborns are particularly vulnerable to rough environments and dust and extreme temperatures can pose life-threatening risks. To address these challenges, we've developed a baby incubator that simulates the temperature and environmental conditions of a mother's womb while also monitoring vital medical conditions such as heart rate, skin temperature, and internal temperature. In response, integrating Internet of Things (IoT) technology into hospital equipment, like this baby incubator, has become a priority. The goal of the paper is to provide an app that enables remote monitoring of a baby's condition, allowing doctors to stay informed and respond quickly if needed. One of the incubator's key features is its ability to maintain optimal humidity levels, preventing the baby's skin from losing too much moisture and becoming brittle or cracked. The incubator is also equipped with monitoring devices that track vital signs, such as temperature and heart rate, enabling healthcare providers to continuously assess the baby's health.

KEYWORDS:

Internet of Things, Incubator, Health monitoring, Heartbeat.

I Introduction:

A transport incubator is a portable device used to safely transfer sick or premature babies, such as from a smaller hospital to a larger facility with a Neonatal Intensive-Care Unit (NICU). In biology, incubators maintain optimal conditions, including temperature, humidity, and gas levels, for growing cultures. Premature babies, born before 37 weeks, often have underdeveloped organs like the lungs and digestive tract. Incubators provide the necessary environment for these babies to survive and thrive by regulating temperature, humidity, and protection from infections, allergens, excessive noise, and light. They can adjust temperature automatically based on the baby's needs and may include special lights for treating neonatal jaundice, ensuring the infant's skin integrity and overall well-being.

We are currently living in an era dominated by smart technologies, often referred to as "ubiquitous computing" or "Web 3.0." The Internet of Things (IoT) has emerged as a key area in this technological landscape, complementing other technologies like cloud computing. Originally discussed in the ITU Internet Reports series, which began in 1997 under the title "Challenges to the Network," the concept of IoT was first coined by Kevin Ashton in 1999 and officially termed "Internet of Things" in 2005.

Kevin Ashton's vision for IoT involved enabling networked devices to share information about physical world objects via the web. IoT allows objects to identify themselves and exhibit intelligent behavior by making or facilitating decisions based on the information they can share. These objects can either access data collected by other devices or contribute to other services. With IoT, any object can connect to the internet at any time and from any place, providing a wide range of services through any network to anyone. This concept has led to the development of new applications such as smart vehicles and smart homes, offering services like notifications, security, energy saving, automation, communication, computing, and entertainment.

Unlike a simple hospital bed, the incubator is designed to create a controlled environment that supports the health and development of newborns. It regulates critical factors like oxygen levels, light exposure, and humidity to match the conditions of a mother's womb. Additionally, the incubator offers protection from external threats such as allergens, loud noises, bacteria, and viruses. To summarize, our smart baby incubator provides a safe and controlled environment for newborns, with the added benefit of IoT integration for remote monitoring. This innovation ensures that healthcare professionals can maintain a high level of care while minimizing physical contact, making it an essential tool in today's healthcare landscape.

The rest of the article is structured as follows: Section II reviews related works; Section III presents the proposed model; Section IV focuses on the analysis of results; and Section V concludes the paper.

II Related Works:

Temperature regulation is crucial for both living organisms and some semiconductor materials. The work in [1] aims to control temperature variations in specific applications, such as baby incubators. Incubators are essential for improving infant survival by providing a warm environment and minimizing heat loss. It uses Arduino and temperature sensors to monitor and control the temperature, maintaining it between 36.5-37.2°C, similar to a mother's womb. The Arduino's programming code is used to achieve precise temperature control, ensuring the optimal conditions for the baby's health and development.

The authors in [2] presents a design for a central real-time monitoring system for premature baby incubators, focusing on environmental temperature control. The incubators collect data using temperature and humidity sensors, as well as web cameras.

This data is displayed on a central monitoring interface through networking technology, allowing for real-time and centralized monitoring of the environment and physical state of multiple premature babies. This system aims to reduce the risk of medical incidents and support the healthy growth of premature infants. The need for sophisticated control systems in incubators is growing quickly in an effort to lower the rates of infant mortality [3]. Many characteristics in an incubator need to be kept an eye on in order to guarantee the baby's health. This study describes a sophisticated control system that keeps an eye on and regulates a number of critical factors that have an impact on a baby's health. Four temperature sensors are used by the system to control the incubator's temperature and track the baby's skin temperature. Two sensors are also used to measure humidity. An application page is made to be easily viewed by users. The technology, which is based on Arduino, enables precise and seamless operation of the incubator using a serial port.

The work referenced in [4], uses an agent-based technique to provide an intelligent strategy for IoT data collecting. The main contribution of the proposed research project is to develop and construct an intelligent system for IoT data gathering. This work involved the development and evaluation of a fully operational incubator with accurate temperature, humidity, and airflow control. To test and fine-tune the Mamdani fuzzy logic controller, a heuristic simulation was developed concurrently with the incubator's development [5]. Ensuring the correct operation of IoT services depends heavily on the security and accuracy of sensor data transferred across the network. Validating data collected in remote IoT networks is therefore a problem that is becoming more and more important. Although the quick fix of adding duplicate identical systems can give validation, real-world change limits frequently make this difficult or even impossible. Thus, authors have presented an intelligent validation approach using multi-agents in this study [6] [7].

An incubator is made with such care and attention to detail that it can offer a newborn baby a secure and healthy environment in which to sleep while its important organs are still developing. Our incubator can be compared to a basic hospital bed in that it offers precisely the right quantity of light exposure, humidity, and oxygen levels and all of which are necessary for a mother's womb [8]. The purpose of the article in [9] is to design an infant incubator based on Android that a health professional can access and operate over the Internet using an Android application. The technology is capable of gathering environmental data from incubators and storing it on a web server. In isolated locations, the system may have a major impact on lowering the premature infant mortality rate. The work in [10] proposes a system for infant incubators that uses a set of weight sensors, temperature and humidity sensors, and a collection of sensors for monitoring the baby's development. Every incubator equipped with this technology is linked to a central Long Range Networks (LoRa) network, enabling the registration of medical data in a database. Last but not least, the system features a Near Field Communication (NFC) interface that enables physician authentication, tablet-based patient evolution viewing, and the addition of new data.

Larger and smaller divisions make up the chamber. The bigger compartment houses the baby's mattress, while the smaller compartment houses the temperature and humidity control device. Relative sensors, fans, lights, heaters, and Arduino Uno microcontrollers are some of the parts of the control system. A software application written in C has been designed for implementation [11].

It is a sophisticated take on traditional incubator systems, fully microcontroller based, and inexpensively developed locally. The system has the ability to regulate the temperature between 36 and 37 degrees Celsius and the relative humidity between 70% and 75%.

There are already sophisticated incubators on the market, but they are far too costly to serve the needs of developing countries. The design in [12] aims at creating a low-cost, thermodynamically sophisticated incubator that can run in a resource-constrained setting. It includes three novelties: (1) a disposable baby chamber to lower infant death from nosocomial infections; (2) a passive cooling system with inexpensive heat pipes and evaporative cooling from clay pots found nearby; and (3) insulated panels and a water-filled thermal bank that efficiently retain and store heat.

III Proposed Model for Incubator:

The controller, which is the main electrical component in the baby incubator, is what gives the actuators their electrical commands by receiving signals from the sensors and activating the actuators in response. The Arduino UNO chip microcontroller, which is widely used and user-friendly, is the controller utilized in this instance. Since it is simple to program, this chip is also available for use with the Arduino Micro. It is imperative to measure the heartbeat pulses first in order to compare the results to the standard values shown in the below figure. An LDR and a high intensity type LED are used to detect heartbeats. The LED and LDR are separated by the finger. A photo transistor or photo diode can be used as a sensor. Transmitted or reflected light can be used to illuminate the skin in visible (red) light for detecting purposes. The minute variations in transmittance or reflectivity resulting from the fluctuating blood concentration in human tissue are essentially imperceptible. Disturbance signals from different sources of noise can have amplitudes that are comparable to or greater than the amplitude of the pulse signal.

A pulse measurement to be valid, the raw signal must undergo significant preprocessing. With the novel signal processing method that is being introduced here, disturbance signals can be effectively suppressed by combining analog and digital signal processing in a way that allows both to be kept simple. In this configuration, an LDR serves as the detector and a red LED provides transmitted light illumination. Other illumination and detection techniques might be employed with the same hardware and software with just minor modifications to the preamplifier circuit. The DHT11 sensor is made up of a thermistor for temperature sensing and a capacitive humidity sensor. The humidity detecting capacitor consists of two electrodes separated by a substrate that can retain moisture as a dielectric. Changes in humidity levels cause changes in the capacitance value. The resistance values are measured, processed, and converted into digital form by the IC. This sensor measures temperature using a negative temperature coefficient thermistor, whose resistance value decreases as temperature rises.

A. Block Diagram:

Here in this section, the block diagram for the proposed model is discussed. Figure.1 shows the detailed block diagram for the same. An incubator is a device that keeps an eye on and maintains surroundings that are healthy for a newborn. It is applied to sick full-term newborns as well as premature births. The incubator keeps an eye on pressure and oxygen replenishment. In addition, it keeps an eye on the surrounding temperature, radiation, pulse activity, and air humidity. We employ sensors and data transmission devices in smart incubators to store data and move it to cloud storage. They can examine the medical data on their computers and mobile devices from anywhere, and they may act on it from there. Wi-Fi and infrared technologies, which measure the critical parameters that need to be regulated for preemies, are the foundation of the design. Variations in this outcome were reported with prompt alert messages to the patient's household and the appropriate hospital administration. This research presents a potentially highly helpful biomedical system that allows physicians to monitor a patient's state from their chair, allowing for prompt and appropriate patient care. They are able to shield the infant from issues. The suggested system's block diagram is displayed in the figure. for putting it into practice using a NodeMCU controller. It is made up of sensors for gas, light, temperature, humidity, and pulse. Here, cloud storage and a Wi-Fi network have been employed to store medical data. in order for computers and mobile devices to be able to view the data. In order to prevent the newborns from unfavorable health conditions, we can inspect the incubator immediately if there is a problem with the medical data.

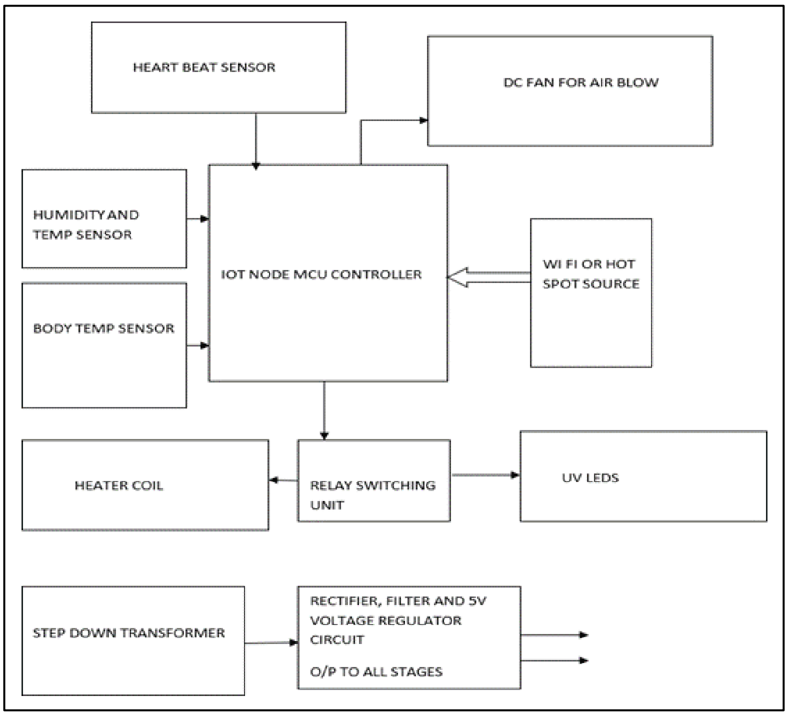

Figure 1: Block Diagram

B. Experimental Setup:

The preterm incubator's fundamental physical design consists of a glass container that is set atop a steel trolley for mobility as shown in figure 2. To ensure the baby's comfort and well-being, a bed is positioned within the glass container. This allows for the best possible baby handling because it's not too long for someone of a modest height to use well, nor is it too short to need the operator to stoop.

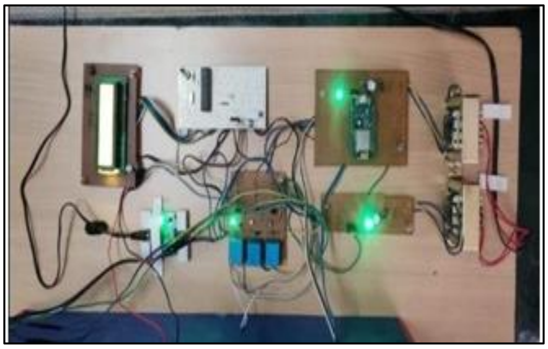

Figure 2: Experimental Setup

C. Working:

The Arduino, the brains behind our invention, is primarily responsible for the basic operation of the Smart Baby Incubator. The glass case is opened, and the infant is settled onto a cozy bed. The temperature and humidity sensors identify the necessary values as soon as the system is turned on, and they send them to the microcontroller as shown. The heater and humidifier are controlled by the microprocessor, which serves as a gateway and only permits operation when certain humidity and temperature levels are reached. The diagram below explains the Smart Baby incubator's fundamental operation. After the user makes adjustments to the temperature and humidity levels, the Arduino compares the computed values with the user-adjusted values and turns on or off the heater and humidifier based on the result. The regulated characteristics and the uncontrollable features are the two primary categories of this incubator's features. The temperature and humidity controls are the main features of this incubator. In contrast, the camera that tracks the baby's movements and the heartbeat sensor that displays the baby's heartbeat on the LCD and the Android mobile application are features that are visible but beyond our control.

IV Results and Discussion:

The experimental and simulated results of the proposed work are discussed in this section. Figure 3 and 4 shows the sensing of the heart beat and display of the pulse rate respectively.

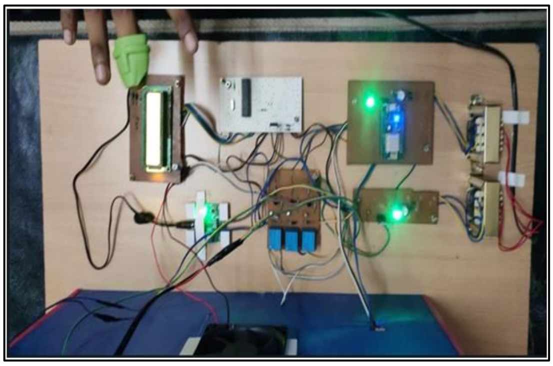

Figure 3: Heart Beat Sensing

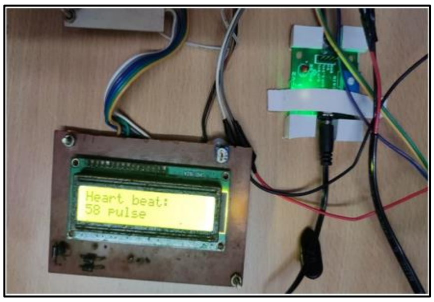

Figure 4: Display of Pulse Rate

Figure 5 depicts the simulation results of the proposed work in which the parameters such as temperature, humidity and heart beat are displayed using blynk application.

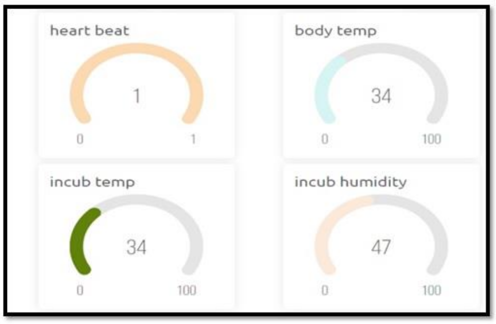

Figure 5: Simulation Results

V Conclusion:

The design of a smart baby incubator represents a significant advancement in neonatal care, providing a safe and controlled environment crucial for the survival and healthy development of infants, especially those born prematurely. By integrating precise control systems for temperature, humidity, and airflow, the incubator ensures optimal conditions that mimic a mother's womb. The use of advanced technologies, such as IoT and fuzzy logic controllers, allows for real-time monitoring and remote access, enhancing the ability of healthcare providers to respond swiftly to any changes in the infant's condition. Additionally, the smart incubator's capabilities to monitor multiple vital parameters simultaneously reduce the risk of medical complications, safeguarding the well-being of the newborns. Overall, this innovative approach not only improves the quality of care provided in neonatal intensive care units but also offers peace of mind to healthcare professionals and parents alike.

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34. Machine Learning Approaches for Data Storage in IoT: A Review

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ABSTRACT:

The widespread adoption of the Internet of Things (IoT) has resulted in the production of vast quantities of data originating from many sources. Efficient classification and storage of this data are critical for deriving actionable insights and enabling real-time decision-making. An overview of data management in IoT is given in this review paper. It discusses data storage types including machine learning and deep learning approaches, and addresses the issues of data storage. Additionally, it highlights how to address these challenges through data classification, anomaly detection, predictive maintenance, and enhancing the compression of data and de-duplication. By leveraging advanced storage architectures and machine learning techniques, effective, safe, and scalable IoT data storage systems can be developed to meet the growing demands of the IoT ecosystem.

KEYWORDS:

IoT, data storage, machine learning, data classification.

I Introduction:

The IoT represents a transformative model in which commonplace objectsare interconnected through the internet, enabling them to collect, exchange, and process data autonomously. This interconnectivity has led to an exponential increase in data generation, posing significant challenges for data storage solutions. An effective way to manage the data lifecycle requirements of a system is through various designs, processes, and methodologies that are together referred to as data management. The massive volume of data and its unique features [1] using conventional database systems wouldn't be a superior choice. Indeed, a number of concepts form the foundation of the design of IoT data management systems. Numerous data management strategies, including middleware-based IoT focused on data and sources, data storage and indexing solutions, and IoT data scheme support solutions, have been presented based on these various ideas. A middleman between items and data storage places is offered by middleware-based IoT techniques.

As a result, the middleware makes data stream routing possible. IoT data can be produced very quickly, in large volumes, and with a variety of data kinds. Data storage solutions provide to these possible issues. Efficient data storage is crucial in IoT environments due to the unique characteristics of IoT data, including its high volume, velocity, variety, and veracity [2]. Traditional data storage methods often fall short in addressing these challenges, necessitating the exploration of more advanced and tailored storage architectures.

Because there is a wide range of data providers and users, IoT data have unique properties such as temperature sensors, humidity sensors, cameras, body sensors, and RFID readers. These data are produced by billions of connected objects across numerous industries, such as supply chain management, healthcare, the military, and transportation either continuously or at discrete intervals [3]. The classification of IoT data includes:

A. Heterogeneous and Multi-Source Characteristics:

- **RFID Data:** Used for tracking and identifying in a variety of applications, including supply chain management, road tolling, passports, and animal tracking. Data is sent by radio waves by RFID tags, which can be active or passive.
- **Sensor Data:** Produced by Wireless Sensor Networks to monitor and control phenomena such as weather, temperature, noise, and video.
- **Positioning Data:** GPS or local positioning systems, such as Wi-Fi access points and cellular base stations, are used to locate tagged objects. This data is crucial for both static and mobile IoT objects.
- **Metadata:** Describes data, enabling users to find and access relevant information about objects, processes, and systems, maximizing data sharing.

B. Large Scale Characteristics:

- The number of IoT objects is expected to reach 212 billion globally by the end of 2020, generating massive amounts of data. Efficient data storage mechanisms, such as cloud computing, data canters, and fog computing, are necessary to handle this scale.

C. Spatio-temporal Characteristics:

- IoT data reflects the current state of the environment or phenomenon but is collected at discrete times, leading to spatio-temporal characteristics that need to be considered for accurate real-time analysis.

D. Multi-dimensional Characteristics:

- IoT applications monitor various indicators like weather, temperature, noise, humidity, light, and pressure, leading to multi-dimensional data. Efficient techniques are required to manage this complexity, especially when data must be captured continuously, at regular intervals, or upon request.

E. Interoperability Characteristics:

- Data-sharing facilitates collaborative work between different IoT applications. For example, in the Internet of Medical Things (IoMT), combining physiological data with traffic information can improve emergency response times and first-aid planning.

F. Contextual Characteristics:

- Context includes location, network conditions, type of service, and Quality of Service (QoS). It describes the environment in which IoT data is generated or consumed, the available resources, and the expected performance metrics like latency.

These characteristics underscore the need for robust and adaptable data management solutions to effectively harness the potential of IoT systems. This review paper aims to provide a comprehensive analysis of various data storage methods suitable for IoT, including cloud, edge, and hybrid storage models. By understanding the landscape of IoT data storage, we can better address the demands of modern IoT systems and leverage new technologies to optimize data management and utilization. Our paper is organised as follows: section I gives brief introduction about the work. Related work is discussed in section II. The section III and IV represents data storage and data storage challenges respectively and section V highlights various machine learning approaches. The section VI concludes the paper.

II Related Work:

The current state of data management schemes, layer-based architecture using distributed approach, efficient IoT data storage and query processing mechanisms for satisfying IoT application are discussed in [1-3]. Author proposed compression data solutions using discrete cosine transform solutions [4] and dividing the data into multiple fragments, and encrypting the data using owner's private key. The Coordinate-based Indexing (COIN) mechanism for the data sharing in edge computing and maintains a virtual space where the switches and the data indexes [5]. An online client algorithm based on machine learning algorithm for IoT unstructured big data analysis using the online data entered by the customer to implement background data mining, the parallel way to verify its efficiency through machine learning algorithms such as K-nearest neighbor algorithm [6]. The proposed work presents [7] threshold secret sharing scheme for storing aggregate data in IoTs in cloud storage. Data storage and verification of local repair code shading block chain based on bilinear accumulator is presented in [8]. The data storage process is performed by using a dual block chain topology that includes a lightweight block chain (local block chain) and a public block chain. The proposed Service Data Processing Mechanism (SDPM) [9, 10] aims to improve data storage efficiency within the context of a Service-oriented Architecture underlying the Internet of Things (So AIoT). The hybrid framework with a software and hardware integration strategy for an industrial platform that exploits features from a Relational Database (RDB) and Triple store and Synchronization mechanism is discussed in [11]. The state-of-the-art technologies and research trends concerning RSBD storage and computing is discussed in [12].

Cloud-based optimized remote sensing data storage technology and cloud storage technology represented by OSS, New SQL, and NoSQL techniques and solution for RSBD storage and management described in [13].Hadoop deep learning architecture and implementation process are analyzed and software performance testing tool Load Runner discussed in [14].Map Chain-D is designed for practical IIoT applications with storage, latency, and communication constraints are discussed in[15].ID-based data storage scheme utilizing anonymous key generation in fog computing distributed data storage method with the combined K-means and PSO clustering mechanism organized with the binary decision tree C4.5 in the IoT area with considering efficiency and reliability approaches discussed in [16, 17].Improved RSA accumulator to solve the problem of data storage expansion in the block chain [18].Two NoSQL databases Google Big table and Dynamo based on CAP theorem [19].The Hadoop distributed file system (HDFS)cloud storage approach using Heuristic algorithm is presented in [20].Edge KV, a decentralized storage system designed for the network edge using the Yahoo! Cloud Serving Benchmark (YCSB) to analyze the system's performance under realistic workloads is proposed in [21].Optimized hash algorithm of IoT data access storage in cloud computing[22].A Gated Recurrent Unit based Digital Twin Framework for Data Allocation and storage in IoT-enabled Smart Home Networks. Low-priority data is stored and processed at the Macro-based Stations (MBSs), and high-priority data is transferred to the upper [23]. A block chain storage optimization scheme based on RS erasure code is proposed in [24]. Novel encoding scheme [25] called Pathed Dewey Order and a two-layer mapping method to store XML documents in HBase tables. Hadoop based big data secure storage scheme using a homomorphic encryption algorithm, dual-threaded encrypted storage is presented in [26]. A real-time intelligent monitoring and notification system (RT-IMNS) in cold storage using Artificial Neural Network (ANN) is proposed in [27].The database heterogeneity of the USPIOT platform an XML based unified management mechanism database is designed in [28].Complex Perceptual Data Placement Algorithm Terminal Node Load Balancing Strategy and the cost-minimization storage selection using two heuristic algorithms: Dynamic Programming (DP) based algorithm and Greedy Style (GS) algorithm, for optimizing the choice of data storage based on IoT application service requirements are described in [29, 30]. The paper [31] propose an algorithm to design the data model from ontological information of the domain and a set of most frequent queries expected to run on the database. Data storing using Ethereum block chain and IPFS and develops smart contracts and Ethereum D Appare presented [32]. Qualitative and quantitative analysis of time series encoding algorithms regarding to various data features. The comparison is conducted in Apache IoTDB, an open source time series database[33].Adaptive Multi-Model Middle-Out using reinforcement learning based compression for time-series data[34].The optimized data storage models the Extreme Learning Machine, SVM-based optimized model and Elastic Chain model for synthetic data are mentioned in [35].The Inter Planetary File System (IPFS), a decentralized storage solution that employs Message Queuing Telemetry Transport (MQTT) protocol for efficient Content Identifiers (CIDs) transfer and a database for archiving CID values and associated metadata [36].

III Data Storage:

In the context of the IoT, data storage techniques refer to the methods used to store and manage the vast amounts of data generated by IoT devices. As IoT devices often produce a continuous stream of data, efficient and scalable storage solutions are necessary to handle this data effectively. Here are some common data storage types used in IoT:

1. **Cloud Storage:** Storing IoT data in the cloud is a popular option due to its scalability, accessibility, and cost-effectiveness. Cloud storage providers offer large-scale, distributed storage systems that can handle massive amounts of data. IoT devices can transmit data to the cloud in real-time, where it is stored, processed, and made available for further analysis.
2. **Edge Storage:** Edge storage involves storing IoT data locally on the edge devices themselves, closer to the source of data generation. This approach helps reduce latency and bandwidth requirements by processing and storing data locally. Edge storage is particularly useful in scenarios where real-time data analysis or quick response times are crucial.
3. **Hybrid storage(Edge-Cloud):** A hybrid storage system combines both edge and cloud storage to create a more flexible and efficient data storage solution. Sensors and local gateways process real-time data, such as traffic conditions or air quality, to make immediate decisions or send alerts, Aggregated data from all sensors is periodically sent to the cloud for long-term storage, comprehensive analysis, and machine learning to detect patterns and trends.
4. **Distributed Storage:** Distributed file systems are designed to store and manage data across multiple nodes or devices in a distributed network. These systems enable efficient storage and retrieval of large amounts of data, ensuring data availability, fault tolerance, and scalability. Examples of distributed file systems used in IoT include Hadoop Distributed File System (HDFS) and Google File System (GFS).
5. **Database Systems:** Database systems are commonly used for structured storage and efficient data retrieval in IoT applications. Relational databases (e.g., MySQL, PostgreSQL) and NoSQL databases (e.g., MongoDB, Cassandra) are utilized to organize, store, and query IoT data based on specific requirements. These databases provide mechanisms for indexing, querying, and aggregating data, enabling efficient data processing and analysis.
6. **Time-Series Databases:** Time-series databases (TSDBs) are designed specifically for handling time-stamped data, which is prevalent in IoT applications. TSDBs optimize the storage and retrieval of time-series data, making them ideal for storing sensor data, telemetry data, and other time-dependent IoT data. Examples of TSDBs include Influx DB and Prometheus.
7. **Spatial data storage:** involves managing and querying data that has a geographic or spatial component, such as locations, shapes, and boundaries. This type of data is crucial in various applications, including geographic information systems (GIS), location-based services, urban planning, and environmental monitoring.
8. **Hierarchical data storage:** is a way of organizing data into a tree-like structure that represents relationships between data elements in a parent-child hierarchy. This structure is often visualized as a tree with branches, where each node represents a data element, and the connections between nodes represent the relationships between them
9. **Object Storage:** Object storage is a method of storing unstructured data as objects, each having a unique identifier. It provides a highly scalable and cost-effective solution for storing large volumes of IoT data. Object storage systems, such as Amazon S3 and OpenStack Swift, are commonly used in IoT deployments for storing multimedia data, logs, and files.

10. **Multi-modal data storage** refers to a storage architecture designed to handle and manage different types or modalities of data within a unified system. Unlike traditional storage systems that may focus on a single data type (e.g., text, images, or time-series data), multi-modal data storage integrates various data types into a cohesive framework. This approach is particularly useful in environments where diverse data types need to be processed and analyzed together, such as in modern applications that involve text, images, videos, sensor data, and more.

It's important to note that different IoT applications and use cases have varying data storage requirements, and a combination of these techniques may be employed to meet specific needs. Factors such as data volume, velocity, variety, and latency requirements play a role in selecting the appropriate data storage approach for an IoT system.

IV Data Storage Challenges:

Data storage in IoT environments presents several challenges due to the unique characteristics of IoT systems and the massive volume of data they generate. Here are some of the main challenges:

1. **Volume and Velocity of Data:** IoT devices generate vast amounts of data continuously. Handling this high volume and high-velocity data can overwhelm traditional storage systems.
2. **Data Heterogeneity:** IoT data comes in various formats (structured, semi-structured, and unstructured) from different devices and sensors. Managing and storing this heterogeneous data efficiently is challenging.
3. **Data Integrity and Quality:** Ensuring the accuracy, consistency, and reliability of data from diverse sources can be difficult. Inconsistent or erroneous data can lead to incorrect analytics and decision-making.
4. **Latency and Real-Time Processing:** Many IoT applications require real-time data processing and low-latency responses. Traditional storage solutions may not meet these requirements, necessitating the use of edge computing or hybrid storage solutions.
5. **Scalability:** Storage systems must scale seamlessly to accommodate the growing number of IoT devices and the increasing volume of data they generate. This requires scalable architecture and infrastructure.
6. **Security and Privacy:** IoT data often contains sensitive information. Ensuring the security and privacy of data during storage and transmission is critical. This includes protecting against unauthorized access, data breaches, and ensuring compliance with regulations.
7. **Energy Efficiency:** IoT devices and the storage systems they interact with must be energy-efficient. High energy consumption can be a limiting factor, especially for battery-operated devices and remote deployments.
8. **Cost Management:** Storing massive amounts of data can be expensive. Finding cost-effective storage solutions while maintaining performance and reliability is a significant challenge.
9. **Data Lifespan and Retention:** Determining how long to store IoT data and managing data lifecycle policies (from creation to deletion) can be complex, especially when different data types have different retention requirements.

10. **Network Bandwidth:** Transferring large amounts of data from IoT devices to centralized storage can strain network bandwidth, especially in environments with limited connectivity. Efficient data transmission and compression techniques are needed.
11. **Integration and Interoperability:** IoT systems often involve multiple vendors and platforms. Ensuring seamless integration and interoperability between different storage systems and IoT devices can be challenging.

To overcome data storage challenges in IoT, future directions should focus on enhancing edge computing for real-time processing, optimizing hybrid storage solutions that combine edge and cloud resources, and implementing advanced data compression and de-duplication techniques.

Integrating AI and machine learning can enhance data management, while block chain technology can ensure data integrity and security. Developing energy-efficient storage solutions, promoting interoperability standards, designing scalable architectures, and ensuring data privacy and regulatory compliance are also crucial. Additionally, exploring quantum computing could revolutionize data processing and storage, providing unprecedented capabilities for the growing IoT ecosystem.

V Machine Learning Approaches:

Machine learning approaches for IoT data storage enhance efficiency and effectiveness through various techniques. Hierarchical deep learning models, such as CNNs and RNNs, classify data at multiple levels, while transfer learning leverages pre-trained models for faster classification.

Data storage is optimized with collaborative filtering, predicting and storing only relevant data, and model pruning and quantization, reducing model sizes for edge storage. Hybrid storage solutions like edge-cloud collaboration balance latency and resource usage, and federated learning trains models across edge devices, enhancing privacy.

Anomaly detection with auto encoders and SVMs prioritizes critical data, and predictive maintenance using LSTM networks and regression models forecasts storage needs. Future directions focus on adaptive learning systems, energy-efficient algorithms, and enhanced security and privacy, ensuring robust and scalable IoT data management. The Table 1 depicts about different machine learning approaches based on various data storage types.

Machine learning offers innovative solutions to address the challenges of IoT data storage. By leveraging advanced classification techniques, optimizing storage allocation, and employing hybrid storage models, ML can significantly enhance the efficiency and effectiveness of IoT data management. Future research should focus on developing adaptive, energy-efficient, and secure ML algorithms to further improve IoT data storage solutions.

Table 1: Different Machine learning approaches for data storage types

	Data Storage Types							
	Cloud storage	**Edge Storage**	**Hybrid Storage**	**Distributed storage**	**Time-Series storage**	**Spatial Data Storage**	**Hierarchical Data Storage**	**Multi Modal Data Storage**
Machine Learning Algorithms	k-Nearest Neighbors (k-NN) [6]	Reinforcement Learning (e.g., Q-Learning, DQN)	Hierarchical Deep Learning Models [14]	Distributed Machine Learning Frameworks [20]	Recurrent Neural Networks (RNNs)	Convolutional Neural Networks (CNNs) [27]	Hierarchical Clustering	Multi-modal Neural Networks
	Random Forest	Lightweight neural network	Collaborative Filtering	Graph Neural Networks (GNNs)	Long Short-Term Memory Networks (LSTMs	Geospatial Analysis Tool	Recursive Neural Networks	Attention Mechanisms
	Gradiet Boosting Machines (GBM)	Online learning algorithm [6]	Transfer Learning	Bayesian Networks	Temporal Convolutional Networks (TCNs)	DBSCAN	Decision Trees	Auto encoder
	Support vector Machines	K-nearest neighbors[17]	Model Pruning and Quantization	Federated Learning	ARIMA (Auto Regressive Integrated Moving Average)	Geographically Weighted Regression (GWR)	Tree-based Ensemble Methods like, Gradient Boosting Trees)	Generative Adversarial Networks (GANs)

VI Conclusion:

The ongoing field of IoT presents numerous data storage challenges, including managing vast and heterogeneous data, ensuring real-time processing, maintaining data integrity, and addressing security and scalability concerns.

Traditional storage solutions often fall short in meeting these demands, necessitating innovative approaches such as hybrid storage architectures that combine the strengths of edge and cloud storage. Furthermore, machine learning techniques offer promising solutions for optimizing data management, from classification and anomaly detection to predictive maintenance and data compression.

By embracing these advanced methodologies, we can develop robust, efficient, and secure data storage systems that are capable of supporting the expansive and dynamic nature of IoT applications.

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35. Performance Analys is of Inter-Satellite Optical Wireless Communication

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Abstract:

When it comes to data transmission technologies, laser frequency offers a significant advantage over other conventional means like radio wave sand microwaves. It is more suited for usage in bidirectional space communication with high-speed objects and communication channels due to its fast data rate, small antenna size for both the transmitter and receiver, and high through put. This work aims to provide a brief over view of the application of lasers in inter satellite communication systems and to compare several metrics, such as eye diagrams, BER (Bit Error Rates), Q-factors, etc., utilizing MIMO, SISO, SIMO, and MISO over a certain distance. We will offer a condensed comparative analysis and some recommendations for further study.

Keywords:

BER, SINR, MIMO, Q-factor, Modulator.

I. Introduction:

Since space communication makes it possible to send data and information over great distances, it is essential to modern civilization. For a long time, conventional space communication methods like microwave transmission have been in use.

But thanks to technological developments, a brand-new kind of space communication called laser communication has surfaced. When compared to more conventional communication methods like microwaves, laser communication technology has a number of advantages.

First off, the increased data rate of laser communication is one of its main benefits. Large volumes of data may be transferred quickly by the usage of laser technology, which enables greater transmission speeds. Second, when it comes to total security and confidentiality, laser communication out performs conventional modes of communication.

This is because laser shave small be am divergence, which makes it harder for eaves droppers to jam or intercept the communication. Furthermore, laser communication is more robust against interference, which increases its depend ability in difficult circumstances.

Thirdly, there is a chance for higher capacity with laser communication technology. Larger capacity is a benefit of laser communication over conventional microwave transmission. As a result, communication systems can transmit more data at once and operate more efficiently.

While there are many benefits to laser communication, there are also some difficulties and things to consider. One of these is laser beam tracking and positioning with extreme precision. This is required to prevent signal loss or degradation due to even small misalignments, and to provide precise and dependable communication between satellites. Furthermore, as environmental circumstances might have an impaction signal propagation, it is important to carefully evaluate these factors while using laser technology for space communication.

II Related Work:

It is difficult to achieve dependable and effective communication in optical wireless communication systems because of things like atmospheric effects, signal intensity changes, and interference.

This highlights how crucial it is to choose the best system architecture and modulation style for depend able communication in these kinds of systems. It is impossible to ignore how Wave Division Multiplexing (WDM) affects the performance of Is OWC (Inter-satellite Optical Wireless Communication).

The performance and potential of Is OWC systems are improved by the inclusion of Dense Wave Division Multiplexing (DWDM). The LP-IsOWC system can further improve system performance and reliability by reducing BER by using Erbium Dropped Fiber Amplifiers (EDFAs) as booster amplifiers.

Overall, the selected papers highlight how crucial it is to take into account a number of variables while developing and refining optical wireless communication systems, including modulation format, system architecture, and the possible advantages of WDM integration. Engineers can efficiently build and improve the performance of optical wireless communication systems by accounting for these aspects.

III Methodology:

We mostly use RZ, NRZ and Manchester line coding scheme to convert our data in binary input. We are sending this binary input code to optical modulator, which is used to convert the information carried by an electric current into beam of light. This beam of light is sent to the receiver where the data processing is happening.

IV. Systemmodel:

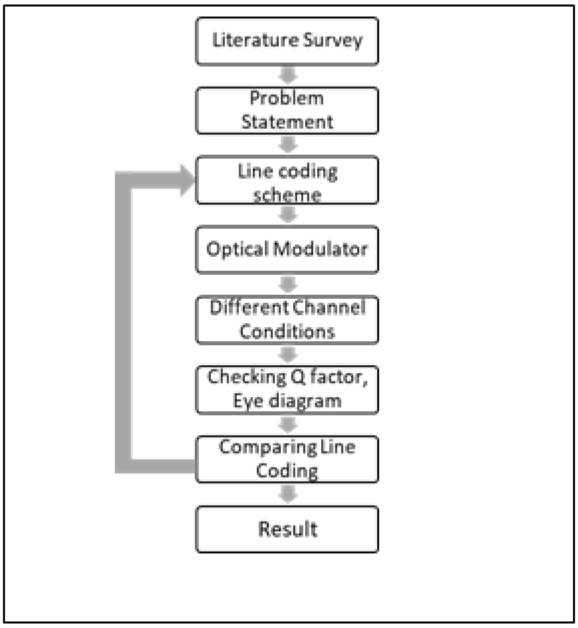

Figure 1: Procedural flow

We are working on free space communication, so according to space we need to prepare our channel, where we can use different channel conditions like wavelength, range, attenuation in free space. The beam of light sent by sender is received by a photo receiver at the receiver side.

We have finalized to go with the factors namely:

Q-factor which represents the ability of the system to maintain its operating frequency, Eye diagram represents the quality of the transmitted signal BER provides the ability of system to correctly transmit the data bit. From these factors we will check the performance of the system. and compare them with the existing data.

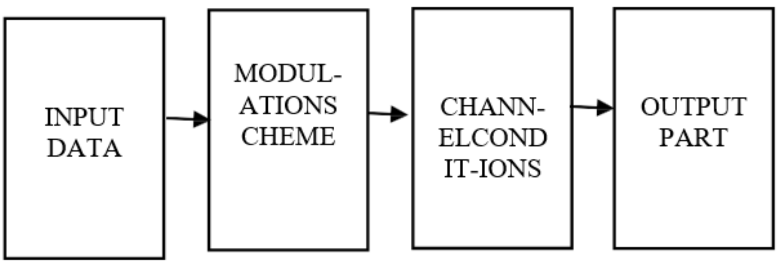

Fig.2SystemModel

A. Input Data: For the proposed model input is generated by Pseudo Random bit sequence generator and converted this to NRZ input format.

B. Modulation Schemes: The input data is sent to MZ modulator for modulation and this data will be attached to the Laser for communication. The modulation scheme used in this system is PSK (Phase Shift Keying).

C. Channel Conditions: We must use free space for this model so the conditions will mostly be constant. There are several channel conditions like Attenuation, Turbulence and path loss which are related the dimensions of the channel.

D. Output: The transmitted data is received by the Photo-receptor which will be converted to electrical signal and will be analyzed by the low pass filter.

V. Implementation:

We are comparing different Line coding schemes like RZ, NRZ and Manchester coding. Out of the se NRZ is giving better results for all the communication techniques. We are implementing four different communication techniques like MIMO, MISO, SIMO, and SISO. The parameters we are using are:

Parameters	Values
Wavelength	850 nm
Range	45000Km
Bit Rate	1.8Gbps
Power of Laser	41Watts

A. SISO (Single Input Single Output):

In this model, SISO(Single Input Single Output) is implemented, NRZ pulse generator is used to generate the input. The signal gets modulated in Analytical modulator and then gets into the OWC(Optical wireless communication) channel. Then it goes to low pass b Bettlefilter and the output is got in BER analyzer through 3Rregenerator.

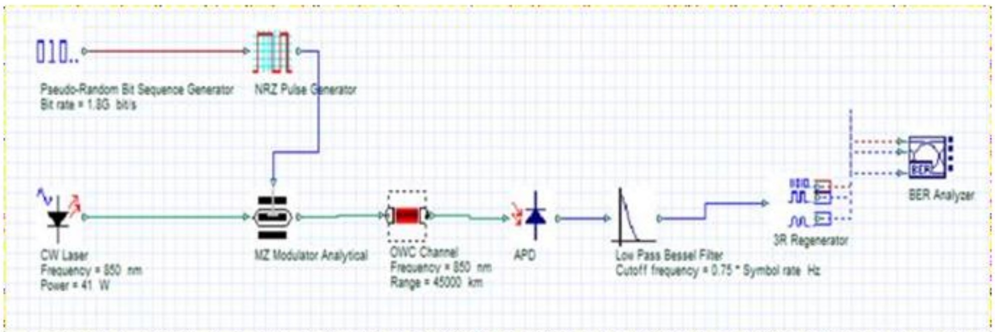

Fig3.SISO

B. SIMO (Single Input Multiple Output):

In this model, only a single input is connected through NRZ generator and CW laser. Power splitter is present to split the signals into multiple parts. Here the power is split into four parts hence 4 OWC channels are used. Hence 4 APDs, 4 Low pass filters, 43 R regenerators and 4 BER analyzers used as shown in the figure.

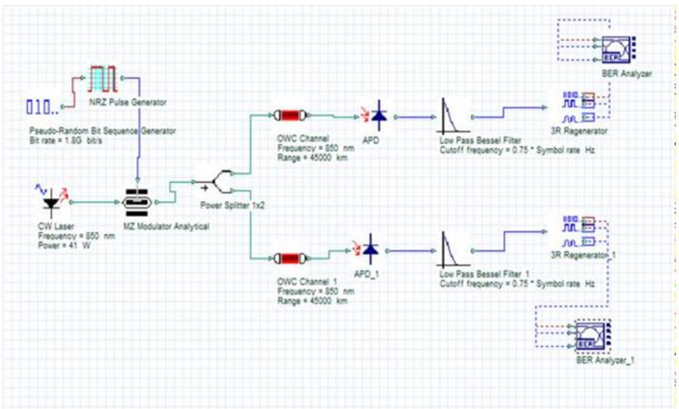

Fig4.SIMO

C. MISO (Multiple Input Single Output):

In this model, 4 NRZ inputs are given with four modulators. Then the modulated signals go through 4 OWC channels. Then there is a power combiner being used and optical amplifiers as shown in figure which combines the power and amplifies output, respectively. Only one output is got from the APD, Low pass filter, 3RregeneratorandBERanalyzer.

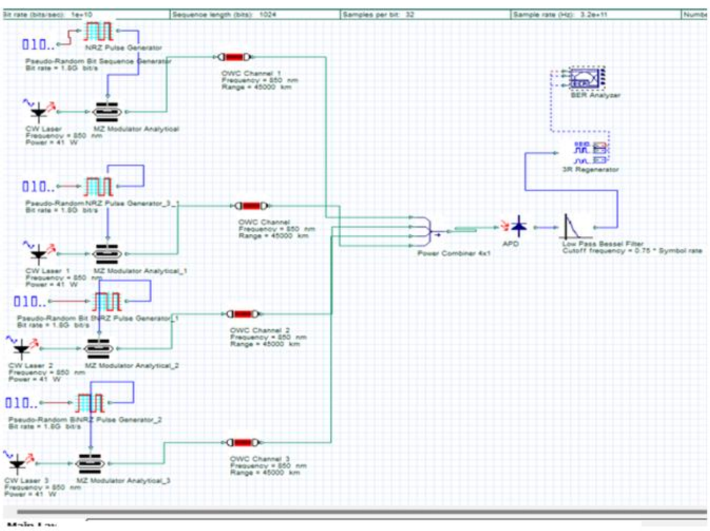

Fig5.MISO

D. MIMO (Multiple Input Multiple Output):

From the diagram, it is observed that four different inputs are given to power combiner which send that signal through the OWC channel. A power splitter is used to divide the modulated signals into four different signals which are received by an APD and converted into electrical signal. A Low pass Bessel filters, 3Rregenerators and BER analyzers are used to generate the results for our understanding.

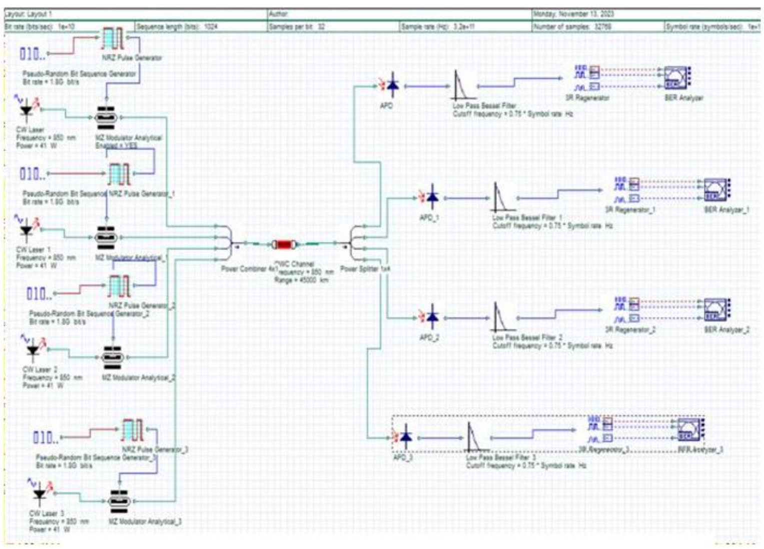

Fig6.MIMO

VI. Result and Discussion:

A. Results for SISO:

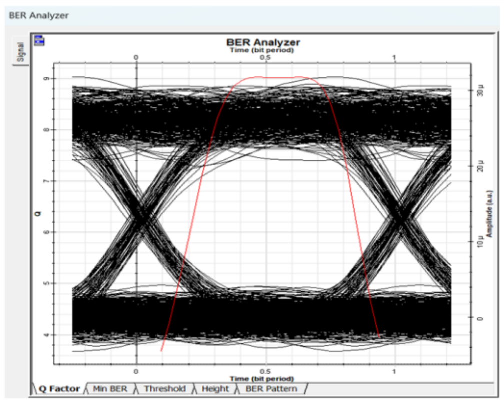

Fig7.Q-factorandEyediagramforSISO

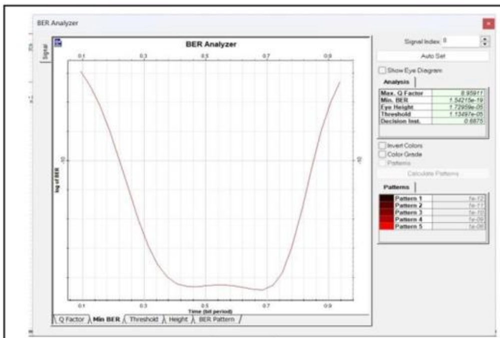

Fig8.BER forSISO

B. Results for SIMO:

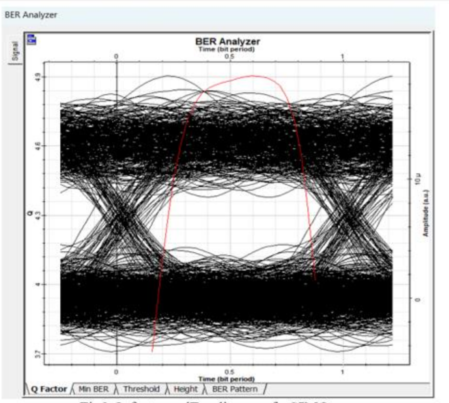

Fig9.Q-factorandEyediagram forSIMO

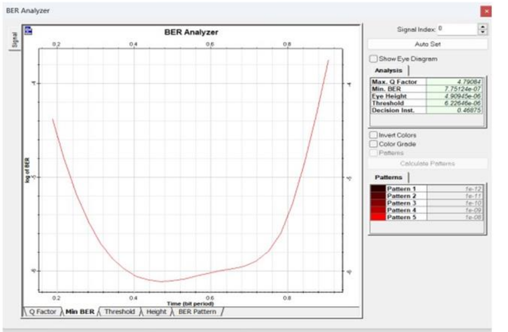

Fig10.BERforSIMO

C. Results for MISO:

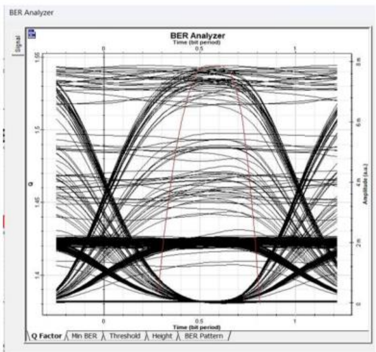

Fig11.Q-factorandEyediagramforMISO

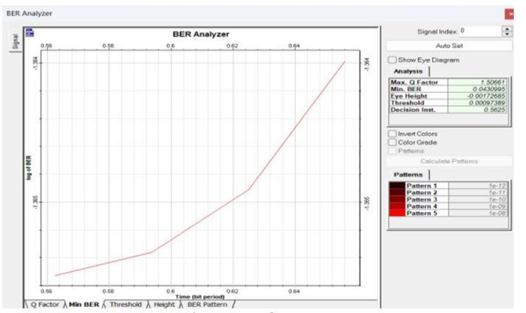

Fig12.BER for MISO

D. Results for MIMO:

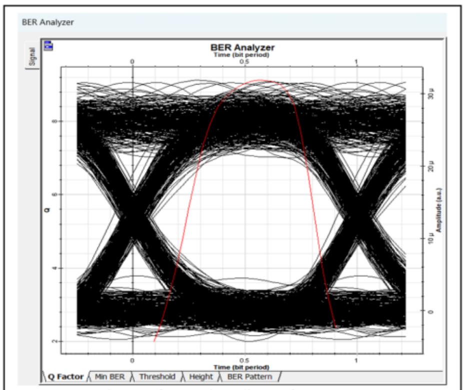

Fig13. Q-factorand EyediagramforMIMO

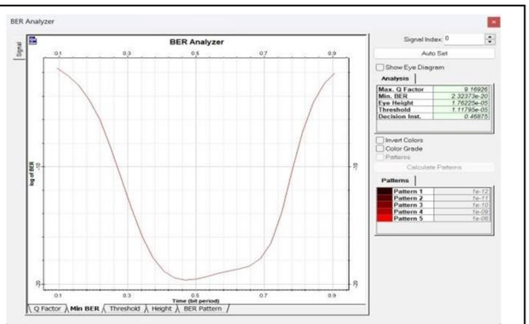

Fig14.BER forMIMO

	SISO	SIMO	MISO	MIMO
Q-Factor	8.95911	4.79084	1.50661	9.16926
BER	1.54215e-19	7.75124e-07	0.0430995	2.32373e-20

For execution of this system the Opti-System software is used through which the above results are generated. By comparing all the diagrams, the table is created to check the results. From the above table, an inference can be taken that when Q-factor, BER of different communication systems are compared, the Q factor of MIMO is the best when compared to other systems. From above diagrams we can conclude that both Q-factor and BER are inversely proportional to each other.

VI. Conclusion:

We can conclude that MIMO system works more efficiently than other systems with the Q-factor of 9.16926. Like MIMO, SIMO also works efficiently which is having Q- factor of 4.79084, so it can be inferred that the proposed system works more efficiently for multiple out puts. When SISO and MISO are compared, single out put is obtained and it is inferred that SISO works effectively with Q-factor of 8.95911, where as the Q-factor for MISO is 1.50661 which is much lesser than the other systems.

When it comes to Bit Error Rate (BER) it can be observed that MIMO system is having lowest value of 2.32373e-20 and MISO has the highest value of 0.0430995. From this it can be concluded that the Q- factor and BER are inversely proportional to each other that means the system having minimum BER and maximum Q- factor is working more efficiently.

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36. Review of Structural Health Monitoring Methods: A Machine Learning Approach

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ABSTRACT:

The discipline of structural health monitoring (SHM) has benefited from a great deal of novel sensing and monitoring systems based on machine vision-based technologies during the last 20 years. Some of the technology's unique intrinsic benefits include immunity to electromagnetic interference, extended range, high accuracy, noncontact, nondestructive, and broad-spectrum, multi-target surveillance. Numerous techniques for structural condition inspection and structural dynamic assessment based on machine vision have been put forth. Measurements of the physical characteristics of the structure, such as displacement, strain/stress, rotation, vibration, fracture, and spalling, are also made in real-world settings. This review article's goal is to provide an overview of the fundamental ideas and real-world uses of the machine vision-based technology used in structural monitoring. It also aims to integrate the technology with other contemporary sensing techniques and address systematic error causes.

I Introduction:

The majority of the public infrastructure in today's society consists of concrete constructions like pavements or bridges and tunnels made of various materials such as concrete, asphalt, or other stone types. The demand for maintenance rises with greater use and ageing facilities, and improper maintenance can result in poor conditions or structural defects. This is a typical issue. For instance, a recent assessment on the health of the US infrastructure by the American Society of Civil Engineers claims that over 2000 dams and over 46,000 bridges are structurally defective, and that on average, every fifth mile of roadway is in bad condition [1].

Alongside those maintenance procedures, the process of structural health monitoring (SHM) and assessment is often conducted. This is a crucial stage since it considers the overall health of the structures and prioritizes and catalogues any potential irregularities. However, because it is frequently done at the target place, this procedure is labor-intensive. It can also be risky at times because infrastructure that are difficult to reach may not be able to be used as planned, such as bridges, tunnels, or highways that must be closed to the public. Furthermore, because the procedure is frequently completed by hand, human variables are involved, which might have a detrimental impact on the results of such structural assessments. Amid the SHM process, the objective is to discover markers for current or future harm. A few common harm sorts that show up on structures are surface splits on asphalts, concrete, bricks, stone and black-top, spalling of concrete and broken or eroded steel [8]. The most common defect of concern is crack which spoils the overall integrity of the structure. The methods used to detect might be as straightforward as visual inspections or taking pictures or videos [5], as well as employing lidar scanners to create 3D representations [9], [10], and ultrasonic wave exams [11], [12].

It is evident that once the data has been collected using such methods, anomaly detection algorithms may be applied and the data can be reviewed at a later time. Cracks frequently don't show up in a consistent manner; they might be of various sizes and forms, obscured by moss or leaves, or otherwise partially covered by occlusions. Because some fractures are so tiny, it may be difficult to tell them apart from their surroundings. Although it might be challenging for people to operate under these settings, machine learning (ML) offers a potential remedy. Over the past few decades, machine learning techniques in the field of computer vision have significantly improved in performance, thanks in part to the introduction of far more potent hardware and software. Numerous technologies and applications have been influenced by these developments in machine learning (ML) in conjunction with computer vision applications in recent years. This can include making autonomous driving possible [13], [14], outperforming humans in picture categorization [15], or supporting experts in the medical field using various scans for diagnosis, including CT [16] or X-rays [17]. Most of the most advanced techniques for such tasks are powered by deep neural networks, which are a subset of machine learning called deep learning (DL). This has also made it possible for research into automating some aspects of the surface health inspection process, such as automatically identifying and measuring fractures as surface defects, to soar [7], [18] [20]. Figure 1 illustrates the overall procedure for integrating DL into the structural health monitoring framework for cracks. In recent years, several researchers have conducted reviews on the subject of structural monitoring and condition assessment using machine vision. Casciati and Wu [24] provided a brief introduction to visual positioning systems for structural monitoring. Jiang et al. [25] outlined the development and application of close-range photogrammetry to measure bridge deformation and geometry.

Koch et al. [26] presented a comprehensive integration of state-of-the-art defect detection and condition assessment for concrete and asphalt structures based on computer vision technologies. However, a comprehensive overview of visual structural monitoring and condition assessment is still desirable.

In this paper, we provide a detailed assessment of machine vision-based monitoring of civil engineering infrastructure, including the main approaches and practical applications.

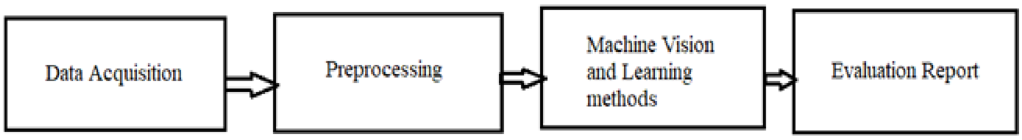

Figure 1: Machine Learning Way for SHM

Summary of the vision based structural monitoring and condition assessment is still desirable. This paper provides a detailed assessment of machine vision-based monitoring of civil engineering infrastructure, including key approaches and practical applications.

II Operation/ Tasks:

Surface crack extraction using computer vision may be divided into many activities. These tasks coincide with conventional computer vision. The choice of classification, detection, and segmentation jobs depends on the needed level of detail in the SHM process.

A. Crack Classification:

Assigning the appropriate class label to a picture is the aim of the image classification problem in the traditional setting of computer vision. To classify images within the crack space in SHM, the easiest approach is to identify which images have cracks and which ones don't. Though this assignment is limited to binary classification, it might still prove difficult because fractures may not always be the only surface imperfection that resembles one. Building on this two-label classification problem, the crack classification task may be expanded to infer the type of crack in addition to determining whether a crack is present.

B. Crack Detection:

Crack detection goes beyond categorisation in that it highlights the position of the crack in order to offer more information in addition to determining whether or not it exists. This can be advantageous since simple classification tasks just highlight the presence of cracks; they do not attempt to offer any form of fracture localisation. In contrast, detection tasks seek to identify break locations. One can approximate the position of a fracture by identifying sub-regions of a picture and then piecing them back together to create a bigger component. Bounding box construction is another method of detection. This job has garnered a significant amount of recent effort and is frequently studied in other large datasets like COCO [32]. Still, this might not always be the best option for cracks. In the worst scenario, the bounding box only indicates the outermost points of a fracture, with a significant portion of the region inside this box being devoid of cracks, because some fissures only manifest as a single linear structure.

C. Crack Segmentation:

This method solves the problem of not having sufficient information about cracks in detection and classification step. This job assigns a specified class label to pixels in images or voxels in 3-D volumes. The segmentation problem may be divided into semantic and instance segmentation. The former classifies all pixels or voxels in input data, without distinguishing between instances. In a picture, many cracks are labelled as belonging to the same class. In contrast, instance segmentation distinguishes between instances. Different cracks are allocated the class label "crack," yet their instance labels differ.

III Review of Machine Vision Based Techniques:

A visual measurement system typically includes image capture equipment (digital camera, lens, gripper), computer, and image processing software. The image processing software platform is integrated with appropriate computational techniques to generate machine parameters for structural monitoring. To use image processing algorithms, an image containing predefined targets is captured by a digital camera. The targets are monitored using digital image processing and pattern matching algorithms [27-30], and the structural displacement at the target points on the structure can be calculated. In this case, horizontal and vertical displacements, referred to as two-dimensional (2D) displacements, can be calculated using digital image correlation [31], Mean Shift tracking algorithm [32], CamShift tracking algorithm [33] and the Lucas-Kanade method [34]. Baska et al. [39] used two types of cameras to capture images of multiple targets fixed on a railway bridge during train passage and determined the displacement response using three image processing techniques: digital image correlation, edge detection, and pattern matching. Li et al. [40] proposed a pose-graph optimized displacement estimation method to reduce the estimation error in a visually controlled paired structured light system.

Nayyarloo et al. [41] developed an image processing system to monitor the seismic response of structures using line-scan cameras. Chang et al. [42] proposed a CCD camera-based method to measure the vertical displacement of a bridge. Santos et al. [43] performed the calibration of an image processing system in measuring the structural displacement of a long-lane suspension bridge. When applying visual methods to measure vibrating targets, there is a high risk of measurement uncertainty due to motion.

Table 1: Review of Different Learning Algorithms for SHM

Type of Learning	Task Performed	Explanation	Examples
Supervised	C	Classification CNN to classify whether images/patches contain cracks or other defect types.	[31], [51]–[53]
	D	Classification of patches using a CNN followed by merging to obtain a coarse detection map. [54], [55	[54], [55]
	s	CNN that classifies the presence of a crack within single pixel. Using a sliding window approach, every pixel within an image is classified. [39], [52], [56]	[39], [52], [56]

Type of Learning	Task Performed	Explanation	Examples
	s	Approaches using a U-Net shape with popular image classification architectures as the encoder and a custom decoder	[36], [63]–[65]
	s	Approaches that use an ensemble of CNNs	[73], [74]
	Q	Approaches that use a CNN to predict the size of a crack	[40], [77]
	Q	Two-step approaches that first segment a crack followed by calculating their dimensions	[77]–[80]
Semi and Weakly Supervised	S	Two stage approaches in which a CNN classifier is trained on image labels and its class activation maps are used to create pseudo segmentation labels of the training images. Those pseudo labels are then used to train a segmentation algorithm.	[81]
	S	Approaches that train on classification labels and then use thresholding to create a segmentation map	[55], [82]
	S	Training on coarse segmentation labels	[83]
Unsupervised	S	Transformation of an input image into latent space or frequency domain before reversing transforming it back into an image. The differences between the input and output then segment areas belonging to cracks or other anomalies.	[84], [85]

Blur caused by the movement of the camera and target. Motion blur will cause significant systematic errors and incomplete measurement data, as the target search process may not achieve accurate detection.

In recent years, research efforts have centred on creating algorithms for mitigation and noise reduction, as well as ways for interpreting blurred pictures [62-64]. Wang et al. [65] suggested a vibration measuring approach based on blurred pictures that takes into account the link between the geometric moments of undistorted and blurred motion. To address the issue of motion blur in an online particle imaging system for analysing wear particles, Peng et al. [66] created an image restoration approach to improve the quality of dynamic particle pictures. Becker [67] conducted a research to analyse motion blur using several fundamental methodologies and a diverse set of parameters. Wu et al. [68] proposed an image line-by-line degradation model and a restoration strategy to account for spatially variable deterioration.

Table 2: Review On Literature of ML for SHM

Method	Input	Output	Source
K-means clustering and canny edge detection	High quality picture of walls	Area of moss and crack in stone monuments	[194]
KNN	Color and geometric data extracted	Loss of material and discoloration on walls	[78]
Banalization of image processing operations	Real-time scene image	Quantity of dust deposited	[79]
Deep CNN	Pathology analysis	Damage analysis	[80]
Fuzzy inference system	Rebound hammer, fractal dimensions	Weathering extent	[81]
Fuzzy logic	Dimensions ,texture and fissure properties of stone blocks	Quality of material used for construction	[82]

IV Review of Machine Learning Based Approaches:

Here, the techniques are split as supervised, semi as well as weakly supervised and unsupervised learning. Table 1 shows the commonly used methods for crack classification (C), detection (D), segmentation (S) and quantification (Q). Table 2 highlights the possible input and output combination for various machine learning ways.

V Research Gap:

Here we look into the various research gaps observed potentially after the review of some literature.

A. Crack Classification:

While multiple datasets for various activities demonstrating fractures are accessible, there is a scarcity of large-scale publically available datasets. The ImageNet dataset, with its large sample size, has boosted DL research in the broader computer vision area. As a result, this area would greatly benefit from having a single, large-scale dataset for training and evaluating algorithms. While the GAPs v2 subset in [53] and SDNet2018 [74] with over 50k pictures for classification are promising, annotated data for segmentation and quantification is also needed. To address this issue, consider combining several datasets, as suggested in [75]. However, the issue of inaccurate labelling persists across several datasets in this region, as shown in subsection VI-A2. To ensure consistency and accuracy, this data might benefit from re-labelling by experienced specialists. Unfortunately, this would require significant expenditures and effort.

B. Semi, Weakly and Unsupervised Learning:

Semi, weak, and unsupervised learning techniques for cracks are under-represented compared to supervised learning. To address the previously described dataset concerns, it may be advantageous to build a standardised dataset for these sorts of learning. Currently, writers manually adjust the label quality of datasets [71], [73], which may not be the most efficient strategy for the future. Creating a uniform dataset for several sorts of learning helps speed up research and improve algorithm comparability. Currently, there are few unsupervised learning techniques that use deep learning. Research in this area might be highly beneficial, given the challenges of getting and labelling data.

C. Temporal Data:

Another issue that goes far beyond DL algorithms is the availability of temporal data showing cracks. Currently available datasets only show cracks at a single point in time. While experts can use their expertise to determine the severity of a crack and its future development, datasets containing data showing the evolution of a crack over a specific time period are not yet available. Continuous data prediction has made significant progress thanks to DL over other areas such as video sequence prediction [76] and time series prediction [77]. SHM can benefit greatly from such datasets to support predictive maintenance actions. DL algorithms can be applied to predict future crack propagation and determine if and when preventive maintenance actions need to be taken. However, the limitations are similar to those of generating regular data sets. Moreover, it may take time for cracks to grow, and it may take years to create such a dataset with training, validation, and test data.

D. Metric:

The vast amount of work in this field has led to a wide variety of evaluation methods, datasets, and metrics. Work performing similar tasks in this field would greatly benefit from consistent evaluation procedures and well-defined metrics, which would greatly increase the comparability of algorithms. As research interest in crack quantification grows, it may be beneficial to establish a standardized measure for determining the accuracy of predicted degrees of rotation inside cracks, including length and thickness.

VI Conclusion and Discussion:

Currently, DL algorithms have achieved state-of-the-art results in various fields and are also applied to SHM. The paper gives a summary of research and accomplishments in the domain of structural monitoring of civil infrastructure using machine vision and machine learning approaches. In particular, we reviewed approaches in different learning types (supervised, semi-supervised, weakly supervised and unsupervised) along with an overview of the common metrics and datasets used. Also, overview of the problems facing research in this field, outline possible research gaps and provide perspectives on future research directions. As a main result, we identified a wealth of research in the field of supervised learning, but note that it is difficult to compare architectures and performance due to the lack of standardized common metrics, datasets and the problem of annotation of datasets.

We hope that these issues will be addressed in the future, and believe that further research in the area of semi-supervised and weakly unsupervised data will advance research and mitigate the problems associated with small datasets and difficult annotation.

While great advances have been made in vision-based SHM, there are still limitations and obstacles to overcome. For example, i) most current research is carried out in laboratory using scale physical models, which may not convert to field continuous monitoring due to complicated site characteristics. ii) Additionally, the quality of pictures acquired by the vision system is still an issue. (iii) As an interdisciplinary and cutting-edge technology, developing a scientific and effective coordination mechanism among civil researchers remains a key challenge.

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37. RFID based Smart Shopping Trolley

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Abstract:

The proposed smart shopping trolley system leverages RFID technology and IoT connectivity to streamline the shopping experience. With an Arduino board, RFID reader and Wi-Fi module, customers can easily navigate through stores, automatically tallying their purchases as they go. This innovative approach minimizes wait times at checkout, providing a seamless and efficient shopping experience. Additionally, the integration with a centralized database and website allows for easy access to purchase history and administrative oversight, enhancing convenience for both customers and retailers.

Keywords:

RFID, RFID Tags, Arduino, Wifi Module, Blynk app

I Introduction:

RFID is the special type wireless card which has inbuilt the embedded chip along with loop antenna. RFID reader is the circuit which generates 125KHZ magnetic signal. This magnetic signal is transmitted by the loop antenna connected along with circuit used to read the RFID card number. In this work, RFID technology is utilized to streamline the shopping experience by automating the billing process. Each product is equipped with its own RFID card, which essentially acts as a security access card and represents the product's identity. An RFID reader, interfaced with a microcontroller, reads these RFID cards as products are placed in the shopping cart. The microcontroller, pre-programmed with the corresponding card numbers, manages this process seamlessly. Additionally, a keypad is integrated with the microcontroller to facilitate user interaction

The primary objective of the proposed work is to alleviate the inconvenience of waiting in long queues during the billing process at shopping malls. By implementing an automatic billing system within the shopping trolley itself, customers can significantly reduce the time spent on checkout. Once customers finish selecting their items, the total amount is displayed on the trolley, allowing them to conveniently pay using their pre-recharged customer card provided by the shop. Finally, all transaction information is transmitted to the central PC of the shopping mall, ensuring efficient management of purchases and inventory. This innovative approach not only enhances customer satisfaction but also optimizes the overall shopping experience.

II Literature Review:

The work in [1] discusses an RFID-based Smart Shopping Cart System, aims to enhance in-person shopping by utilizing Radio Frequency Identification (RFID) for automatic product identification, allowing real-time viewing of total costs to reduce checkout time. The study emphasizes the need for a technology-oriented, cost-effective, and scalable system to improve the overall shopping experience.

The "Intelligent Shopping Cart" system, detailed in the paper [2], employs RFID and ZigBee technologies to streamline in-person shopping. It aims to reduce time spent in malls by automatically identifying products, updating billing in real time, and enhancing inventory management. The system consists of three key components: Server Communication, User Interface and Display and Automatic Billing. The integration of these components into an embedded system offers a cost-effective and scalable solution. The proposed model has the potential to significantly improve the shopping experience by providing efficiency, convenience, and real-time updates.

A smart shopping system utilizing RFID technology for automated billing is presented in [3-5]. Products with RFID tags are scanned when placed in the cart, displaying real-time billing information. This approach minimizes manual billing, accelerates item retrieval, and reduces waiting times. The system incorporates Raspberry Pi, Arduino, RFID tags, and a database. Electronic Shopping Cart System utilizing RFID technology with tags on products, an RFID reader, a microcontroller integrated with Embedded C and VB6.0 software for efficient shopping is proposed in [6].

The RFID and GSM-based Smart Trolley system is delivered in [7]. The "Smart Shopping Trolley" using RFID technology, Zigbee modules, an ESP8266, and an LCD display is produced in [8]. This approach enhances accuracy and speed. The work in [9] introduces a home automation concept using ESP32 with Blynk, IR remote, and manual switches to control 8 relays with or without internet connectivity. The system aims to improve living standards, reduce human effort, and save energy by enabling remote control and monitoring of home appliances via an Android-based smartphone application. Utilizing Wi-Fi technology, the system offers accuracy, high range, and easy installation, making it user-friendly and suitable for a wide range of applications.

With these survey it is observed that the privacy concerns may arise due to the continuous tracking of items and user data. These technologies lead to system malfunctions or errors, impacting the accuracy of billing. Implementation costs and maintenance may pose financial challenges, particularly for smaller retailers. Additionally, user dependency on smartphones and technical literacy might limit widespread adoption. To Address these drawbacks a system smart shopping cart using RFID technology and Blynk app is proposed in this paper for successful integration into diverse retail environments, ensuring both user satisfaction and data.

III Proposed Work:

The proposed smart shopping cart using RFID technology and Blynk app is presented in this section. The block diagram of proposed work is as shown in figure 1.

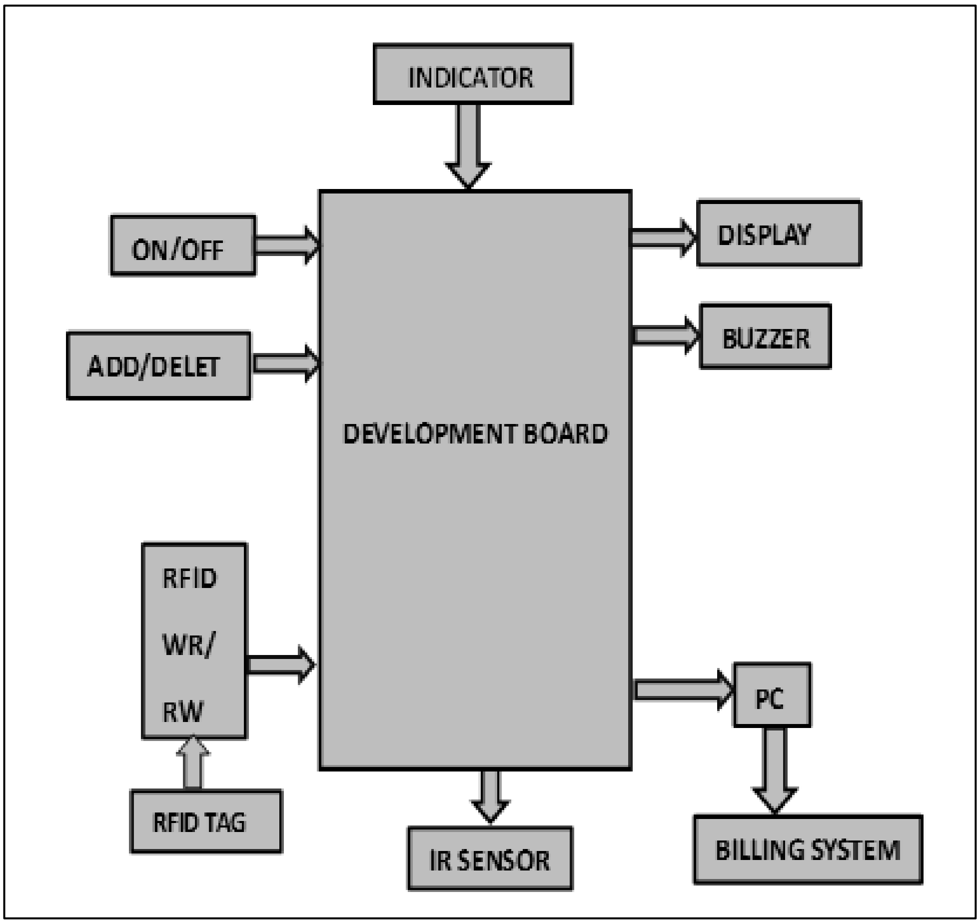


Figure 1: Block Diagram of Proposed System

A. Components:

The details of the components used in this work are as follows:

- **RFID Reader:** The RFID Reader RC522 (shown in figure 2) is a popular module based on the MFRC522 integrated circuit. It operates at 13.56 MHz and is commonly used for reading and writing RFID tags in various projects, including access control systems, smart locks, and inventory management solutions. The module typically communicates with a microcontroller such as Arduino via SPI (Serial Peripheral Interface) protocol and provides functionalities for reading RFID tags' unique identification data. It offers a cost-effective and reliable solution for RFID-based applications.

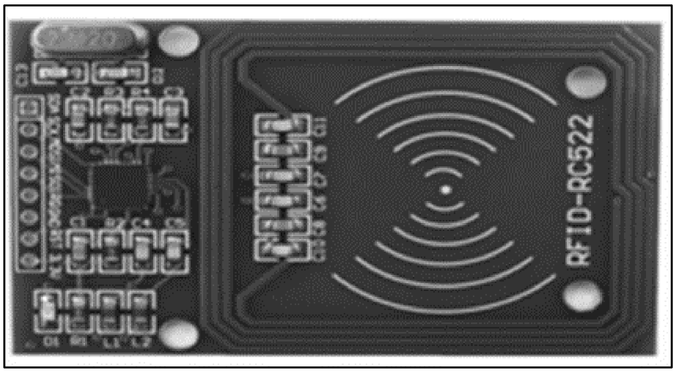


Figure 2: RFID- RC522

- **RFID Tags:** An RFID tag is a small electronic device comprising a microchip storing unique identification data and an antenna for wireless communication. It enables objects to be tracked and identified when activated by an RFID reader. These tags can be passive, drawing power from reader signals, or active, with their power source, and operate at various frequencies depending on the application.
- **Wi-Fi Module:** The ESP8266 as shown in figure 3 is a versatile Wi-Fi module widely used in IoT (Internet of Things) projects due to its low cost and ease of use. It integrates a microcontroller and Wi-Fi capability in a single chip, making it suitable for connecting devices to the internet wirelessly. The module supports various communication protocols and can be programmed using Arduino IDE or other development environments. With its small form factor and low power consumption, the ESP8266 enables devices to communicate and exchange data over Wi-Fi networks, facilitating remote monitoring, control, and data transfer in IoT applications.

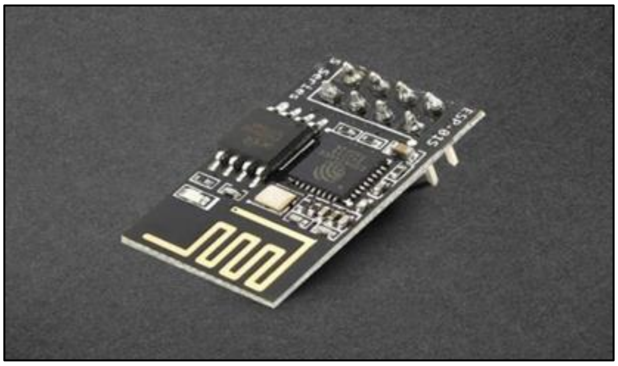


Figure 3: Wi-Fi Module – ESP8266

- **Arduino:** The Arduino Uno shown in figure 4 is a popular microcontroller board widely used in electronics projects. It features an Atmega328P microcontroller, digital and analog input/output pins, a USB interface for programming and communication, and a power jack for an external power supply. The Uno is compatible with a wide range of sensors, actuators, and other components, making it ideal for prototyping and DIY projects.

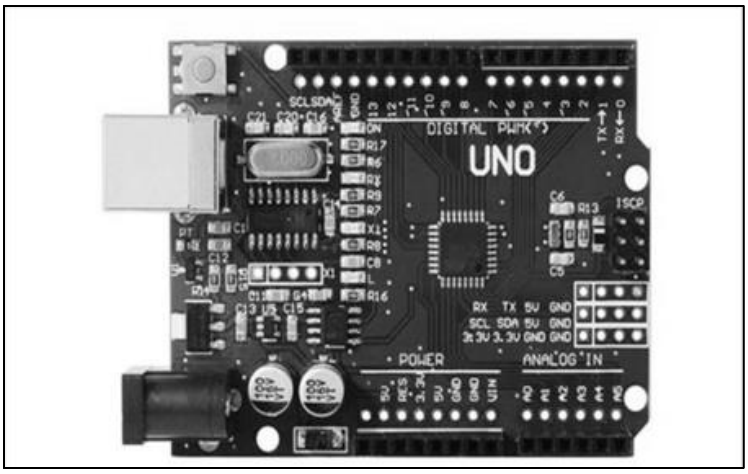


Figure 4: Arduino Uno

- **LCD Display:** An LCD (Liquid Crystal Display) display is a flat panel (shown in figure 5) that uses liquid crystals to produce images or text. It's commonly used in electronic devices like digital clocks, calculators, and consumer electronics for showing information. In projects, an LCD can be connected to a microcontroller like Arduino to provide visual feedback or display data in real time.

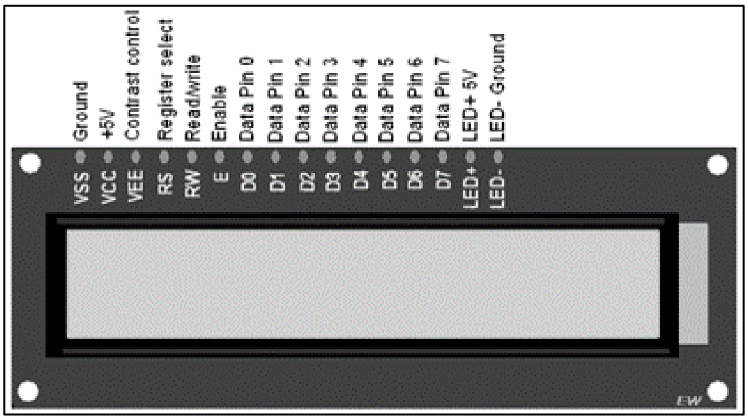


Figure 5: LCD Display

- **IR Sensor:** An IR (Infrared) sensor is a device that detects infrared radiation emitted by objects. It's commonly used in various applications such as motion detection, proximity sensing, and object detection. In projects, an IR sensor can be used to detect motion or presence, allowing for the automation of tasks or the creation of interactive systems.

B. Flow Chart:

The flow diagram of the proposed model is as shown in figure 6.

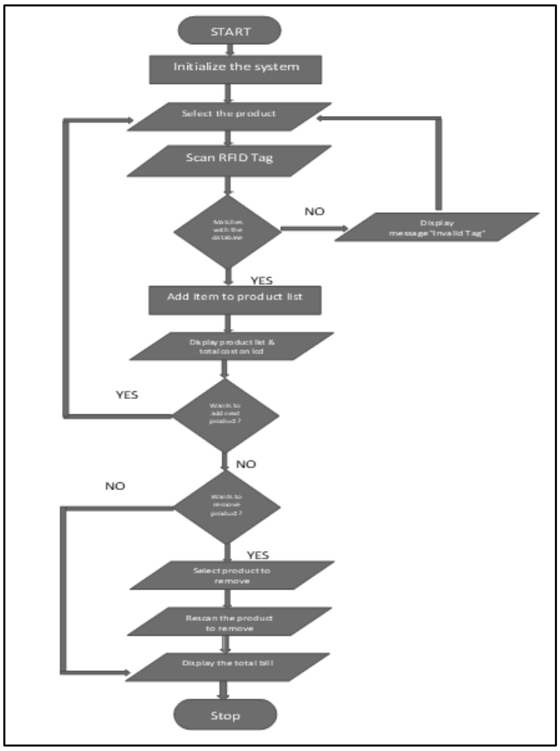


Figure 6: Flow Chart of Proposed Model

C. Software Used:

Blynk is a platform that enables developers to create IoT (Internet of Things) applications easily. It provides a framework for building apps for controlling hardware remotely through smartphones or tablets. With Blynk, a user interface is created to interact with your IoT devices, such as Arduino, Raspberry Pi, ESP8266 and others, shown in figure 7 without much coding. It simplifies the process of connecting hardware to the internet and creating mobile apps to control them. The proposed Smart Shopping Cart, utilize Blynk to create a user-friendly interface for controlling and monitoring the cart remotely. Blynk provides a mobile control interface, allowing users to interact with the Smart Shopping Cart using their smartphones. With Blynk, users can monitor the items in their shopping cart in real-time, including scanned products, total bill, and payment status. Blynk widgets such as buttons and sliders enable users to add or remove products from the cart remotely, triggering actions such as RFID scanning and bill updates. This work leverage Blynk's customizable user interface to create a tailored experience for our users, incorporating various widgets like buttons, displays, and indicators. Blynk's cross-platform compatibility ensures that users can control the Smart Shopping Cart using their preferred mobile platform, whether iOS or Android. Additionally, Blynk's cloud connectivity allows for remote control of the shopping cart from anywhere in the world, as long as there is an internet connection. With Blynk's secure data transmission protocols, we ensure that all communication between the mobile app and the Smart Shopping Cart is encrypted, protecting user privacy and sensitive information. Overall, Blynk simplifies the development of the software end of our Smart Shopping Cart project, providing a seamless and intuitive user experience for our customers.

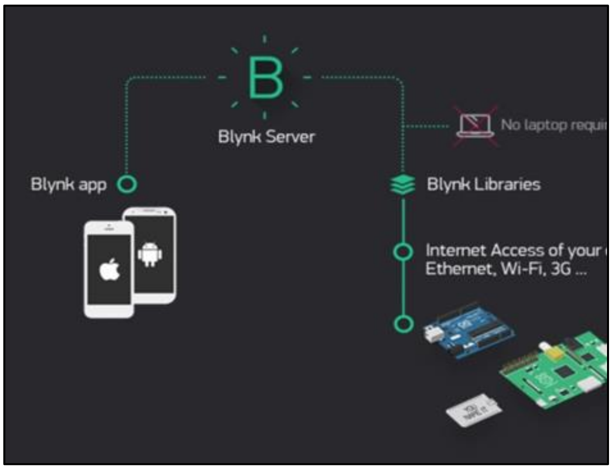
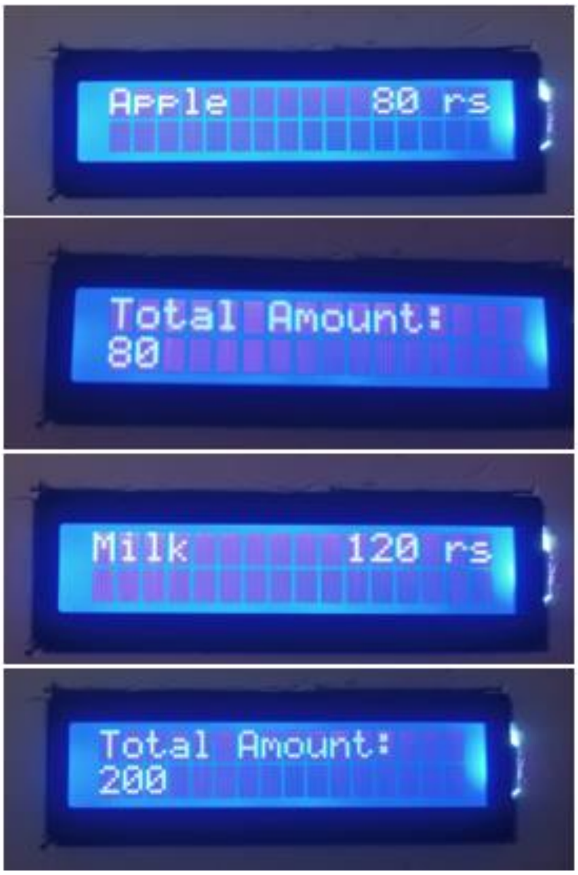
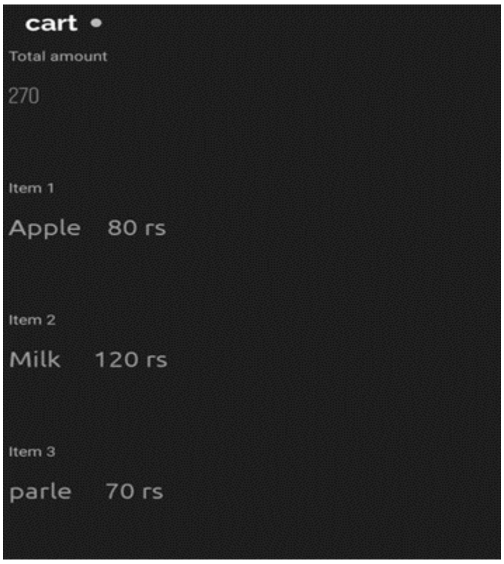


Figure 7: Hardware Connection Diagram with Blynk App

III Results:

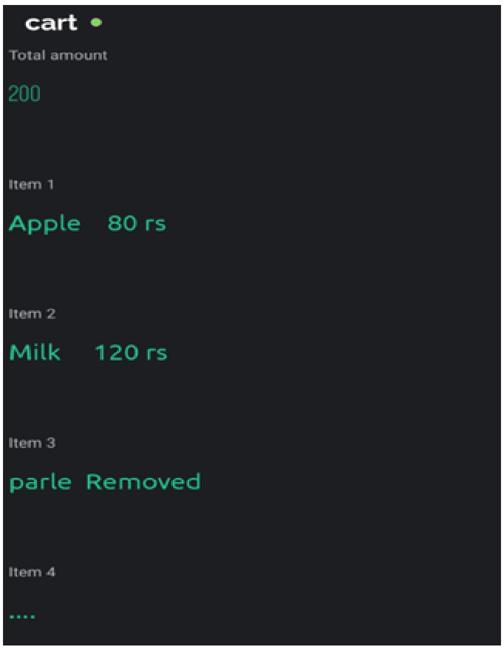
The screenshots of the results obtained by the work are shown below.




cart
Total amount
270
Item 1
Apple 80 rs
Item 2
Milk 120 rs
Item 3
parle 70 rs


parle 70 rs


Total Amount:
270


cart
Total amount
200
Item 1
Apple 80 rs
Item 2
Milk 120 rs
Item 3
parle Removed
Item 4
....

IV Conclusion:

The Smart Shopping Cart project represents a significant step forward in modernizing the retail experience. By integrating RFID technology, Blynk software, and a user-friendly interface, a system has developed that simplifies and enhances the shopping process for both customers and retailers. This innovative solution addresses several key challenges faced by the retail industry, including long checkout queues, manual inventory management, and inefficiencies in the shopping process.

With real-time monitoring, remote control capabilities, and seamless integration with existing retail infrastructure, the Smart Shopping Cart project offers numerous benefits. Customers benefit from a streamlined and efficient shopping experience, with automatic product scanning, real-time bill updates, and convenient payment options. Retailers benefit from increased operational efficiency, reduced waiting times, and improved inventory management, leading to cost savings and enhanced customer satisfaction.

By continuing to innovate and improve the Smart Shopping Cart project, it can be aimed to revolutionize the retail experience and set new standards for efficiency, convenience, and customer satisfaction in the industry.

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38. Smart Home Automation using IoT

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ABSTRACT:

The rapid advancement of Internet of Things (IoT) technology has revolutionized the concept of home automation, transforming traditional homes into intelligent, connected ecosystems. This paper presents an in-depth exploration of smart home automation utilizing IoT, focusing on the design, implementation, and potential applications. The system integrates various IoT devices, sensors, and actuators to monitor and control home environments efficiently. The effectiveness of the proposed smart home automation system is validated through experimental setups and real-world scenarios. Results demonstrate significant improvements in convenience, energy efficiency, and security compared to conventional home automation systems. This research provides a comprehensive framework for future developments in IoT-based smart home technologies, paving the way for more intelligent and responsive living environments.

KEYWORDS:

Smart Home Automation, Internet of Things (IoT), Sensors, Actuators, Energy Efficiency, Security, Privacy, Cloud Services, Remote Monitoring.

I Introduction:

IoT is an environment made up of physically connected, network-connected items that have been given IP addresses and can connect to networks without the need for human interaction. It can transmit data across a network without requiring communication between people or between people and computers.

A collection of hardware components, such as microprocessors, sensors, and other components, make up an Internet of Things system. These components communicate data to and from the microcontroller and server. Real-time monitoring and control of home equipment can be accessed and managed by users using a mobile or online application.

The concept of home automation has evolved significantly over the past few decades. Initially, it involved the simple remote control of home devices such as lighting, heating, and appliances. However, the advent of the Internet of Things (IoT) has catalyzed a paradigm shift, transforming traditional home automation into sophisticated smart home systems. IoT enables devices to communicate with each other and with centralized control systems via the internet, creating interconnected networks that enhance the functionality, efficiency, and convenience of home environments.

The journey of home automation began with simple mechanical devices and manually controlled systems. Over time, these evolved into electrically operated devices with limited remote control capabilities. The true revolution came with the advent of IoT, which introduced the ability for devices to communicate over the internet, share data, and be controlled remotely. This has led to the creation of highly sophisticated smart home systems that offer unparalleled convenience, efficiency, and security.

Systems that are hardwired or wireless can be used to set up smart houses. Smart home technology offers financial savings and convenience to homeowners. Producers and consumers of smart home equipment are still beset by security vulnerabilities and glitches. Homeowners can begin using smart home devices with smaller individual gadgets that cost less than $100, even if full-scale home automation may cost thousands of dollars. This paper explains the monitoring and controlling of device settings using communication modules, sensors, actuators, and microcontrollers.

II Literature Review:

Several technical papers are reviewed before taking up this work to identify the gaps. This section of the paper explains the literature survey.

The paper presents an advanced IoT-based home automation system that leverages Google Assistant and the Thing Speak IoT platform. The system aims to enhance the convenience, security, and energy efficiency of modern homes by integrating voice control and real-time data processing capabilities.

This paper provides a comprehensive framework for developing advanced IoT-based home automation systems, paving the way for future innovations in smart home technologies. The paper concludes that integrating Google Assistant with the Thing Speak IoT platform offers a robust and user-friendly solution for advanced home automation. The system's ability to process voice commands, analyze real-time data, and automate responses significantly enhances the smart home experience. Future work includes expanding the system's capabilities and exploring additional applications in smart home technology [1].

This paper presents the design and implementation of an interactive Internet of Things (IoT)-based home automation system controlled by speech. This paper provides a detailed framework for developing speech-controlled home automation systems, highlighting the potential for future advancements in making home environments more accessible and convenient through IoT and voice technology integration. The system aims to improve the convenience and accessibility of home automation by enabling users to control home appliances through voice commands.

The system utilizes speech recognition technology to interpret voice commands from users. It converts spoken words into digital commands that can be processed by the system. The system integrates various home appliances into a centralized system via an IoT network and allows remote control and monitoring of devices through the internet. The system architecture includes modules for speech processing, data acquisition, data processing, and device control. Speech commands are captured using a microphone and processed using a speech recognition module (e.g., Google Speech API). Recognized commands are transmitted to a microcontroller, which then controls the respective home appliances via relays or other interfacing circuits.

The system incorporates security measures such as encrypted communication channels and user authentication to protect against unauthorized access and data breaches. Experimental results demonstrate the system's effectiveness in accurately recognizing and executing voice commands. User feedback indicates a high level of satisfaction with the convenience and functionality provided by the speech-controlled system. The paper discussed about the interactive IoT-based speech-controlled home automation system significantly enhances user convenience and accessibility. The integration of speech recognition with IoT technology offers a robust solution for modern home automation needs. Future work includes expanding the system's capabilities, improving speech recognition accuracy, and exploring additional applications for the technology [2].

The paper discusses the development of a smart home automation system leveraging the Internet of Things (IoT). This paper offers a detailed framework for developing smart home automation systems using IoT, highlighting the potential for enhancing user experience and energy efficiency through advanced technology integration. The system is designed to provide users with enhanced control, convenience, security, and energy efficiency in managing home appliances and systems.

The system integrates various home appliances and sensors into a cohesive network and facilitates remote control and monitoring via internet connectivity. The system is composed of interconnected modules for data acquisition, processing, and control. Devices are connected to microcontrollers which relay data to a central server. The server processes data and issues control commands based on user inputs and predefined rules.

The system allows users to control lighting, heating, air conditioning, security cameras, and other appliances remotely. The system implements automation rules (e.g., turning off lights when no motion is detected) to enhance energy efficiency. A mobile app is developed to provide an intuitive interface for managing home automation which supports real-time notifications and remote control capabilities. The system optimizes energy usage by automating control of appliances based on sensor data and reduces energy consumption through intelligent scheduling and real-time adjustments. Experimental results validate the system's functionality in terms of reliability, responsiveness, and user satisfaction. Performance metrics indicate efficient communication and accurate execution of control commands [3].

The paper explores the development of an IoT-based home automation system aimed at improving the convenience, security, and efficiency of managing household appliances. The proposed system leverages IoT technology to provide remote monitoring and control capabilities, making home automation more accessible and effective. This paper presents a comprehensive approach to developing an IoT-based home automation system, demonstrating the potential to enhance user experience and operational efficiency through advanced technology integration. The system integrates various household devices into a unified network and also enables remote access and control through internet connectivity.

The system consists of interconnected modules for data collection, processing, and control. Devices are connected to microcontrollers, which send data to a central server for processing. The server issues control commands based on user inputs and predefined automation rules. The system allows users to control lighting, HVAC systems, security cameras, and other appliances remotely.

The system developed supports automation scenarios like turning off lights when no motion is detected or adjusting the thermostat based on ambient temperature. The user interface provides easy access to control and monitor home devices. Features like real-time notifications and control options for enhanced user convenience are also provided. The automation system optimizes energy use by adjusting device operations based on real-time sensor data. It reduces energy consumption through intelligent automation and user-defined schedules. Experimental results show the system's effectiveness in providing reliable and responsive control over home appliances. User feedback indicates high satisfaction with the system's functionality and ease of use [4].

But these literatures concentrated on a single goal of using IoT for home automation. We thought of developing a system with the following objectives along with using IoT without compromising the comforts provided to the users:

- IoT based home automation for monitoring resistive and inductive loads. The lights and fans in a room are controlled remotely by the mobile app
- Automatic turns on and off of the lights and fans in a room based on the presence or absence of a person in a room
- Automatic speed control of a fan based on the temperature of the room

III Methodology:

The proposed system uses sensors such as PIR motion sensor and DHT11 temperature sensor to gather the information about the environment in the room. The developed mobile app helps the user to know about the status of the lights and fans in a room remotely and provides the facility to control them also. The block diagram of the proposed system is shown in Figure 1.

The system consists of Arduino Uno, Wi-Fi, sensors, relays and resistive and inductive loads such as bulbs and fans. The mobile app is created from the software studio and the number of bulbs and fans are incorporated. The mobile app is designed to provide users with an intuitive and efficient way to control lights and fans in their home remotely. Leveraging IoT technology, the app connects to smart devices installed in the home, allowing for real-time monitoring and control.

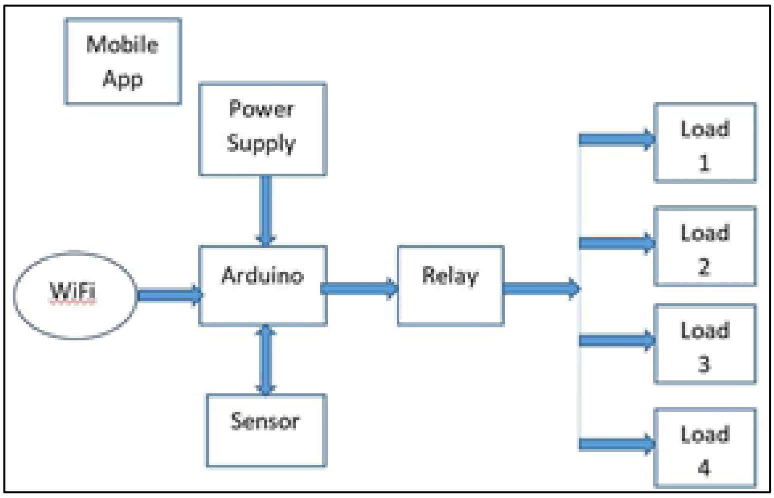

Figure 1: Block Diagram of the System

Load Controlling:

- Create software from the studio and build the front-end mobile app.
- Dump the program in Arduino IDE which connects the Arduino and mobile through Wi-Fi connection.
- After WIFI connection is established between mobile and Arduino, the Arduino is able to receive the command from the mobile app
- The relay connected to Arduino is capable of controlling the resistive and inductive loads.
- The loads are monitored using the mobile app by switching the on/off condition.

Temperature Based Fan Speed Control:

- The temperature sensor (such as DHT11) connected to Arduino will measure the temperature.
- A fan is connected to a PWM capable pin on the Arduino is to control its speed.
- A program in Arduino IDE is written to read the temperature and humidity from the sensor and control the fan speed accordingly.
- The program will determine the desired fan speed based on the temperature reading.
- User has to define temperature thresholds for different fan speeds (low, medium, high).
- The system will increase fan speed if the temperature exceeds a threshold.
- The system developed will decrease fan speed if the temperature falls below a threshold.
- The system will turn off the fan if the temperature is below a certain minimum threshold.

Motion Sensor:

- PIR sensor is used to detect whether a human has moved in or out of sensor range.
- PIRs are basically made of a pyroelectric sensor which detect the levels of infrared radiation.

- The sensor detects the motion by comparing the changes in infrared radiation.
- The sensor amplifies and processes the detected signal.
- When sensor detects motion, it triggers an output signal. This output can be used to activate a relay, turn on the light and send a signal to a microcontroller or other devices.
- The PIR sensor is connected to the power supply
- The system is tested for various lighting conditions to ensure reliable operation.
- It is necessary to regularly monitor the sensor's performance and conduct maintenance as needed to ensure continued operation.

Flowchart:

The flowchart begins with creating the application in Android Studio for the mobile's front end and then proceeds to select the WIFI module (the Arduino UNO), as shown in Figure 2. If a WIFI connection is established between the mobile app and the Arduino UNO, continue to the next step to provide the input command to the relay; otherwise, return to step 2. Upon receiving the command from the Arduino UNO to the relay, you can control home appliances through the mobile app.

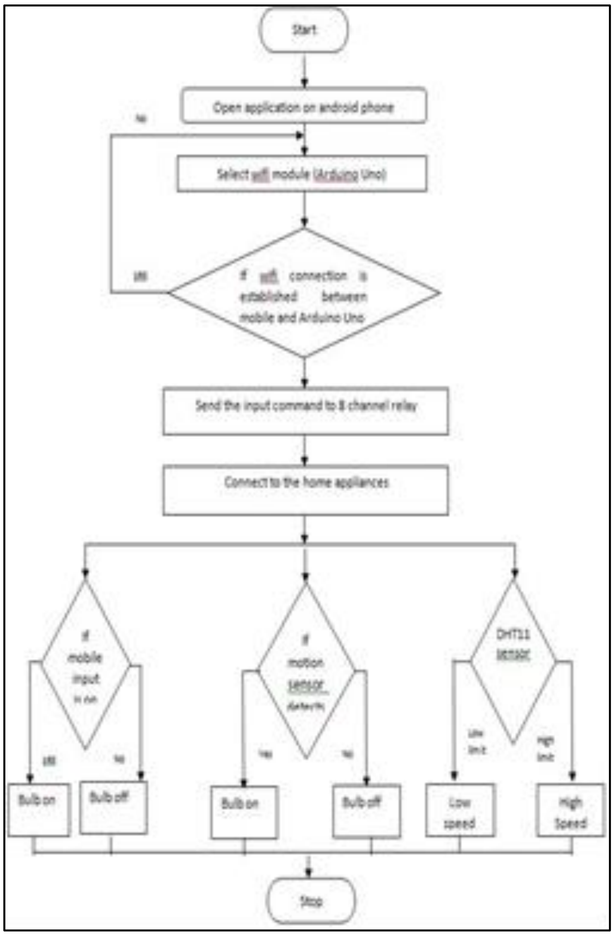

Figure 2: Flow chart

In the first condition, if the mobile app input is on, the bulb turns on; otherwise, it turns off. In the second condition, when a motion-based sensor detects an object, it triggers the output and sends a command to turn on the light. In the third condition, the DHT11 connected to the Arduino (UNO) reads the temperature. If the temperature exceeds the threshold, the fan runs at high speed; if it's below the threshold, the fan runs at low speed.

Figure 3: Working Model of the System

IV Results and Discussions:

The proposed work is successfully completed and following objects are achieved.

- The Resistive load is successfully controlled through the developed mobile app.
- The motion-based sensor (Passive infrared sensor) detects the human being present in front of sensor.
- The DHT11 sensor detects the temperature of the room and controls the speed of fan.

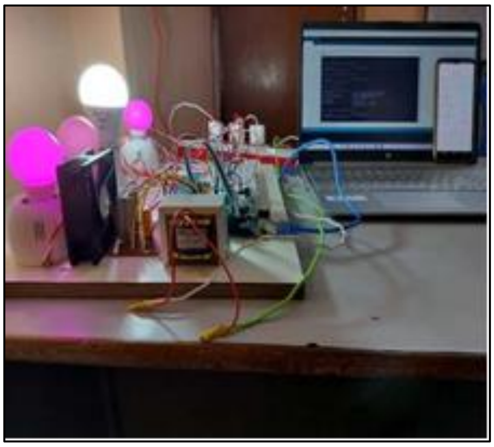

Figure 4: Developed Mobile App

V Conclusion:

The exploration and implementation of home automation systems using IoT technology demonstrate significant advancements in enhancing convenience, security, and energy efficiency in modern households. By integrating various household appliances into a cohesive IoT network, users gain unprecedented control and monitoring capabilities, accessible from anywhere at any time. The ability to control lights, fans, and other appliances remotely through a mobile application or voice commands simplifies daily routines. Automation features such as scheduling and scene creation further streamline household management, allows users to customize their environment effortlessly. IoT-based home automation systems incorporate robust security measures, and real-time alerts. Intelligent automation and real-time monitoring enable significant energy savings by optimizing the operation of home appliances. Features like energy usage tracking and automated power management contribute to more sustainable living practices.

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39. Speech Intelligibility Enhancement based on Spectral Splitting Technique

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Abstract:

People with moderate sensorineural hearing loss (MSNHL) have difficulty in recognizing speech in loud environment because of masking. There is no medical treatment for this loss. By spectrally dividing the voice signal using a pair of time varying FIR comb filters (TVCF) for binaural hearing aid, the effect of frequency masking can be reduced. As a result, perception of voice signal is increased. Using a frequency sampling method TVCF of order 512 are designed. These filters are having 22 octave bands (one-third) varying from frequency 0 kHz to 11 kHz. Magnitude responses of these filters are complementary to one another which sweep along the frequency axis with time shift less than just noticeable difference (JND). This enhances gap identification capability while maintaining the advantages of the frequency splitting method. To evaluate effectiveness of frequency splitting scheme, the Modified Rhyme Test (MRT) is used for speech intelligibility test. This test is examined on bilateral MSNHL subjects. Three hundred monosyllabic CVC (Consonant Vowel Consonant) syllables, serve as the test signals, are utilized to evaluate the scheme. The findings show that in environments with higher levels of noise, people are better able to comprehend and interpret processed speech.

Keywords:

Masking, Time-varying FIR filter, Spectral splitting, MRT.

I Introduction:

Sensorineural deafness occurs because of injury to the hair cells of cochlea in the inner ear or the nerve that connects the inner ear to the brain. Frequency masking is one of the characteristics of sensorineural hearing loss (SNHL) [1]. Many researchers showed that this masking can be reduced by using a pair of FIR comb filters with complementary magnitude responses to split the speech spectrum into two parts with complementary spectral components for binaural hearing aids [2-3].

The scheme enhanced the ability to perceive speech. The aim of works [2-3] was to improve speech perception in moderate sensorineural hearing loss (MSNHL) persons using spectral splitting scheme. In the work [2] filters were designed with a sampling frequency of 10 kHz with 513 filter coefficients using frequency sampling method. The methodology was assessed on normal hearing subjects as well as bilateral MSNHL subjects. For binaural hearing aid, the scheme was useful.

The approximate 4:2 compressor adders in the memory-less DA-based FIR filter architecture were suggested in the article for hearing aid [4]. In DA (*Distributed Arithmetic)* architecture, increasing the filter order caused the ROM's size to grow gradually. Compressor adders were used in the design of memory-less DA as a way to reduce power consumption and area of the FIR filters, creating the necessary area and power reduction for the use of hearing aids. The suggested DA-based FIR filter architecture was created utilizing the Synapsis Application Specific Integrated Circuit Design Compiler on 90 nm technology. Comparing the suggested design to systolic architecture, there was a 45% decrease in area delay product, and compared to OBC (Offset Binary Coding) DA architecture, there was a 10% reduction in ADP. The results indicated that the suggested architecture has fewer slices than the best current solutions. The suggested design also incorporates a FPGA. Using MATLAB Simulink, the suggested design was applied as a decimation filter to eliminate undesired signals in hearing aid applications.

For the purpose of listening, the study [5] suggested a hearing loss system model with a variable bandwidth FIR filter (VBF) and adaptive algorithms. The purpose of the adjustable band filter was to deliver the right amount of sound. There were several sub-filters in this filter, and each one was developed with a specific set of bandwidths. By trial and error, the sub-bands were acquired and their magnitudes were adjusted appropriately. To enhance the signal's quality, algorithms like Recursive Least Squares (RLS), Normalized Least Mean Squares (NLMS), and Least Mean Squares (LMS) were used. The multiple bandwidth filters were analyzed with different degree of loss. The difference between the ideal and actual responses was computed to find the matching error. The results demonstrated that the suggested filter offered a minimal matching error and was between 0 and 2.5 dB.

The study [6] aims to investigate the combined effects of amplitude compression, frequency splitting, and adaptive Wiener filter on the intelligibility of speech for individuals with hearing impairments in unfavorable listening conditions. The adaptive Wiener filter operated by varying the filter frequency response between samples in accordance with the statistics of the speech signal (mean and variance). To reduce the impact of spectral masking, the speech signal was spectrally separated using the filter bank technique. Amplitude compression was used with a compression factor of 0.6 in order to solve the issue of hearing loss. The intelligibly measurement was done with MRT (Modified Rhyme Test) measure on MSNHL people. There were three hundred consonant-vowel-consonant (CVC) words in the test protocol. The results indicated that processing with this scheme enhanced speech intelligibility when compared to an adaptive Wiener filter. A maximum improvement in speech recognition score of 32.935 percent was noted at a lower SNR value of -6 dB. Therefore, in loud circumstances, the combined method helped those with hearing impairments to understand speech better.

To make speech more understandable for near-end listeners in noisy environments, a speech pre-processing technique was described [7]. Based on a spectro-temporal auditory model, the method increased the intelligibility by redistribution of speech energy over time and frequency for a perceptual distortion measure.

The two objective predictors of intelligibility were used for both before and after processing. They were coherence speech intelligibility index (CSII) and short-time objective intelligibility (STOI). To judge the effectiveness of the suggested approach voice quality was reduced using F-16, babble, factory and white noise within a -15 to 5 dB SNR range. CSII score for unprocessed speech (with white noise) was 0.4 and for processed speech was 0.65. Results showed that there was an improvement in intelligibility with the proposed concept.

The work [8] introduced an effective method that improved clean voice intelligibility in noisy environment. In order to restore voice intelligibility, the algorithm increased the average speech spectrum over the average noise spectrum. It was taken care in the algorithm to prevent the hearing damage from increased speech spectrum. The Speech Intelligibility Index (SII) was used to assess the performance of suggested algorithm. In addition to white noise and destroyer engine noise from the NOISEX-92 database, the SII was computed for each speech file in the TIMIT database. A time adaptive and frequency dependent SNR recovery approach was presented. The SII was same for SNR 15dB to 20dB or increased by 0.5. This indicated improved speech intelligibility.

For individuals with sensorineural hearing impairment, a multiband frequency compression (MFC) approach in addition to noise reduction was developed to neutralize the spectral masking effect [9]. Noise reduction technique i.e. Wiener filter and spectral subtraction approaches were used in combine technique. MRT was used to measure the intelligibility of processed speech in the presence of additive noise and tested on both normal hearing and hearing-impaired individuals. As compared to spectral subtraction technique with an MFC scheme, the results of MRT processing for the compression factor of 0.6 using a cascading wiener filter with an MFC scheme on hearing-impaired subjects showed a maximum improvement in speech intelligibility of 25.92% to 30.134 % and a decrease in response times of 0.815 to 1.626 seconds for SNR values of + 6 dB to - 6 dB in steps of + 3 dB, respectively.

Since sensorineural hearing loss cannot be treated medically, the purpose of the current study is to divide the speech spectrum using a pair of time-varying FIR comb filters with complementary magnitude responses to enhance speech perception in MSNHL people. A time-varying filter's magnitude response (Hm(f)) and impulse response (Hm(n) are not static, making them function of time 'm'. We suggested a continuous shift in magnitude responses with time shifts chosen below just noticeable difference (JND) for binaural dichotic presentation. Using this filter feature, additionally, gap identification capability in speech is enhanced without negating the benefit of the frequency splitting technique. Thus, speech perception is enhanced.

II Designing:

The processing of signal block diagram is shown in figure 1. Using a pair of TVCF of order 512 that have complementary magnitude responses to one another, a voice signal is separated into two signals with complementary spectral components to present idiotically. MATLAB programming software is used for developing filters. Frequency sampling approach [10] of filter design is used with a sampling frequency of 22 kHz. The following is the FIR filter's system function which is static with respect to time.

$$|H(f)| = \sqrt{2(1 - cos\left(\frac{2\pi f}{f_s}\right)}$$

The dynamic magnitude response of the time-varying FIR filter is represented by $|H_m(f)|$. There are 11 pass bands and 11 stop bands in time-varying FIR filters, and are based on octave bands (one-third). A sampling frequency of 22 kHz is considered to have better speech quality. Larger bands at higher frequencies and narrow bands at lower frequencies can be seen in 1/3-octave bands. For higher frequency bands, the transition bandwidth is varied between 70 and 80 Hz. Figure 2 shows the superimposed complementary magnitude responses of a pair of time-varying FIR comb filters at various points of time. The time shift of below JND is taken into consideration for the continuous shift in magnitude responses. Crossover gain is kept between -6 dB and -6.5 dB for bands with higher frequencies and between -4 dB and -7 dB for bands with lower frequencies in order to minimize the variation in perceived loudness.

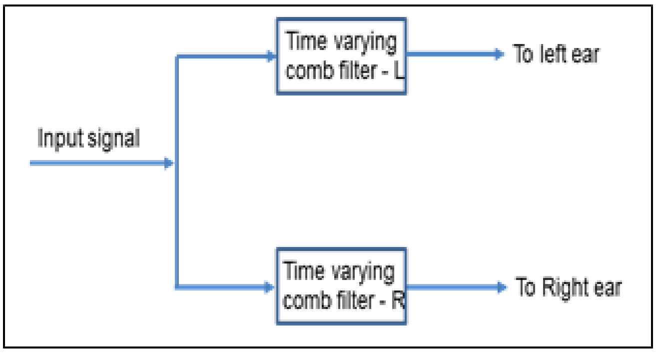
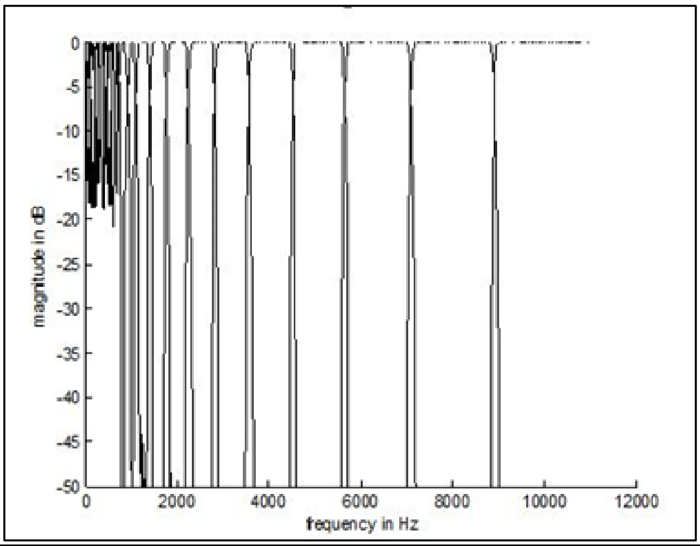
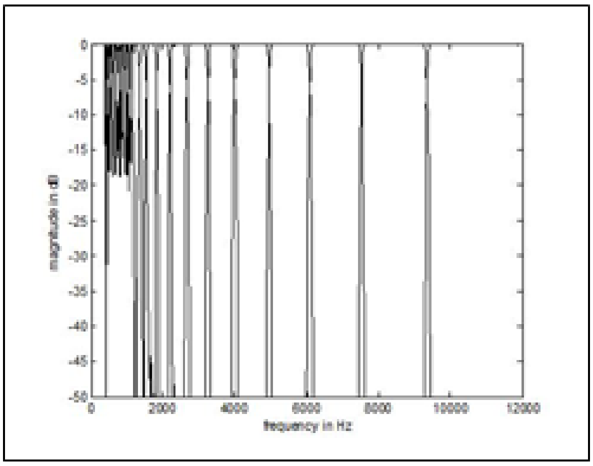


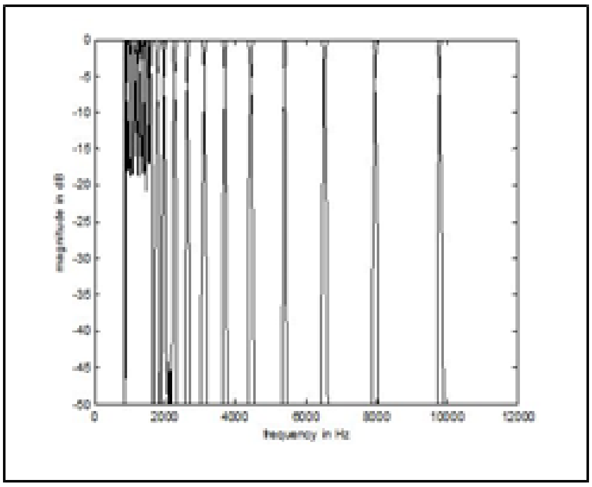
Figure 1: Signal processing with a pair of time-varying FIR comb filters.



(a)



(b)



(c)

Figure 2 (a), (b) and (c) superimposed complementary magnitude responses of a pair of time-varying FIR comb filters at various points of time.

III Results:

The method of spectral splitting of speech signal employing a pair of time-varying comb filters with the continuous sweep in magnitude responses with a time shift below JND is tested for speech intelligibility using an MRT test on six bilateral MSNHL listeners utilizing 300 monosyllabic CVC words as test signals. The guy uttered the CVC words, in an audiometry room and words were recorded using a B&K microphone model No. 2210 with a sampling frequency of 10 KHz and 16-bit quantization. "Would you write…." heard before every CVC word. Six bilateral MSNHL subjects between the ages of 30 and 49(three men and three women) took part in hearing tests to evaluate intelligibility. Bilateral MSNHL audiometric level is shown in table1. The testing procedure was carried out using an automated test administration system. The subjects received preliminary information on the testing protocol and stimuli. Once subjects were comfortable with the testing process, CVC words were presented to them. These words were presented at a reasonable speech signal volume.

A total of 1800 words (300 words x 6 SNR levels) were presented to each participant to respond. The voice recognition score (in percentage terms) and response time (in seconds) were recorded using a random file. All 300 words were grouped into six test lists, each containing 50 words. Each test list's words were chosen using a two-level randomization procedure to overcome biasing (i.e.1x, 1y, 2x, 2y, 3x, 3y; here, x, y indicates the word level inside each set while the number indicates the set level). The test was conducted for about a month, depending on the subject's interest and availability. Table 2 presents listening test results for SNHL individuals with MRT materials. The average speech recognition score (%) for both processed and unprocessed speech at different SNR conditions is shown. Comparing the average recognition scores of processed speech to the unprocessed speech average recognition scores at SNR levels (∞ dB, 6 dB to -6 dB in step of 3dB), the improvements in processed speech recognition scores are -0.44,17.06, 22.44, 24.83, 26.11 and 28.61 in % age respectively.

The average response time (in second) of the same participants for the given SNR levels are shown in table 3, where it is evident that processed speech response time is less compared to unprocessed. The reductions in response time are -0.049, 0.603, 0.904, 0.950, 1.083 and 1.125 in seconds respectively at defined SNR.

Table 1: Average Threshold Level for The Subjects with SNHL (Bilateral Moderate) In Audiogram

Subjects Sex & Age	Ear	Hearing threshold level (dB HL)					
		Frequency					
		250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
S1[M,40]	[1]R	60	45	55	40	60	65
	[2]L	40	55	55	50	60	60
S2[M,49]	R	50	55	50	45	55	60
	L	55	50	45	55	50	55
S3[M,41]	R	20	30	60	40	50	50
	L	20	30	60	50	40	50
S4[F,33]	R	65	60	55	50	40	45
	L	60	55	55	50	45	50
S5[F,30]	R	25	30	40	50	60	90
	L	20	30	40	50	60	85
S6[F,38]	R	35	45	55	60	65	70
	L	25	40	45	50	60	60

[1]R: Right ear, [2]L: Left ear

Table 2: Speech Recognition Scores (In Percentage) For Bilateral SNHL Subjects

Subjects Sex & Age	SNR (dB)											
	∞ dB		6 dB		3 dB		0 dB		-3 dB		-6 dB	
	[3]Unpr	[4]Pro	Unpr	Pro	Unpr	Pro	Unpr	Pro	Unpr	Pro	Unpr	Pro
S1[M,40]	88	86.67	67	83.00	59.33	79.67	50.33	76.00	44.66	71.33	41	71.33
S2[M,49]	86	85.67	67.66	85.67	59.66	81.00	51	76.00	42.66	70.00	45	73.67
S3[M,41]	87	86.00	67.33	84.33	60	81.67	49.33	72.00	45	69.00	41.66	69.33
S4[F,33]	86	87.00	66.33	83.00	61	83.00	50.66	73.33	46.33	71.00	41.33	68.00
S5[F,30]	85.66	85.67	66	83.00	57	82.67	48.66	75.00	45	72.00	40	68.00
S6[F,38]	86.33	85.33	67.33	85.00	59.33	83.00	49.66	76.33	43.33	70.33	41.33	71.67
Avg.	86.5	86.06	66.94	84.00	59.38	81.83	49.94	74.78	44.49	70.61	41.72	70.33
Improvement	-0.44		17.06		22.44		24.83		26.11		28.61	

[3]Unpr: Unprocessed, [4]Pro: Processed

Table 3: Response Time (In Seconds) For Bilateral SNHL Subjects.

[5]Sub.	Response Time in seconds											
	SNR in dB											
	∞		+6		+3		0		-3		-6	
	Unpr	Pro	Unpr	Pro	Unpr	Pro	Unpr	Pro	Unpr	Pro	Unpr	Pro
S1	3.459	3.168	4.778	3.423	4.413	3.154	4.635	3.329	4.768	3.687	5.339	4.532
S2	3.758	3.855	3.874	3.437	4.394	3.653	3.613	3.169	4.838	3.421	5.135	4.452
S3	3.658	3.633	4.774	3.782	3.484	3.132	4.945	4.243	4.484	3.487	5.873	4.487
S4	3.474	3.321	3.749	3.523	4.937	3.145	4.957	3.623	4.887	3.839	4.964	3.682
S5	4.341	4.629	3.563	3.389	4.335	3.739	4.434	3.221	4.686	3.483	4.733	3.234
S6	3.857	4.237	3.874	3.442	4.334	3.653	3.914	3.216	4.347	3.598	5.481	4.387
Avg.	3.757	3.807	4.102	3.499	4.316	3.413	4.416	3.467	4.668	3.586	5.254	4.129
[6]Redn.	-0.049		0.603		0.904		0.950		1.083		1.125	

[5]Sub: Subjects, [6]Redn: Reduction

IV Conclusion:

A pair of time-varying comb filters (FIR) can be used to divide a speech signal into two complementary signals for binaural dichotic presentation. The magnitude responses of these filters are continuously change along frequency axis with time shift below JND, helping to reduce the frequency masking effect and enhance speech perception. The suggested method is evaluated for intelligibility using the MRT test conducted on bilateral SNHL subjects.

The outcome demonstrated a 28.61% increase in intelligibility and 1.125 seconds decrease in response time at SNR -6dB. The proposed approach with a pair of time-varying comb filters is found to work better in a noisy environment.

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40. Survey on Health Monitoring System

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Abstract:

The burgeoning integration of IoT and wearable technologies has revolutionized healthcare, giving rise to a plethora of health monitoring systems. This survey comprehensively analyzes the current landscape of these systems, examining their architectures, sensor technologies, communication protocols, data management strategies, and security measures. By identifying common challenges, such as data privacy, energy efficiency, and real-time processing, this research underscores the need for innovative solutions. The survey also explores the potential of emerging technologies like AI and machine learning in enhancing health monitoring capabilities. Motivated by these findings, we embarked on a work to develop a "Health Monitoring System using IoT" that addresses specific identified gaps. This survey serves as a foundation for our project and guides future research towards more efficient, accurate, and user-centric health monitoring solutions.

Keywords:

IoT, LCD, EEG, ECG, AI&M.

I Introduction:

The convergence of Internet of Things (IoT) and wearable technologies has ushered in a new era of healthcare, characterized by the emergence of health monitoring systems. These systems, equipped with an array of sensors including heart rate, temperature, humidity, SpO2 (blood oxygen saturation), and potentially others such as blood pressure, electrocardiogram (ECG), and electroencephalogram (EEG), can collect and transmitting vital health data in real-time, enabling continuous and remote patient monitoring. By providing insights into an individual's physiological state, these systems hold immense potential to revolutionize preventive care, chronic disease management, and emergency response.

The potential benefits of health monitoring systems are far-reaching. For patients, these systems offer the convenience of self-management, empowering them to take proactive steps towards improving their health. For healthcare providers, remote monitoring capabilities enhance patient care, optimize resource allocation, and facilitate early intervention. Additionally, health monitoring systems can contribute to population health management by generating valuable data for epidemiological studies and public health initiatives.

However, the development and deployment of effective health monitoring systems presents significant challenges. Issues such as data privacy, security, energy efficiency, and algorithm accuracy require careful consideration. Furthermore, the integration of these systems into existing healthcare infrastructure necessitates a holistic approach that involves collaboration between technologists, healthcare providers, and policymakers.

This survey aims to provide a comprehensive overview of the current state-of-the-art in health monitoring systems, identifying key trends, challenges, and opportunities. By examining existing research and development efforts, this study seeks to contribute to the advancement of this rapidly evolving field and inform the design of future health monitoring solutions.

II Literature Survey:

In this paper, the author Tarannum Khan & Manju K. Chattopadhyay [1] have proposed smart health monitoring system effectively addresses the need for remote patient care, especially in rural areas, by combining biomedical sensors, data storage, cloud connectivity, and a mobile app. While successfully demonstrating functionality, the system can be enhanced through improved sensor accuracy, data security, scalability, integration with existing healthcare systems, advanced analytics, user-friendly design, expanded monitoring parameters, and telemedicine capabilities. Long-term sustainability and cost-effectiveness should also be considered for widespread implementation. Regular evaluation and updates are essential to optimize the system's performance and impact on patient outcomes.

The author Srinivasarao Udaraet al. [2] discussed that their project aims to develop an affordable, portable health monitoring system for remote areas with limited access to specialist doctors. Utilizing IoT, the system enables data transmission to a remote server for doctor access. It is built on an Arduino Mega 2560, featuring an ADS1292R ECG shield, LM35 temperature sensor, ESP8266 Wi-Fi module, and a 16x2 LCD display. Sensors provide analog outputs, interfaced with the Arduino's analog pins, while a Pulse oximeter measures pulse rate and blood pressure. Data from these sensors is displayed locally on the LCD and transmitted to an IoT platform via ESP8266. The platform logs and processes this data, accessible from anywhere with the IoT account credentials. This system continuously monitors patient conditions, sending alerts if critical thresholds are exceeded, and enables remote specialists to review patient data. By consolidating various monitoring tools into one module, the system simplifies patient monitoring in underserved areas.

In one of the works, the author Shubham Banka et.al.[3] proposed an IoT-based healthcare system to enhance patient care, particularly in underserved areas. By utilizing wearable devices and a Raspberry pi, the systems continuously monitor vital signs and transmit data to central server for analysis. This enables early disease detection. remote patient monitoring & timely alerts to care givers. This system has potential to revolutionize health care delivery by providing timely efficient & accessible care.

The author Preethi D. & Malathi M. [4] have discussed an IoT-based patient health monitoring system utilizing an Arduino microcontroller to gather data from sensors like pulse rate and temperature (potentially including blood pressure). This information is displayed on an LCD, transmitted to a cloud platform for remote access and analysis, and alerts are sent via buzzer and SMS/notification in case of abnormal readings. The work aims to provide continuous, real-time patient monitoring, enabling timely medical interventions, and empowering caregivers with accessible health updates. This technology holds the potential to revolutionize healthcare by facilitating remote patient care, early detection of health issues, and improved patient outcomes.

In this paper, the author Amol A. Sonune et. al. [5] discussed about distribution transformers are crucial in power networks but require frequent monitoring due to their widespread distribution. Traditional monitoring involves manual checks, which can be labour-intensive and imprecise. This system leverages IoT to monitor transformer parameters such as load current, voltage, oil level, and temperature. Using sensors, data is collected and sent to an ESP32 microcontroller, which integrates Wi-Fi and Bluetooth, eliminating the need for external modules and reducing the system's size. The ESP32 checks parameter limits and sends data to the Blynk IoT platform, allowing operators to make informed decisions and pre-empt failures. IoT enables remote sensing and control, improving efficiency and reducing human intervention. While SCADA systems are used for power transformers, they are costly and less practical for distribution transformers. This system provides real-time monitoring, identifying potential issues like overloads and overheating, thus extending transformer life and improving reliability. Embedded systems in this setup offer cost savings, low power consumption, and high reliability, making it a practical alternative to manual monitoring. The author Prajoona Valsalanet. al. [6] discussed about Health concerns are crucial as technology advances, exemplified by the recent coronavirus impact on China's economy. Remote health monitoring, powered by the Internet of Things (IoT), offers a solution to manage epidemics effectively. This project focuses on developing a smart health tracking system using sensors to monitor vital signs and internet connectivity to alert loved ones of issues. The system aims to reduce healthcare costs by minimizing physician visits, hospitalizations, and diagnostic tests. Sensors linked to a microcontroller display real-time data on an LCD and send alerts via IoT if critical changes are detected. Compared to SMS-based systems, IoT provides more detailed and accessible patient information through a web interface. In rural areas, where medical facilities are scarce, this system enables early detection of health issues, preventing severe complications and unnecessary costs. By storing health data in the cloud and allowing remote access for doctors, IoT-based monitoring enhances healthcare accessibility and efficiency.

In one of the work, the author Jayakumar S. et. al. [7] discussed that their project proposes an IoT-based healthcare application for continuous, low-cost patient monitoring. The system uses sensors like ECG monitors, heart rate monitors, and temperature sensors to track vital signs. Data is collected and transmitted to the cloud via a microcontroller, where it is processed and analysed. If an emergency is detected, alerts are sent to caregivers or doctors, facilitating timely intervention. This approach addresses the challenge of limited healthcare access in rural areas, where timely and affordable treatment is often lacking. The system aims to provide vital parameters such as temperature and pulse using Thing Speak, an IoT platform. The focus is on improving accuracy through IoT and enabling mass screenings in remote areas. Future work will integrate machine learning for disease prediction and enhance the system with lightweight sensors and improved features for broader applicability.

The authors Sumeet Dhali & Suraj Prakash [8] proposed an IoT-based health monitoring system which is developed to address the critical need for timely patient care. Wearable sensors continuously monitor vital parameters, transmitting data to a central server for analysis. This work enables remote patient monitoring, early disease detection, and predictive healthcare. By providing real-time insights to healthcare professionals, the work aims to improve patient outcomes and reduce mortality rates due to delayed treatment. The integration of IoT technology has the potential to revolutionize healthcare delivery by making it more accessible, efficient, and patient-centred. Additionally, this work can facilitate personalized treatment plans, empower patients through self-management tools, and contribute to the development of new healthcare models focused on prevention and wellness.

The author Anil Kadu et. al. [9] have discussed the rise of user-friendly health monitoring systems addressing a critical need timely and accurate diagnosis. Traditional methods sometimes fail to detect diseases early, hindering proper treatment. This IoT-based system tackles this challenge by continuously monitoring key patient parameters (pulse rate, oxygen saturation) and predicting potential health issues. Sensor data is displayed on an LCD and transmitted to an app, allowing for real-time tracking. Furthermore, the authors also suggested to improve system's ability to generate predictive insights that can assist healthcare providers in developing personalized treatment plans. This technology holds the promise of transforming healthcare delivery into a more proactive and patient-centric approach. Ultimately, this IoT-based health monitoring system represents a significant step forward in preventing diseases, improving patient outcomes, and optimizing healthcare resource utilization.

In this paper, the author Mohit Yadav et. al. [10] discussed about the advent of coronavirus, healthcare has become a top priority globally. Patients often experience discomfort due to bulky monitoring equipment with numerous wires. To address this, an IoT-based health monitoring system is proposed as an effective solution. IoT, rapidly advancing in healthcare research, enables remote monitoring of patients. This system allows authorized personnel to track patients from remote locations and is particularly useful in overwhelmed hospitals where emergency care is needed. The IoT-based system monitors vital signs such as heart rate, body temperature, and more, predicting conditions like heart attacks or chronic illnesses. It improves care quality by minimizing patient mobility and offering timely assistance. Using Raspberry Pi, the system collects data from various sensors, including temperature, pulse, and humidity, and transmits it to a cloud server. This data is then accessible to doctors via a smartphone IoT platform, facilitating diagnosis and enhancing patient care.

In one of the works, the author Mohammed Hasan Ali et. al. [11] discussed about monitoring COVID-19 patients presents significant challenges, which can be addressed using IoT technology. This research leverages IoT to track COVID-19 symptoms in real-time through wearable devices that monitor health indicators such as temperature, oxygen saturation, and heart rate. The system comprises three layers: the first collects patient data, the second stores it in the cloud, and the third uses the data to alert patients and their families. Deep-learning models, specifically an optimized Convolutional Neural Network (MHCNN), are used for further analysis and accurate classification of health conditions. IoT facilitates remote monitoring, allowing for timely intervention and reducing the disease's spread by identifying potential cases and managing contact tracing. Additionally, IoT can assist in medication tracking, remote consultations, and even controlling drones for public health measures. The system, tested with MATLAB, achieves 98.76% accuracy and aims for continued improvements in disease recognition and accuracy.

The author Sharath M. et. al. [12] have addressed healthcare disparities in remote regions, an IoT-based smart edge system is proposed. This work utilizes wearable sensors and advanced algorithms to continuously monitor patient health, transforming raw data into actionable health summaries and criticality alerts. By enabling early interventions, reducing healthcare costs, and improving accessibility, this solution aims to enhance patient outcomes, particularly in underserved areas. This work innovative approach has the potential to revolutionize healthcare delivery by providing timely, data-driven care to those who need it most. With the capacity to scale and integrate with existing healthcare systems, this IoT solution can contribute to building a more equitable and efficient healthcare ecosystem. In this paper, the author M. Malathi et. al. [13] discussed about Health monitoring systems are evolving rapidly, addressing the challenge of continuous patient monitoring in hospitals. Their project uses an Arduino Mega 2560 microcontroller to track vital signs such as blood pressure, body temperature, and heart rate. Embedded C is employed to process sensor data, which is then transmitted via GSM and Wi-Fi modules to update both caretakers and doctors through IoT cloud storage and web pages. The system is particularly relevant during the COVID-19 pandemic, reducing the need for in-person consultations and maintaining social distancing. It also includes an ECG sensor to monitor heart activity. The IoT-based system offers significant cost savings, enhances patient care, and can be applied in emergency situations such as road accidents. It reduces the need for constant human oversight, making it ideal for bedridden patients and those in ICU. The system operates with 90% accuracy and plans to integrate additional sensors like cholesterol and glucose monitors in the future.

III Conclusion:

In conclusion, health monitoring systems, powered by IoT and wearable technologies, have immense potential to revolutionize healthcare delivery. This survey has unveiled the current state-of-the-art in these systems, highlighting their architectural diversity, sensor capabilities, communication protocols, and data management strategies. While significant strides have been made, challenges such as data privacy, energy efficiency, and real-time processing persist. The integration of artificial intelligence and machine learning offers promising avenues for addressing these challenges and unlocking new possibilities for early disease detection, personalized treatment plans, and remote patient monitoring. By addressing these critical areas, we can harness the full potential of health monitoring systems to improve population health outcomes and enhance the quality of life for individuals worldwide.

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41. Towards 6G: An Overview of Next Generation Communication

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Abstract:

Sixth generation (or 6G) cellular communication standards are a major improvement over the existing 5G networks. As we approach the dawn of this new era, 6G promises to bring about significant changes that will enhance connection and open up a plethora of creative applications in a variety of fields. The transition from 1G to 5G has already altered how we work, live, and communicate with one another. This platform will be enhanced by 6G, which will offer hitherto unheard-of capabilities. Through this paper, various research areas of 6G are discussed.

Keywords:

6G, IRS, AI & Machine learning, OTFS.

I Introduction:

6G, or the sixth generation of wireless communication technology, is the anticipated successor to 5G. While still in the research and development phase, 6G is expected to revolutionize mobile communications by offering unprecedented speed, connectivity, and capabilities. The following are some of the Key Features of 6G:

A. Higher Data Rates:

Data rates of up to one terabit per second (Tbps) are anticipated with 6G, significantly outpacing 5G's gigabit speeds [1,2]. This will facilitate the real-time distribution of massive volumes of data, supporting applications that require a lot of data, such as augmented reality and HD video streaming.

B. Ultra-Low Latency:

6G is notable for its extremely low latency, which can be as low as a few milliseconds [3]. Applications requiring quick response times, such as industrial automation, remote surgery, and autonomous driving, will require this.

C. Enhanced Connectivity:

From densely populated urban areas to sparsely populated remote rural locations, 6G promises to deliver flawless connectivity in a variety of settings. A ubiquitous system is one of the proposals of 6G wherein terrestrial, satellite, underwater are brought together on a common platform [4].

D. Advanced AI and Machine Learning Integration:

Self-optimized network and management can be achieved by the incorporation of AI ML techniques in 6G [5]. AI-ML technologies will enhance security standards, manage resources more effectively, and maximize network performance.

E. Improved Security and Privacy:

With the increasing reliance on digital communication, security and privacy are of outmost importance. 6G will leverage advanced encryption techniques and AI-driven security techniques to protect data and ensure user secrecy [6].

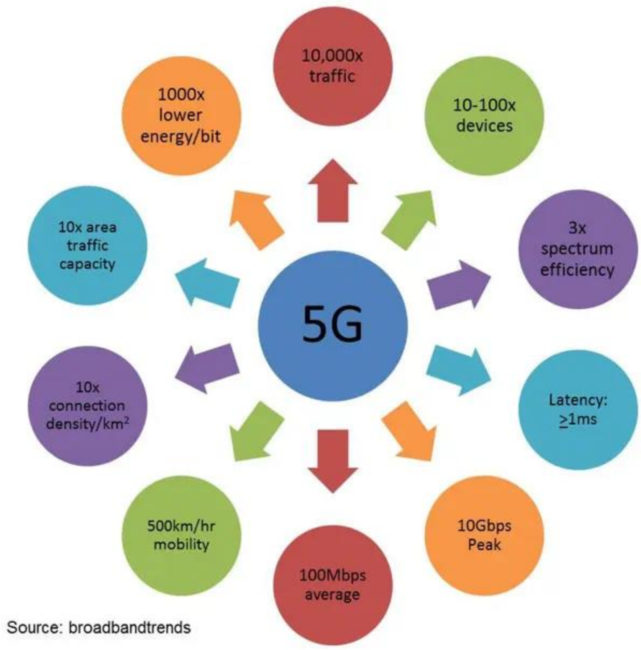

Figure 1: Features of 6G

II Technological Innovations:

A. Terahertz (THz) Frequency Bands):

Utilizing the THz spectrum (0.1-10 THz) is of outmost importance for achieving the high data rates of 6G. Research is ongoing to design THz antennas, propagation models and transceivers. Innovations in materials science and photonics will be critical in overcoming challenges like atmospheric attenuation and signal dispersion[7].

B. Advanced Modulation Techniques:

Recent modulation methods such as Quadrature Amplitude Modulation (QAM) and Filtered Orthogonal Frequency Division Multiplexing (F-OFDM) are being explored to increase spectral utilization. These techniques will enable faster data rates over the same bandwidth, crucial for meeting the data demands of future applications.

C. Intelligent Reflecting Surfaces (IRS):

IRS essentially involves using large number of small surfaces equipped with adjustable elements to reflect signals in desired directions, enhancing coverage and capacity [8-9]. This can significantly decrease the need for extra base stations, making network deployment more cost-effective and energy-efficient.

D. Quantum Communications:

Quantum technologies, particularly quantum key distribution (QKD), aims to revolutionize security of network [10]. Quantum superposition and entanglement principles enable unbreakable encryption, ensuring data confidentiality and secrecy against future cyber threats.

E. Network Slicing and Edge Computing:

Network slicing creates virtual networks which can be customized to specific services, ensuring optimal performance for different applications. Edge computing will process data nearer to the source, thus reducing the latency and bandwidth usage, and enabling real-time data analytics and decision-making.

F. NOMA:

Non-Orthogonal Multiple Access." It's a technology designed to improve the efficiency and capacity of wireless communication systems. NOMA is a multiple access technique that allows multiple users to share the same resource blocks simultaneously [11]. Unlike traditional Orthogonal Multiple Access (OMA) methods, NOMA differentiates users by their power levels or code, not by time or frequency. Enhance spectral efficiency, accommodate a large number of devices, and improve user experience by supporting diverse service requirements. Power Domain NOMA: Users are allocated varying power levels, depending on the distance.

The base station transmits a superimposed signal with different power levels, and users reconstruct their respective signals using a technique known as Successive Interference Cancellation (SIC). Code Domain NOMA: Users are assigned different codes. Signals are superimposed in the code domain, and users separate their signals using specific decoding techniques.

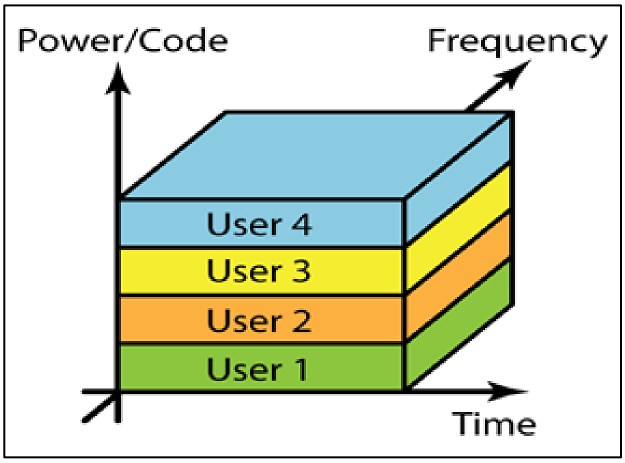

Figure 2: NOMA

G. OTFS:

OTFS (Orthogonal Time Frequency Space) modulation is a next generation modulation technique aimed to overcome the issues of high mobility and multipath propagation in wireless communication systems. The transmission symbols are converted in to a two-dimensional delay Doppler spread domain [12]. OTFS has the capability to provide high speed mobility support because of delay Doppler domain. Conventionally as the speed of UE increases, it becomes difficult to estimate the rapidly changing channel characteristics and hence high-speed mobility is an issue in prior generation communication. This method provides robustness against interference and changes in the channel. This feature of 6G is particularly very useful for applications like high-speed bullet trains, drones, UAV, aero planes etc.

- **Delay-Doppler Domain:** OTFS operates in delay Doppler domain compared to earlier techniques which operated in time frequency domain. It captures and models the effect of Doppler more precisely and helps in robust communication.
- **Channel Resilience:** By transforming complex channel impairments like fading and Doppler effects into more controllable forms in the Delay-Doppler domain, OTFS is able to handle severe channel impairments.
- **Improved Detection:** In dynamic situations, the modulation approach makes it easier to detect and decode information.
- **High Mobility Support:** Excels in situations when the transmitter and receiver are moving at high relative speeds, like high-speed trains and vehicular communication.
- **Enhanced Spectral Efficiency:** Better utilization of the spectrum because of its strong multipath and Doppler impact handling.

- **Better Performance in Multipath Channels:** handles multipath propagation's difficulties well, increasing communication dependability overall.

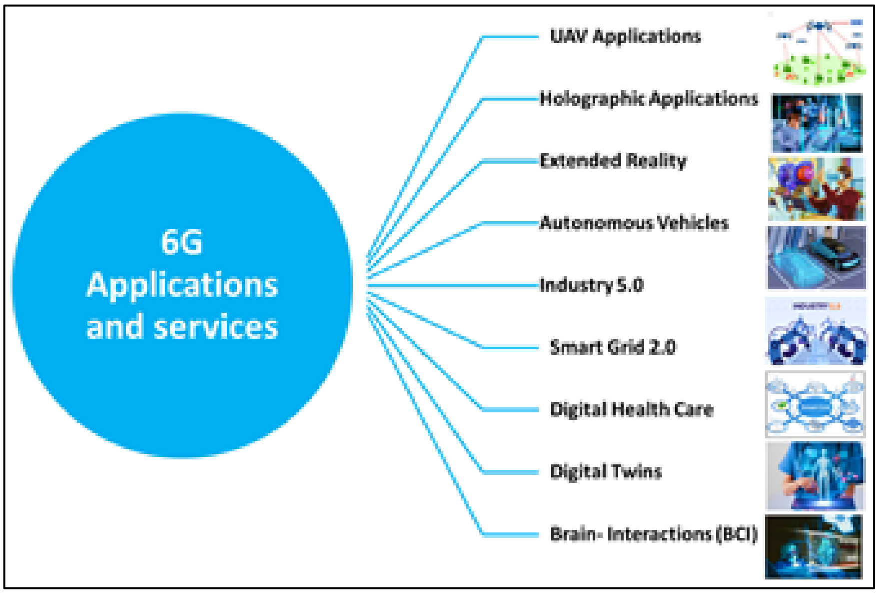

Figure 3: Applications

III Applications of 6G:

The following are some of the applications of 6G [13].

- **Autonomous Driving:** Enhancing the communication capabilities of autonomous vehicles, enabling real-time data exchange with other vehicles, infrastructure, and pedestrians.
- **Traffic Management:** Improving traffic flow, reducing congestion, and enhancing road safety through intelligent traffic management systems.
- **Extended Reality (XR) VR and AR:** Providing the bandwidth and low latency required for seamless VR and AR experiences, transforming education, training, healthcare, and entertainment.
- **Remote Collaboration:** Enabling realistic and interactive remote collaboration environments, enhancing productivity and engagement in virtual meetings and conferences.
- **Smart Cities and Infrastructure:** IoT Integration: Supporting extensive IoT networks for smart utilities, waste management, and energy systems, enhancing urban living and sustainability.
- **Advanced Surveillance:** Facilitating real-time, high-definition surveillance and monitoring systems for public safety and smart infrastructure management.
- **Healthcare and Telemedicine:** Remote Surgery: Enabling high-definition, real-time remote surgeries with minimal latency, improving access to medical expertise in remote areas [14].

- **Telehealth:** Enhancing telehealth services with high-resolution video consultations, remote monitoring, and AI-driven diagnostics.
- **Industrial Automation and Robotics:** Smart Manufacturing: Supporting advanced manufacturing processes with real-time control and automation, improving efficiency and reducing downtime [15].
- **Collaborative Robots:** Enabling robots to work safely and efficiently alongside humans in various industrial and service applications.
- **Entertainment and Media:** Immersive Experiences: Delivering high-quality, immersive content with augmented reality, holography, and interactive media experiences. Interactive Gaming: Enhancing online gaming with low latency, high resolution, and seamless multiplayer experiences.
- **Climate Monitoring:** Supporting networks of sensors for real-time climate monitoring and disaster management, enhancing environmental protection efforts.
- **Sustainable Development:** Enabling smart grids, efficient energy management, and sustainable resource utilization across various industries.
- **Satellite Communication:** Enhancing satellite communication systems, providing high-speed, low-latency connectivity in remote and underserved regions.
- **Space Exploration:** Supporting advanced communication systems for space missions, enabling real-time data transmission and control for space exploration.

IV Challenges and Considerations:

A. Technical Challenges:

Developing terahertz technology, making sure artificial intelligence is seamlessly integrated into network management, and reducing the complexity of network slicing are important problems. The challenges of signal transmission, spectrum assignment, and interference mitigation in the THz range require research.

B. Regulatory and Standardization Issues:

Worldwide standards must be established for 6G in order to ensure interoperability and a smooth worldwide deployment. In order to distribute spectrum, establish technological procedures, and handle cybersecurity laws, authorities will need to work together. In order to prevent fragmentation and provide a standard 6G environment, international cooperation will be required.

C. Security and Privacy Concerns:

As the communication system grows more intricate every day, maintaining privacy and secrecy will become increasingly difficult. To protect user data and uphold confidence, advanced encryption standards, AI-driven security algorithms, and extensive privacy regulations will be required.

D. Environmental Impact:

Sustainable solutions are needed for sixth generation infrastructure's power consumption and e-waste production. Reusable tactics, green system design, and clever energy-saving measures will be essential components in lowering 6G networks' environmental impact.

V Future Prospects OF 6G:

A. Expected Timeline for Deployment:

It is projected that the first commercial 6G systems will go live in 2030 after extensive standardization, development, and research efforts. To prepare for this upgrade, test frameworks and prototype projects are already being established globally.

B. Potential Economic and Societal Impacts:

It is projected that 6G will significantly accelerate economic growth by opening up new markets, fostering innovation, and raising productivity in a variety of industries. It will also have a significant impact on society, opening up new avenues for education, entertainment, and healthcare as well as enhancing general quality of life and closing the digital divide.

C. Research and Development Directions:

Subsequent investigations will concentrate on reducing the technological obstacles, developing novel technologies, and investigating intelligent uses. Public private partnership mode, international agreement, and collaborative research projects will be necessary to enhance 6G technology and guarantee its successful global rollout.

VI Conclusion:

As the 6G age approaches, there are a ton of fascinating and huge possibilities. In addition to being a 5G upgrade, 6G will bring about a radical change in computation, networking, and communication. We can fully utilize 6G by resolving its technical, legal, and environmental issues, opening the door to a more intelligent, connected, and sustainable future. The development of 6G is a joint project, and its effective execution will require cooperation, ingenuity, and a dedication to conquering the obstacles that lie ahead. Through this paper, various aspects of 6G are discussed, which helped in narrowing down objectives. Going ahead, the future research work will focus on intelligent reconfigurable surfaces, NOMA, OTFS.

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42. A Comprehensive Review of Resource Management Techniques in Edge Computing

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ABSTRACT:

Edge computing is a transformative approach that brings computation and data storage closer to the data source, enhancing response times and saving bandwidth. This paper provides a comprehensive review of resource management techniques in edge computing, addressing the key challenges and presenting future directions for research. We discuss various methods for resource allocation, load balancing, scheduling, and optimization. The review also highlights the security aspects and potential solutions for efficient resource management in edge environments.

I Introduction:

Edge computing is a transformative paradigm that represents a significant shift from traditional cloud computing architectures. Unlike cloud computing, which relies on centralized data centers, edge computing brings computation and data storage closer to the data sources, i.e., to the 'edge' of the network. This proximity to data sources offers numerous benefits, including reduced latency, improved bandwidth efficiency, enhanced privacy, and greater reliability. The impetus for edge computing stems from the explosive growth of data generated by Internet of Things (IoT) devices. According to a report by Cisco, the number of connected devices is expected to reach 29.3 billion by 2023, generating an unprecedented amount of data. Traditional cloud computing models are not well-suited to handle this deluge of data due to inherent latency and bandwidth limitations. By processing data closer to where it is generated, edge computing addresses these challenges effectively. Resource management is a critical aspect of edge computing. Effective resource management ensures that computational resources are allocated efficiently, tasks are scheduled optimally, and loads are balanced across the network. This is particularly important in edge computing environments due to the heterogeneous and distributed nature of edge devices. Unlike homogeneous data center environments, edge computing environments consist of a diverse array of devices with varying computational capacities, connectivity options, and power constraints. This diversity necessitates advanced resource management techniques that can adapt to the unique characteristics of edge environments.

Resource allocation in edge computing involves assigning computational resources to tasks in a manner that maximizes performance while minimizing latency and energy consumption. Traditional resource allocation algorithms, such as those used in cloud computing, are not directly applicable to edge computing due to the dynamic and distributed nature of edge environments. As a result, novel algorithms that consider factors such as device heterogeneity, dynamic workloads, and real-time constraints are required. For instance, machine learning-based algorithms have been proposed to predict resource requirements and optimize allocation dynamically (Shi et al., 2016). Load balancing in edge computing aims to distribute workloads evenly across available resources to prevent any single node from becoming a bottleneck. Effective load balancing improves system performance, enhances reliability, and ensures a more efficient utilization of resources. Various strategies have been proposed for load balancing in edge computing, including round-robin, least connections, and dynamic load balancing methods. These strategies differ in their complexity, adaptability, and effectiveness. For example, dynamic load balancing methods use real-time data to make informed decisions about workload distribution, thereby adapting to changing network conditions and workload characteristics (Zhang et al., 2018). Resource scheduling in edge computing determines the order and timing of task execution. Scheduling tasks efficiently is crucial for meeting the quality of service (QoS) requirements of edge applications, particularly those with real-time constraints. Real-time scheduling algorithms prioritize tasks based on their urgency and deadlines, ensuring that critical tasks are executed promptly. Non-real-time scheduling algorithms, on the other hand, focus on optimizing overall system throughput and resource utilization. Hybrid scheduling approaches that combine elements of both real-time and non-real-time scheduling have also been explored to balance the competing demands of different types of applications (Xu et al., 2020).

Optimization techniques in edge computing involve adjusting resource usage to improve performance and efficiency. These techniques include load prediction models, which anticipate future workloads based on historical data and adjust resource allocation proactively. Additionally, energy-efficient algorithms aim to minimize energy consumption without compromising performance, which is particularly important for battery-powered edge devices. For instance, energy-aware task offloading strategies have been developed to reduce energy consumption by dynamically deciding whether to process tasks locally or offload them to more powerful edge servers (Wang et al., 2019).

The objectives and scope of this review are to provide an in-depth analysis of resource management techniques in edge computing, with a focus on recent advancements and challenges. The paper is structured as follows: Section 2 presents the background and related work, providing a comprehensive overview of existing surveys and studies in the field. Section 3 discusses various resource management techniques, including resource allocation, load balancing, scheduling, and optimization, highlighting key algorithms and methodologies. Section 4 addresses the challenges and future directions in resource management for edge computing, emphasizing areas that require further research.

Finally, Section 5 concludes the paper by summarizing the key findings and discussing their implications for future research and practice.

II Literature Survey:

Edge computing has emerged as a crucial paradigm in the realm of distributed computing, aiming to mitigate the limitations of traditional cloud computing by bringing computational resources closer to the data sources. This section delves into the foundational concepts of edge computing, explores its evolution, and examines related work in the field. Edge computing refers to a distributed computing framework where data processing occurs at the edge of the network, near the source of data generation. Unlike centralized cloud computing, which relies on remote data centers, edge computing leverages local processing units, such as gateways, routers, and end devices. This proximity reduces latency, conserves bandwidth, and enhances the responsiveness of applications. The concept of edge computing is not entirely new. It evolved from earlier paradigms like content delivery networks (CDNs) and fog computing. CDNs aimed to reduce latency by caching content closer to users, while fog computing, introduced by Cisco in 2012, extended cloud capabilities to the network edge, providing a foundation for today's edge computing models.

Numerous surveys have been conducted to explore different facets of edge computing. For instance, Shi et al. (2016) provided a comprehensive overview of edge computing, highlighting its potential applications and challenges. They discussed how edge computing complements cloud computing by addressing issues related to latency, bandwidth, and privacy. Similarly, Satyanarayanan (2017) emphasized the importance of edge computing in enabling real-time applications, particularly in the context of IoT. In the domain of resource management, several surveys have focused on specific aspects such as resource allocation, load balancing, and scheduling. For example, Abbas et al. (2018) reviewed resource management techniques in mobile edge computing, categorizing them into resource provisioning, offloading, and orchestration. Their survey underscored the need for adaptive and scalable resource management solutions to handle the dynamic nature of edge environments.

While existing surveys provide valuable insights, this review aims to fill certain gaps by offering a more focused and detailed analysis of resource management techniques in edge computing. Specifically, it addresses the following aspects:

- **Comprehensive Coverage:** Unlike previous surveys that focus on individual aspects of resource management, this review encompasses a broader range of techniques, including resource allocation, load balancing, scheduling, and optimization. By providing a holistic view, it aims to highlight the interplay between these techniques and their collective impact on system performance.
- **Recent Advancements:** Edge computing is a rapidly evolving field, with new techniques and approaches being proposed regularly. This review incorporates recent advancements from the past few years, ensuring that readers are updated with the latest trends and innovations.
- **Challenges and Future Directions:** While previous surveys often conclude with a discussion of challenges, this review delves deeper into specific issues such as security, scalability, and interoperability. It also outlines potential future research directions,

offering a roadmap for researchers and practitioners to address current limitations and explore new opportunities.

By addressing these key differences and contributions, this review aims to provide a valuable resource for researchers, developers, and decision-makers involved in the design and deployment of edge computing systems.

III Resource Management in Edge Computing:

- Resource management in edge computing is a multifaceted challenge that encompasses several interrelated aspects, including resource allocation, load balancing, scheduling, and optimization. This section explores each of these aspects in detail, highlighting their importance, techniques, and challenges.

- o Resource Allocation; Resource allocation involves assigning computational resources to tasks in a manner that maximizes performance and efficiency. In edge computing, this task is complicated by the heterogeneity and dynamic nature of edge devices. Traditional resource allocation algorithms used in cloud computing are often unsuitable for edge environments, necessitating the development of novel approaches.
- o Techniques and Algorithms:
- o **Heuristic Algorithms:** Heuristic algorithms, such as greedy algorithms and genetic algorithms, provide near-optimal solutions for resource allocation problems. These algorithms are particularly useful in edge computing due to their ability to handle complex and dynamic environments. For example, a greedy algorithm might allocate resources based on the current availability and task requirements, while a genetic algorithm could evolve resource allocation strategies over time to optimize performance.
- o **Machine Learning-based Algorithms:** Machine learning-based algorithms leverage historical data and predictive models to optimize resource allocation dynamically. These algorithms can adapt to changing conditions and workload patterns, making them well-suited for edge environments. Techniques such as reinforcement learning and deep learning have been applied to resource allocation problems, with promising results. For instance, a reinforcement learning algorithm might learn to allocate resources based on feedback from previous allocations, continually improving its performance over time.

Resource allocation in edge computing faces several challenges, including resource heterogeneity, dynamic network conditions, and varying workload demands. Addressing these challenges requires adaptive and scalable solutions that can respond to changes in real-time. For instance, adaptive algorithms can adjust resource allocation based on real-time monitoring data, ensuring optimal performance even in dynamic environments.

- **Load Balancing:** Load balancing distributes workloads evenly across available resources to prevent any single node from becoming a bottleneck. Effective load balancing improves system performance, enhances reliability, and ensures efficient utilization of resources.

- o **Round-Robin:** Round-robin is a simple and effective load balancing strategy for homogeneous environments. It distributes tasks in a cyclic manner, ensuring that all nodes receive an equal share of the workload. This strategy is easy to implement and works well when all nodes have similar capabilities.

- **Least Connections:** Least connections is suitable for environments with varying workload sizes. It assigns tasks to the node with the fewest active connections, balancing the load based on current activity levels. This strategy is more adaptable than round-robin and can handle heterogeneous environments more effectively.
- **Dynamic Load Balancing:** Dynamic load balancing methods use real-time data to make informed decisions about workload distribution. These methods can adapt to changing conditions and workload patterns, ensuring optimal performance. For example, a dynamic load balancing algorithm might monitor resource usage across the network and redistribute tasks as needed to prevent overloads and ensure efficient utilization of resources.

- **Resource Scheduling:** Resource scheduling determines the order and timing of task execution. Efficient scheduling is crucial for meeting the quality of service (QoS) requirements of edge applications, particularly those with real-time constraints.

  - **Priority-based Scheduling:** Priority-based scheduling assigns tasks based on their priority levels. High-priority tasks are executed first, ensuring that critical applications receive the necessary resources. This approach is particularly useful for applications with stringent QoS requirements, such as real-time video streaming or autonomous vehicle control.
  - **Fair Scheduling:** Fair scheduling ensures equal resource allocation to all tasks, promoting fairness and preventing resource monopolization. This approach is suitable for environments where all tasks have similar importance and resource demands. For example, a fair scheduling algorithm might allocate resources evenly among all tasks, ensuring that no single task dominates the available resources.
  - **Real-time vs. Non-real-time Scheduling:** Real-time scheduling is crucial for applications with strict latency requirements, such as industrial automation or telemedicine. Real-time scheduling algorithms prioritize tasks based on their urgency and deadlines, ensuring that critical tasks are executed promptly. Non-real-time scheduling algorithms, on the other hand, focus on optimizing overall system throughput and resource utilization, making them more suitable for applications with less stringent timing requirements.

- **Resource Monitoring and Optimization:** Resource monitoring involves tracking resource usage to ensure efficient utilization. Optimization techniques adjust resource usage to improve performance and efficiency.

  - **Agent-based Monitoring:** Agent-based monitoring deploys agents to collect resource usage data from various nodes in the network. These agents can provide detailed and real-time insights into resource utilization, helping to identify bottlenecks and optimize resource allocation. For example, an agent might monitor CPU and memory usage on an edge device, reporting this data to a central controller for analysis and optimization.
  - **Network-wide Monitoring:** Network-wide monitoring uses network devices to monitor resource usage across the entire edge network. This approach provides a comprehensive view of resource utilization and helps to identify patterns and trends.

For instance, a network-wide monitoring system might track data traffic and processing loads across multiple edge nodes, providing insights into overall network performance.

- **Optimization Techniques:**
- **Load Prediction Models:** Load prediction models anticipate future workloads based on historical data and adjust resource allocation proactively. These models can help prevent resource shortages and ensure optimal performance. For example, a load prediction model might analyze past usage patterns to predict future demand, allowing resources to be allocated in advance to meet anticipated needs.
- **Energy-efficient Algorithms:** Energy-efficient algorithms aim to minimize energy consumption while maintaining performance, which is particularly important for battery-powered edge devices. These algorithms optimize resource usage to reduce energy consumption, extending the battery life of edge devices. For instance, an energy-efficient algorithm might offload tasks to more energy-efficient nodes or adjust processing speeds to balance performance and energy use.

By addressing these key aspects of resource management, this section provides a comprehensive overview of the techniques and challenges involved in optimizing resource usage in edge computing environments.

IV Challenges and Future Directions:

The field of edge computing presents several challenges that need to be addressed to realize its full potential. This section explores the key challenges and outlines potential future research directions.

- **Security Issues:** Security is a significant concern in edge computing due to the distributed nature of edge devices. These devices are often located in less secure environments, making them vulnerable to physical attacks and unauthorized access. Additionally, the data processed at the edge may be sensitive, necessitating robust security measures to protect against data breaches and cyberattacks.
- **Resource Heterogeneity:** Edge computing environments consist of a diverse array of devices with varying computational capacities, storage capabilities, and energy resources. Managing this heterogeneity poses a challenge for resource allocation, load balancing, and scheduling. Ensuring that tasks are executed efficiently across different devices requires adaptive and scalable resource management solutions.
- **Dynamic Network Conditions:** The network conditions in edge computing environments are highly dynamic, with varying levels of connectivity, bandwidth, and latency. These fluctuations can impact the performance and reliability of edge applications, necessitating real-time monitoring and adaptive resource management strategies.

Emerging Trends and Future Research Directions:

- **AI and Machine Learning Integration:** Integrating artificial intelligence (AI) and machine learning (ML) techniques into edge computing can enhance predictive resource management, improve decision-making, and optimize performance. For example, ML algorithms can analyze historical data to predict future workloads and dynamically adjust resource allocation to meet demand.

- **Security Enhancements:** Developing robust security frameworks for edge computing is critical to protect against cyber threats and ensure data privacy. Future research should focus on advanced encryption techniques, secure communication protocols, and intrusion detection systems tailored for edge environments.
- **Scalability Solutions:** As the number of edge devices continues to grow, ensuring that resource management techniques can scale effectively is crucial. Future research should explore scalable algorithms and architectures that can handle large-scale deployments while maintaining performance and reliability.
- **Interoperability:** Ensuring interoperability between different edge computing platforms and devices is essential for seamless integration and operation. Standardization efforts and the development of common protocols can facilitate interoperability and promote the widespread adoption of edge computing.
- **Energy Efficiency:** Optimizing energy consumption is a critical concern, particularly for battery-powered edge devices. Future research should focus on developing energy-efficient algorithms, exploring alternative energy sources, and designing hardware that reduces power consumption. By addressing these challenges and exploring these future research directions, the field of edge computing can continue to evolve and expand, unlocking new opportunities and applications.

V Conclusion:

This paper provided a comprehensive review of resource management techniques in edge computing. We discussed various methods for resource allocation, load balancing, scheduling, and optimization. Future research should focus on integrating AI, enhancing security, and developing scalable solutions for efficient resource management in edge environments.

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43. Applications of Machine Learning and Deep Learning in Farming: A Review

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ABSTRACT:

India is largely an agriculture product producing country. Agriculture in India is facing many challenges like drought, flood, disease, pricing, yield and etc. Precision agriculture is one of the rapidly developing fields. To address current challenges in agriculture, Deep learning stands as a promising technology in precision farming, facilitating the advancement of sophisticated disease detection and categorization methods. Plant disease recognition by deep learning, eliminates the need for manual identification of disease features, rendering feature abstraction more objective and enhancing technological efficiency. This paper provides a comprehensive review of machine learning and deep learning techniques applied to detect and classify plant diseases. The paper discusses available datasets for crop and plant disease detection and abstraction, followed by a comparative investigation of various algorithms utilized in leaf disease detection.

KEYWORDS:

Classification, Machine learning, Object detection, Deep learning, and Plant leaf disease detection.

I Introduction:

Indian economic development relies heavily on agriculture, which faces numerous challenges. Meeting the current food demands of the population has become increasingly difficult due to factors such as population explosion, uneven weather conditions, and shortfall of resources. In addition to these challenges, the severity and prevalence of crop diseases have been on the rise.

The presence of plant diseases significantly hampers agricultural production, exacerbating food insecurity if not addressed promptly. Continuous monitoring is essential to mitigate production losses caused by crop diseases. Precision agriculture, a rapidly evolving field, aims to tackle concerns regarding agricultural sustainability. Machine learning (ML) stands out as a promising technology in this domain, enabling machines to learn autonomously without direct programming. Numerous studies have leveraged Machine Learning methods for detection and classification of plant diseases [1][2], primarily utilizing plant or leaf images as input and categorizing them as healthy or diseased, or performing multiclass classification for multiple diseases. Machine learning (ML) techniques such as Random Forest and Deep Learning(DL) have been commonly used for this purpose [1][2]. However, fewer studies have focused on simultaneously identifying the disease type and the diseased input image regions [1]. This aspect gains significance in scenarios with multiple plant diseases or when precise localization of diseased regions in large crop images is required. Moreover, the object detection challenge poses greater difficulty compared to classification, and DL methods struggle in uncontrolled environments, such as images with noisy backgrounds. This paper aims to review the application of ML and DL methods in either classifying or detecting plant diseases, offering insights into their efficacy within the realm of precision agriculture. Numerous research papers have explored ML and DL techniques in the context of precision agriculture, contributing to ongoing efforts to enhance agricultural productivity and sustainability.

II Literature Review:

This section offers an in-depth examination of disease detection and classification techniques employing ML and DL methodologies, as evidenced in the existing literature.

A. Disease Classification:

Amara et al. [3] LeNet architecture is used to classify diseases in banana leaves. In their work they downsized images to 60x60 in the pre-processing steps and converted to greyscale. This architecture achieved accuracy between 92% to 99% with plant village data set.

Cruz et al. [4] applied the LeNet architecture to detect indications of olive decline in their research. They trained the LeNet architecture network using the Plant Village dataset, where images were pre-processed by resizing them to 256×256. Their reported accuracy reached an impressive 99%.

De Chant et al. [5] introduced a 3 stage method of employing CNN models to identify N.L.B. infected maize plants in their investigation. They curetted a bespoke dataset comprising 1,796 images and achieved an accuracy of 96.7% in their results.

The Lu et al. [6] authors presented a multistage CNN architecture, drawing inspiration from AlexNet, with the aim of detecting diseases in rice plants. To compile their dataset, they collected images from both agricultural-pest and insect-pest databases. Before analysis, the images underwent preprocessing steps, including resizing to 512 × 512 pixels and the application of the Z.C.A Whitening technique to eliminate data correlation. This model achieved a notable accuracy of 95.48%.

In their study, Oppenheim and Shani [7] harnessed the power of a CNN to categorize potatoes into five classes. Four categories are infected and one is healthy. Their dataset includes 400 images of infected potatoes captured through three digital cameras. As part of the preprocessing phase, they standardized the images by 224×224 pixels and converting them to grayscale. They achieve the accuracies ranging from 83% when trained with only 10% of the data to an impressive 96% with 90% of the data utilized for training.

Barbedo [8] identified the key factors affecting the design and efficacy of CNNs in the realm of plant disease identification. PDDB dataset having 50,000 images is used to identify corn diseases. Additionally, they conducted an investigation into nine factors influencing disease detection in maize fields. Four different datasets were used for training; achieved the highest accuracy of 87% with a subdivided dataset.

Lu et al. [9] conducted a study utilizing a high-resolution spectral sensor for the detection of tomato leaves diseases at various growth stages. They introduced the K-Nearest Neighbor (KNN) algorithm [1] for identification of the sensor data into 4 groups: early_stage, late_stage, healthy, and asymptomatic. They used PCA to achieve 85.7% in healthy leaves and 86.4% in asymptomatic leaves, 73.5% in early stage and 77.1% for late stage leaves.

In their study, Pineda et al. [10] focused on predicting diseases caused by the bacteria Dickeyadadantii in melon leaves. Using three machine learning (ML) algorithms, namely LRA, SVM, and ANN. Their investigation demonstrating a superior accuracy of 99.1%, particularly in classifying images depicting entire leaves.

Al-Saddik et al. [11] examined spectral bands for developing a multispectral camera for UAV to detect diseased grapevine fields. The targeted disease is highly contagious, incurable, and can cause significant production losses. To identify the most effective spectral bands, 2 spectral examination methodologies were employed. One method involved a feature selection, utilizing the successive projection algorithm. The second method focused on classic vegetation metrics. SVM and discriminant classifiers were employed in this study. The accuracy of the models varied depending on the grapevine variety under consideration. The approach using the successive projection algorithm outperformed the common vegetation metrics, achieving a classification accuracy exceeding 96%.

Dhingra et al. [12] introduced methodologies aimed at identifying diseases affecting basil leaves through the application of digital image processing methods. They employed nine distinct classifiers for this purpose. The process of image acquisition involved gathering samples from an herb garden, with careful attention given to standardizing the surface condition of the leaves. The classifiers use Decision Trees (DT), Support Vector Machines (SVM), linear models, Naive Bayes, K-Nearest Neighbors (KNN), AdaBoost, discriminant analysis, Random Forests (RF), and Artificial Neural Networks (ANNs). The classification task aimed to segregate the images into two primary categories such as infected and healthy. Among the nine classifiers employed, Random Forests (RF) emerged as the most accurate, achieving an impressive exactness of 98.4%.

Habib et al. [13] introduced agro-medical expert system for the identification of papaya diseases using computer vision methods to analyze images captured through portable devices. The objective of the study was to disease detection and disease classification. They achieved a commendable accuracy rate of 90.15%.

Karthik et al. [14] introduced 2 types of Deep Neural Network (DNN) models aimed at discerning infection present in tomato leaves [1]. One model uses residual learning atop a feed forward CNN to acquire essential features, and other model incorporated strengthened attention mechanisms and residual learning within CNNs. These models tested using the Plant Village dataset, achieving reported accuracies about 95% and 98%.

In their study, Chowdhury et al. [15] investigated the classification of tomato diseases using the Efficient-Net CNN architecture on tomato leaf images. They employed a dataset comprising 18,162 tomato images from the Plant-Village dataset for training and fine tuning the model for detecting both good/healthy and infected tomato leaf images. Impressively, they achieved a classification accuracy of 0.999 with Efficient_NetB7 and 0.998 with Efficient_NetB4.

Karlekar and Seal [16] recommended a machine vision technology for identifying and categorizing leaf diseases within crops of soybean. Their approach involves isolating the leaf section by removing multifaceted backgrounds from the whole image. Subsequently, a Convolutional Neural Network (CNN) named SoyNet, trained on the PDDB dataset comprising 16 classes, classifies the segmented leaf images. During preprocessing, the images are resized to 100 × 100 pixels. Impressively, this model achieves an identification accuracy of 0.9814.

B. Disease Detection:

Jiang et al. [17] utilized a deep learning (DL) methodology with GoogLeNet architecture to detect infections in apple leaves. Custom dataset consisting of 2029 images depicting unhealthy apple leaves and subsequently trained their algorithm to identify 5 apple leaf ailments like Alternaria leaf spot, brown spot, mosaic, grey spot, and rust. Their model achieved a commendable detection accuracy of 0.7880mAP.

Li et al. [18] introduced a methodology for disease identification in rice crops employing a convolutional neural network. They collected images using mobile phones and used Faster R-CNN as the underlying framework for image detection. Comparative analysis demonstrated that their proposed approach outperforms ResNet50 and ResNet101 in terms of accuracy and efficiency.

Saleem et al. [19] integrated three different algorithms for object detection with four feature extractors and three optimization techniques to address plant disease identification. Among these, the S.S.D model linked with the InceptionV2 feature extractor and trained using the Adam-optimizer achieving a mAP of 73.07%.

Sun et al. [20] introduced a model designed to detect maize-leaf blight infection on maize crops utilizing the S.S.D. algorithm. They employed a dataset comprising 18,000 images captured by a camera mounted on a UAV. Their model achieved an impressive accuracy of 91.83%.

Xie et al. [21] introduced a deep learning-based detector designed for identifying leaf infections in grape plants. They used disease dataset consisting of 4,449 original images and augmented it with an added 62,286 unhealthy leaf images. The model trained using data augmentation techniques. This approach resulted an accuracy of 81.1%.

Roy and Bhaduri [22] introduced deep learning (DL) model for apple plant disease detection. They achieved a detection rate of 56.9 frames per second [1] while enhancing the mean average precision (mAP) up to 91.2% [1].

Selvaraj et al. [23] introduced a pixel-based classification method integrated with machine learning (ML) models to detect banana crops using multilevel satellite images and unmanned aerial vehicles (UAVs). They utilized Random Forest (RF) for pixel-based classification and devised a mixed model strategy incorporating RetinaNet along with minimized-classifier for banana localization and infection classification [1] using U.A.V RGB images. Their proposed method produced accuracies of 0.994, 0.928, 0.933, and 0.908 for detecting banana bunchy top disease [1].

III Challenges in Plant Disease Detection:

Following an extensive examination of machine learning (ML) and deep learning (DL) algorithms for plant/crop disease/infection detection and classification, many challenges in real field applications of plant disease detection have come to light.

1. Existing models are predominantly on image data, neglecting valuable non-image data such as environmental data (temperature and humidity). This oversight limits the understanding of plant health and disease dynamics. Addressing this gap by integrating nominate data into classification and object detection algorithms [1] is crucial for enhancing the accuracy and robustness of predictions.
2. The availability of fully annotated open datasets for plant disease research remains limited. Numerous studies heavily rely on the Plant Village dataset, primarily acquired under controlled laboratory conditions. There's a pressing need for larger datasets collected under real-world settings to better reflect diverse environmental conditions and disease manifestations.
3. While most research approaches views disease detection as a classification problem, often binary or Multiclass [1], there is growing acknowledgments that object detection methods can provide more comprehensive insights by not only identifying the type of disease but also pinpointing the affected regions within the image. Object detection methodologies have the potential to facilitate more detailed analyses of plant health.
4. Researcher depends on a single dataset for both training and testing their models. Models trained on single dataset frequently exhibit subpar performance when applied to different datasets. To improve the model performance, diverse range of datasets could be used.
5. Instead of relying only on CNNs models, researcher can find neural network architectures like recurrent- neural- networks (RNN)that improves disease detection.
6. Many researchers use long leaf image data sets for analysis. They can investigate on small leaves also. That enhances the detection of disease in early stage

IV Future Research Scope of Disease Detection in Plants:

Apart from the aforementioned challenges, there exist numerous promising avenues for future research in the field of plant disease detection.

1. To enhance prediction accuracy in disease detection algorithms, it's imperative to develop models that can seamlessly integrate nominate data [1], such as environmental factors. By incorporating additional contextual information beyond visual cues, these models can provide a more comprehensive understanding of the underlying factors influencing plant health. This holistic approach enables more accurate and robust predictions, thereby improving the efficacy of disease detection systems.
2. To bolster the generalizability of models in agricultural settings, it's crucial to collaborate with domain experts to create diverse and real-world datasets. By capturing data under varied environmental conditions and agricultural practices, these datasets can better reflect the complexities of real-world scenarios. This collaborative effort ensures that models are trained on a representative range of data, improving their ability to adapt and perform accurately across different agricultural contexts.
3. There's a growing need to prioritize object detection methods in plant disease prediction endeavors. By leveraging object detection techniques, researchers can glean more granular insights into disease localization within plant images. This shift in focus promises to enhance the precision and specificity of disease detection models, enabling more accurate identification of affected regions and facilitating targeted intervention strategies.
4. Developed model must be practically implementable.
5. To overcome challenges posed by variable lighting conditions and occluded images, it's crucial to implement techniques that enhance algorithm robustness. By developing strategies specifically designed to mitigate the effects of illumination variations and image occlusions, algorithms can maintain their performance consistency across diverse environmental settings and image complexities. This proactive approach ensures that disease detection systems remain reliable and effective under real-world conditions, ultimately improving their utility in agricultural applications.
6. Efforts to enhance computational efficiency are paramount, which is necessitating a focus on optimizing model architectures and algorithms to cater to real-time applications. By streamlining computational processes and reducing resource demands, optimized models can deliver swift and responsive performance, crucial for deployment in dynamic agricultural settings. This optimization drive ensures that disease detection systems not only maintain high accuracy but also operate seamlessly in real-world scenarios, maximizing their practical utility and impact.

After the extensive investigation of the different existing work in this area, a brief outline of the research gap, reasons, and probable solutions are being demonstrated in the Table I.

Table I: Outline of The Research Gaps, Reasons and Solutions of Some of Previous Works

Source	Crop	Dataset	Algorithms	Research Gap	Reason	Solutions
3	Banana	Plant Village	LeNet	Fixed/predefined data set	Difficulty in getting real world data. This leads no practical applications.	Getting real world data using UAV and classifying diseases is useful for Agriculture.
4	Olive Symptoms	Plant Village	CNN	Time consuming	They trained the model with two different data set.	Models need to be improved.
5	Maiz-plants	Custom dataset	CNN	Three stage approach used	Data set is only 1796 images.	Size of the dataset need to be Improved.
6	Rice Plants	Own Database	CNN	Own database with less images	Many images were taken from book.	Real time data is required for achieving good accuracy.
7	Potatoes	Own data Base	CNN	Own database with less images	400 Images were taken from simple digital camera. Resolution was the problem.	Size of the dataset need to be increased.
8	Corn	PDDB	CNN	Achieved accuracy is only 87%	Multiple data set with many subdivision.	Experiment with single dataset with real time Images.
9	Tomato	Custom	KNN	Accuracy is less about 73.5%	Data set is not sufficient for analysis.	Data Set and algorithms need to be improved.

Source	Crop	Dataset	Algorithms	Research Gap	Reason	Solutions
14	Tomato Leaves	Plant Village	DNN	Time consuming.	Used two models.	Select Different models.
15	Tomato Leaf images	Plant Village	Efficient Net CNN	Two segmentation models used	Numbers of parameters are more.	Improve the models using minimum parameters.

V Conclusion:

This study gave us insight into existing research employed utilizing machine learning (ML) and deep learning (DL) methods used for farming. This study was highlighting on methodologies for plant and crop disease detection and classification. Here, introduced a classification scheme that classifies related works into distinct classes. These studies are divided into two categories based on methodology, namely classification and object detection approaches. The review here presented an overview of available datasets for plant disease detection and classification, offering insights into their respective classes, data characteristics, and suitability for either classification or object detection tasks. This comprehensive analysis aims to provide valuable insights and guidance for researchers in farming.

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44. Aggregation Based on Clustered Data (ABCD) with Edge Computing

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ABSTRACT:

In the era of big data and the Internet of Things (IoT), efficient data processing is crucial. This paper explores the integration of cluster-based data aggregation with edge computing and machine learning to enhance data processing efficiency, reduce latency and improve decision-making in real-time applications. We present a comprehensive framework to discuss key benefits and challenges, and illustrate the implementation with a case study in a smart city environment.

KEYWORDS:

Data Aggregation, Clustered Data Edge Computing, Edge Devices.

I Introduction:

A wireless network, or WSN, is made up of several nodes and base stations. These networks work together to cooperatively transfer data to the main location while keeping an eye on environmental or physical parameters like temperature, sound, pressure, and so on.

Sensor nodes in the Internet of Things form wireless sensor networks (WSN) crucial for various applications, but face challenges due to limited energy resources.

High energy consumption poses a significant challenge for sensor nodes, leading to shortened network life cycles.

The non-rechargeable and restricted power supply of nodes has prompted research into novel approaches to enhance the energy balance and energy efficiency of wireless sensor networks.

The different challenges in wireless sensor networks include the following.

- ***Fault Performance*****:** Physical harm could happen because some sensor nodes stop functioning due to power outages. The ability of a sensor network to continue operating normally even in the event that a sensor node fails is known as fault tolerance.
- ***Scalability:*** Routing systems should be scalable enough to handle events, and the number of nodes employed in the detecting region could be in the range of hundreds to thousands.
- ***Quality of Service:*** The application may require certain levels of quality of service, such as energy efficiency, long lifetime, and trustworthy data.
- ***Data Aggregation:*** Data aggregation is the process of combining data from multiple sources with various functions, such as average, max, and min.
- ***Data Compression:*** Procedure for altering data to make it smaller Data compression can reduce storage requirements, expedite file transfers, and lower expenses associated with storage hardware and network bandwidth.
- ***Data Latency:*** Data latency is the total time elapsed between when data are acquired by a sensor and when these data are made available to the public.

Edge Devices: Positioned between end devices and the central cloud, responsible for local data processing, analysis, and communication management. They are more powerful and reduce the load on central systems.

End Devices: Simple devices at the edge of the network that collect data or perform actions based on received instructions. They rely on edge devices or central systems for complex processing tasks.

II. Literature Survey/Related Works.

A sensor is a device/apparatus that can react to and identify input from environmental or physical factors, such as pressure, heat, light, etc. An electrical signal that is sent to a controller for additional processing is the sensor's output.

Proposes a two-layer WSN system based on edge computing to address challenges related to high energy consumption and short life cycle of WSN data transmission [1]. Establishes optimization models for wireless energy consumption and distance in sensor networks. Sparrow search algorithm is used to evenly distribute sensor nodes in the system, reducing resource consumption and prolonging the network's life cycle.

An efficient data aggregation scheme (EDAS) for IoT-based wireless sensor networks (WSN) to address issues like data redundancy, high computation overhead, and high energy consumption. It utilizes an improved low energy adaptive clustering algorithm (I-LEACH) to form an optimal number of cluster heads (CH) based on node residual energy and average network energy. Network coding is used to eliminate data redundancy through linear XOR operations, ensuring non-replicated data transmissions [2].

Vehicle clustering has received attention for a promising approach to enhancing in network stability, reliability, and scalability [3]. An efficient greedy algorithm is developed, which by considering vehicle states over a prediction horizon, identifies a set of cluster heads and their designated cluster members. We leverage the capabilities of Vehicular Edge Computing servers and implement a load-balancing approach that distributes computation tasks among the VEC servers to prevent the overloading of any single server.

A data aggregation approach based on Adaptive Huffman Coding, which by identifying and eliminating duplicate data reduces the volume of clustering data transmitted to VEC servers.

One of the main challenges in constructing wireless sensor networks (WSNs) is the limited energy of the sensor nodes. One useful tactic to reduce energy usage and increase network lifespan is data aggregation [4]. The best method has been shown to be cluster-based data aggregation due to its benefits, which include low computing overhead, flexible, scalable, accurate, reliable, and accurate data processing.

The Internet of Things (IoT) and machine learning (ML) have developed quickly, and large amounts of data produced by edge devices like laptops, smartphones, and artificial intelligence (AI) speakers have been utilized extensively to train ML models [5]. In Multi-Access Edge Computing, we employed the blockchain technique based on clusters.

Sensor networks use clustering strategies to minimize communication overheads, guarantee optimal resource utilization, lower total system energy consumption, and minimize inter-SN interference.

The primary purpose of clustering routing is to lower the data transmission rate by using the Cluster Head's (CH) information pooling technique.

The three energy-intensive functions of SNs are sensing, processing, and communication. According to technical standards, the processor needs the same amount of energy to transport one bit of data as it does to execute several arithmetic operations. Furthermore, practically all SNs can provide a similar data rate due to the physical environment of a heavily deployed SN network, meaning that transmitting such data is redundant. Therefore, it is essential to combine all the elements that promote SN clustering in a way that makes it possible to transfer only compact data.

The Clustering Algorithms challenges [6]

Determining the optimal number of clusters: Selecting the right number of clusters for the data is one of the main issues in clustering. Improper clustering outcomes can arise from selecting an inappropriate number of clusters.

Handling high: *dimensional data:* The ills of dimensionality mean that clustering techniques may perform poorly on high-dimensional data. The significance of the distance or similarity metrics between data points decreases with the number of dimensions. Additionally, low density problems and increased computational cost in clustering techniques can be caused by high-dimensional data.

Sensitivity to initialization: Numerous clustering techniques are dependent on the initial configuration, including K-means. It might be difficult to get consistent and trustworthy findings from clustering since different initializations can produce varied results.

Dealing with different cluster shapes and sizes: Convex or isotropic clusters are two examples of the underlying structures that are commonly assumed by clustering methods. However, clusters with irregular shapes, variable sizes, or overlapping boundaries are frequently found in real-world data.

Handling noisy or outlier data: Due to their ability to distort cluster boundaries and create misleading clusters, noisy data points can have a substantial impact on the clustering process.

Scalability to large datasets: Some clustering techniques have memory or processing complexity issues that make them difficult to scale to huge datasets. The clustering method may grow more time-consuming or perhaps impossible as the dataset grows.

To overcome these obstacles, one must carefully analyze the dataset's properties, choose the best algorithms, and use preprocessing or algorithmic changes.

To guarantee the caliber and dependability of the clustering results, it is crucial to assess and validate the clustering results using domain expertise and extra studies.

Managing the sensory data is a tedious task in sensor cloud. Usually sensor nodes produce multiple data and have heterogeneity character. Fog computing is a new paradigm to remove the latency problem and improves the system accuracy. Fog computing is a middleware between end devices and cloud server.

As number of users increase, the resource allocation becomes very difficult in sensor cloud. In this paper [7], they have proposed a methodology for resource provision and pricing model for sensor cloud. The resource allocation is completed on priority basis as requested by the user.

Vehicular Ad hoc Networks mainly depends on the cloud computing for the services like storage, computing and networking. With the increase in the number of vehicles connected to the cloud, the problems like network congestion and increased delay arises. Hence fog enhanced vehicular services having several advantages compared to the cloud-only model. Resources at the fog layer are less compared to the cloud but with the proper utilization of these resources, it is possible to serve the requesting vehicles diverted towards it [8].

Heterogeneous Sensor Nodes: Refers to a collection of sensor nodes that differ in terms of capabilities, types of sensors, communication protocols, power consumption, and computational power. It also refers to the diversity within the network in terms of hardware, software & functionality.

These nodes often communicate with each other within a localized network (e.g., WSN) and may require gateways or aggregators to connect to external networks or the internet.

The focus is on localized data collection, possibly with on-site data processing or aggregation before transmission to a central server. Typically deployed in specific environments like industrial monitoring, environmental sensing, or military applications. Hence heterogeneous sensor nodes refer to a collection of diverse sensors within a network.

IoT Sensor Devices: They are designed to collect data and communicate it over the internet, often integrating with cloud platforms for processing and analysis. They are generally designed to connect to the internet directly or through a gateway.

Generally designed to be low-power and efficient, with some capable of energy harvesting. These devices may have more integrated processing power and memory to handle data preprocessing, reducing the need for constant communication with external servers.

They are often part of a larger ecosystem and data is not only collected but also used for real-time decision-making, automation, and remote monitoring.

IoT devices may also support edge computing, where some processing is done locally before data is sent to the cloud, enabling faster response times and reduced bandwidth usage

III. Proposed Scheme for System Architecture:

Our proposed framework integrates cluster-based data aggregation, edge computing, and machine learning. The architecture consists of three main layers: data collection, edge processing, and centralized analysis. The Flow chart of the main three layers is being separated into many layers as shown in the Figure 1. This flow chart initial Phase consists of data collection in which many sensors will send the environment signal to the processor. Once sensor network is formed and them after the clustering process will take place, once clustering is done cluster head is selected within the group which node is having more energy.

Data collected need to be filter / preprocessed for further work after that the data will have computation.

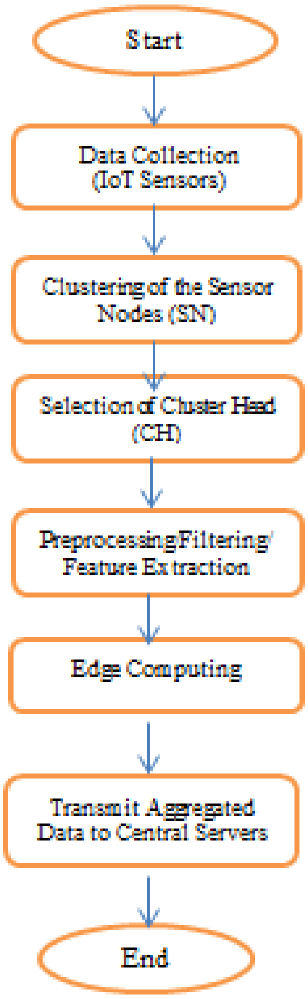

Figure 1: Flow Chart of the Data Aggregation in Clustering Methods with Edge Computing

A. Data Collection:

IoT devices collect raw data, which is grouped into clusters based on predefined criteria, such as geographical location or data type. Data is collected from various IoT devices distributed across different locations. These devices gather raw data on parameters such as environmental conditions, traffic, and energy consumption. Data is initially clustered based on criteria like geographical proximity, data type, and temporal aspects.

B. Cluster-Based Data Aggregation:

Since the CHs serve as the entry point between the SNs and the BS, choosing a cluster head comes first in most clustering schemes. Since the CH serves as a communication mediator between the BS and the SNs, choosing the CH is an important step in the subsequent clustering processes that increase the network's lifespan and energy efficiency.

Clustering Characteristics:

- ***Inter-cluster head connectivity:*** Indicates how well SNs or CHs are able to communicate with the BS. In the event that the CH is unable to establish long-distance communication, the clustering scheme must offer the BS intermediate routing paths.
- ***Cluster count:*** It is a measure of how many clusters are created in a given round; the more CHs, the smaller the cluster distribution size and the higher the level of energy conservation. Certain clustering techniques involve pre-assigned CH selection, which allows the CHs to be chosen at random and produces varying amounts of clusters.
- ***Cluster size:*** The ideal path length in a cluster between each node and its distance from the CH. Energy consumption improves with decreasing cluster size since less transmission distance and CH load are required. Certain clustering techniques have a fixed cluster size, particularly when the clusters are fixed for the duration of their service life; however, other clustering techniques have a variable cluster size.
- ***Cluster density:*** It refers to the quantity of regular nodes inside a cluster, it is a laborious work for the CHs in dense clusters to reduce energy usage. Because of this, the majority of clustering techniques use sparse cluster density and fixed clustering.
- ***Message count:*** It is used to describe the minimum amount of message transmissions needed to pick a CH. The CH selection process requires a greater amount of energy the more messages there are. The majority of non-probabilistic algorithms need message transfer in order to choose the CH.
- ***Stability:*** If a cluster's members are not fixed, then clustering methods are adaptable if not, they are fixed since the cluster count cannot be changed during the CH selection process. Enhancing the cluster count increases an SN's stability.

Clustering Methods:

- **K-Means:** Groups data into K clusters by minimizing within-cluster variance.
- **Hierarchical Clustering:** Creates a dendrogram to represent data groupings.
- **DBSCAN:** Clusters data based on density, identifying outliers effectively.

Aggregation Techniques:

- **Summarization:** Calculating statistical summaries like mean, median, and mode.
- **Sampling:** Selecting representative data points from each cluster.
- **Compression:** Reducing the data size using compression algorithms.

C. Edge Processing:

Edge nodes preprocess the clustered data, performing tasks such as filtering, noise reduction, and preliminary analysis. Simple machine learning models deployed at the edge detect anomalies and make quick decisions.

1. Preprocessing:

- ***Filtering:*** Removing noise and irrelevant data.
- **Normalization:** Standardizing data to a common scale.

- ***Feature Extraction*****:** Identifying and extracting important features from the raw data.

2. Local Analysis:

- ***Anomaly Detection*****:** Using lightweight machine learning models to detect unusual patterns.
- ***Real-Time Analytics:*** Performing quick, on-the-fly analysis to support immediate decision-making.

3. Communication:

- ***Data Transmission*****:** Transmitting processed data to central servers for further analysis.
- ***Decentralized Coordination*****:** Edge nodes coordinate with each other to ensure consistency and avoid redundant processing.

Complex machine learning models run on central servers for in-depth analysis. These models aggregate insights from multiple edge nodes to provide comprehensive analytics and long-term predictions.

The term "machine learning" was coined by Arthur Samuel, and the models play a prominent role in our daily lives, which is a branch of artificial intelligence (AI) and computer science that focuses on the using data and algorithms to enable AI to imitate the way that humans learn, gradually improving its accuracy i.e. is to figure out how we can build process/systems that improve over time and with repeated use.

Edge devices often require lightweight machine learning models and methods due to their limited computational resources, power constraints, and the need for real-time processing. Here are some popular lightweight machine learning models and methods commonly used for edge devices:

1. Tiny Machine Learning: Is a growing field focused on developing machine learning models that are small enough to run on microcontrollers and other edge devices with limited resources.

The benefits of Tiny ML

- **Latency:** The data does not need to be transferred to a server for inference because the model operates on edge devices. Data transfers typically take time, which causes a slight delay. Removing this requirement decreases latency.
- **Energy savings:** Microcontrollers need a very small amount of power, which enables them to operate for long periods without needing to be charged. On top of that, extensive server infrastructure is not required as no information transfer occurs: the result is energy, resource, and cost savings.
- **Reduced bandwidth:** Little to no internet connectivity is required for inference. There are on-device sensors that capture data and process it on the device. This means there is no raw sensor data constantly being delivered to the server.

- **Data privacy:** Your data is not kept on servers because the model runs on the edge. No transfer of information to servers increases the guarantee of data privacy.

2. Quantized Models: Quantization reduces the precision of the numbers used in a model (e.g., from 32-bit floating-point to 8-bit integers), which reduces the model size and computational requirements.

3. AutoML for Edge Devices: AutoML tools automate the design of machine learning models, optimizing them for deployment on edge devices by focusing on model size, latency, and accuracy. Customized machine learning models for specific tasks like object detection, where edge deployment is crucial. AutoML Vision Edge allows you to train and deploy low-latency, high accuracy models optimized for edge devices. AutoML Tables enables your entire team to automatically build and deploy state-of-the-art machine learning models on structured data at massively increased speed and scale.

IV. Results and Discussion:

- **Efficiency:** As an alternative to depending on data centers located hundreds of miles away, data can be processed and stored closer to the devices. As a result, network transport energy usage may be significantly reduced, and edge computing's low latency may be advantageous. Lightweight Algorithms versions suitable for resource-constrained edge devices. Implementing approximate clustering algorithms that trade off a bit of accuracy for significant gains in speed and reduced resource usage. Develop incremental or online clustering methods that can update clusters as new data arrives without requiring a full re-computation.
- **Real-Time Analysis:** Edge Computing Optimization Distribute the clustering tasks across multiple edge nodes to balance the computational load which dynamically assign tasks based on current node workloads and network conditions.

Implement a multi-tier edge architecture where initial clustering is done at the most peripheral edge nodes (e.g., sensors or gateways), and more complex processing is done at higher-level edge servers. This reduces the data volume transmitted upstream and leverages local processing capabilities.

Optimize resource allocation on edge nodes by prioritizing tasks and efficiently managing CPU, memory, and storage.

Enable direct communication between edge nodes to share intermediate results and collaborate on clustering tasks, reducing the dependency on central servers and minimizing latency.

Minimize the amount of data transmitted between edge nodes and central servers by transmitting only essential summaries or compressed data rather than raw data. There are several challenges of integrating edge computing with machine learning requires specialized expertise. Resource constraints on edge devices may limit the deployment of sophisticated models. Future work will focus on optimizing resource allocation and enhancing model deployment strategies.

V. Conclusion:

Integrating cluster-based data aggregation with edge computing offers a powerful approach to efficient, real-time data processing. This framework demonstrates significant improvements in latency reduction, data efficiency, and decision-making capabilities. Continued research and development in this area will further enhance the potential of IoT and edge computing data applications.

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45. Challenges and Future Prospects of Thin Film Deposition Techniques: A Critical Review

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ABSTRACT:

Thin film technology is widely utilized across multiple industries to enhance the mechanical, physical, and chemical properties of bulk materials. This paper provides an overview of the current status, challenges, and future potential of thin film deposition techniques. It delves into various thin film deposition processes, detailing their distinct characteristics, future prospects, and common applications - such as enhancing energy efficiency, wear resistance, and corrosion resistance. The primary focus is on physical and chemical vapor deposition techniques. Generally, thin films with minimal thickness are produced through physical vapor deposition (PVD) and chemical vapor deposition (CVD). While PVD has its limitations, it remains a valuable method and is often more advantageous than CVD for depositing thin film materials. The paper also explores notable similarities and differences between these specific methods, and categorizes sub-methods that share common principles.

KEYWORDS:

Thin Film, deposition methods, evaporation, Sputtering.

I. Introduction:

Thin film deposition refers to the process of applying thin film coatings onto a substrate material, which can be composed of various materials and possess a diverse range of characteristics capable of enhancing or altering the substrate's performance [1]. Because of their potential technological value and scientific interest in their properties, a wide variety of materials have been synthesized as thin films.

These thin films serve a broad range of applications, from nanoscale structures to large coatings on window glass. Researchers have explored numerous techniques in order to identify the most reliable and cost-effective methods for producing thin films. These techniques are generally categorized into two main groups based on the deposition process: physical deposition and chemical deposition methods [2].

The structure of the review work is as follows: Section 2 offers a concise comparison between Chemical Vapor Deposition and Physical Vapor Deposition. Section 3 outlines the various methods used for the deposition of thin films.

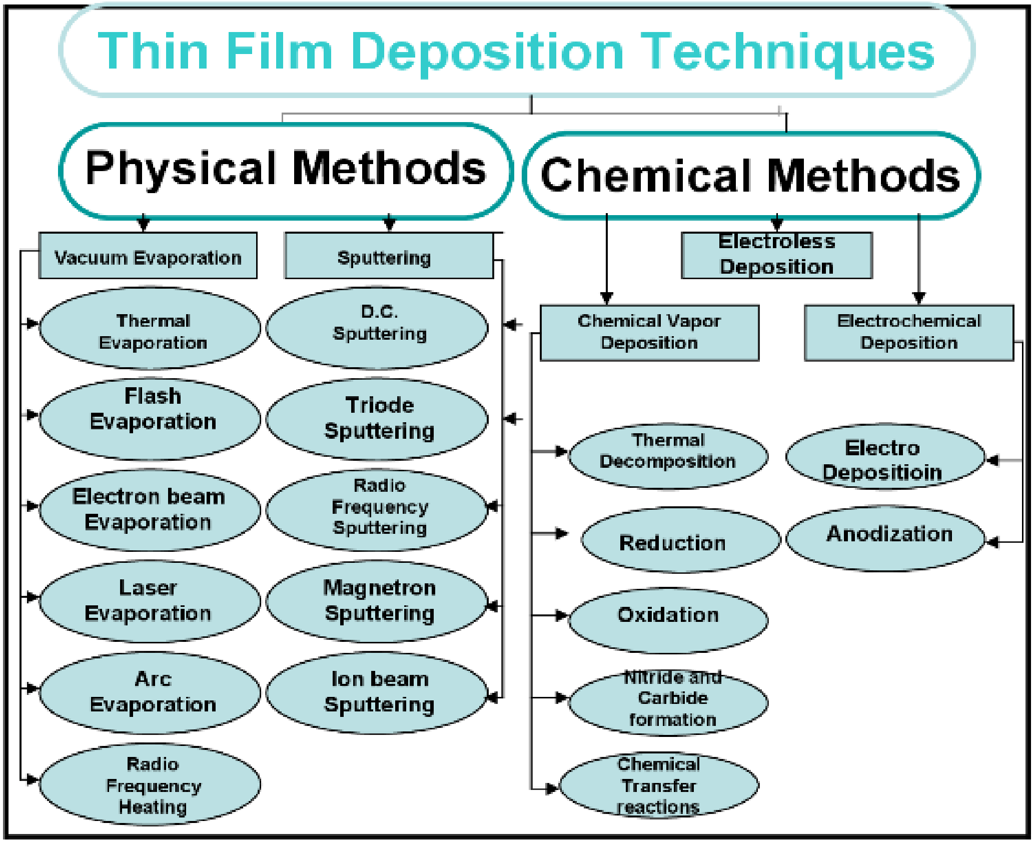

Figure 1: Different Thin Film Deposition Techniques.

II. Comparative study of PVD and CVD:

The deposition process is categorized into two types: physical vapor deposition (PVD) and chemical vapor deposition (CVD), based on the distinct principles underlying the film deposition methods [3]. The contrast between PVD and CVD is detailed in the following table. The primary disparity between PVD and CVD lies in the physical state of the coating material: in PVD, the material is in solid form, whereas in CVD, it is in gaseous form.

Table I: Difference Between PVD and CVD

Description	CVD	PVD
Source material state	Gas precursor	solid
Process	Chemical reaction in gaseous phase, importance of fluid dynamics	Evaporation and collision impact on the solid target
Temperatures	Higher, appx 600-1100 °C	Lower, appx below 450 °C
Layers	Multi-layer possible	Majorly single layer
Coating thickness	Thicker and thin both	Thin
Wear resistance, toughness	High, low	Less, higher
State of stress in coating	Tensile	Compressive
Used for	Elements, compounds, alloys difficult	Alloys easily
Process, Material	Each process is material specific	One process, many materials
Line of sight	Not needed	Needed
Step Coverage	Better (50-100%), can even fill gaps	Poor

A. Physical Vapour Deposition (PVD) Method:

PVD, which stands for Physical Vapor Deposition, comprises a range of thin film deposition techniques. Within PVD, a solid material is vaporized within a vacuum environment and then applied onto substrates either as a pure material or an alloy composition. This vaporization process either causes the material to evaporate or to be sputtered, generating a gaseous plume or beam that deposits a film onto the substrate. PVD refers to a collection of thin film deposition techniques in which a solid material is vaporized within a vacuum and then deposited onto a substrate [4].

Coatings generated through this technique demonstrate high durability, resistance to scratching and corrosion, and suitability for a variety of applications, from solar cells to eyeglasses and semiconductors. PVD presents numerous advantages, such as creating tough coatings that can resist corrosion and scratching, as well as producing thin films capable of withstanding high temperatures. However, PVD may involve higher costs compared to other thin film deposition methods, and the expenses can vary across different PVD techniques. Furthermore, PVD is an environmentally friendly process, as it reduces the use, management, and disposal of toxic substances in comparison to "wet" processes involving fluid precursors and chemical reactions. Due to its capacity to generate exceptionally pure, clean, and durable coatings, Physical Vapor Deposition is particularly favored in the surgical and medical implant industries. The most prevalent types of PVD include evaporation and magnetron sputtering [5].

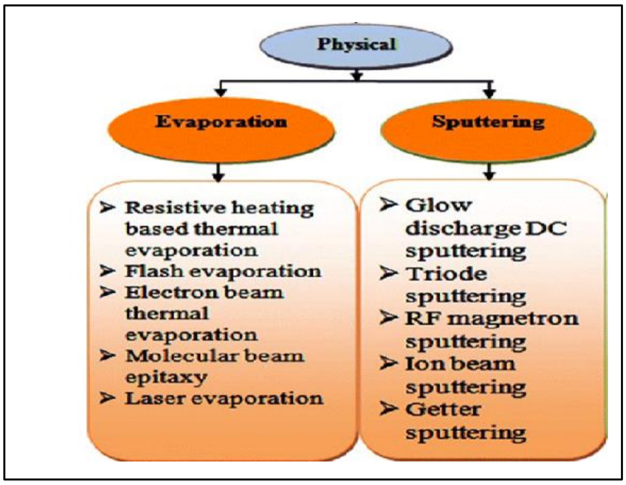

Figure 2: Different Physical Vapour Deposition Methods.

III. Deposition Methods:

In the evaporation process, the thin film material—such as metals, alloys, or compounds—is heated until it reaches its evaporation point and transforms into vapor. This vapor then moves through the vacuum chamber and deposits onto the substrate, creating a thin layer. The substrate is typically positioned at a specific angle or distance from the evaporation source to manage the thickness and uniformity of the deposited film.

The main factors influencing the evaporation process are the temperature of the evaporation source, the pressure within the vacuum chamber, the distance between the source and the substrate, and the angle of the substrate[6-7]. By adjusting these parameters, the desired properties of the thin film—such as thickness, composition, and surface morphology—can be achieved.

In essence, the evaporation process utilized for thin film deposition entails heating a material to the point of vaporization, after which the vapor is deposited onto a substrate to create a thin layer. This method is extensively utilized due to its capability to generate consistent, high-quality thin films ideal for a diverse array of applications, such as optics, electronics, and coatings [8].

A. Electron-beam evaporation:

In E-beam evaporation, a vacuum chamber is utilized along with an electron gun, a material source (typically in a crucible or filament form), and a substrate holder. The vacuum environment is crucial to prevent contamination and unwanted reactions during deposition.

The process starts with the material to be deposited placed in the crucible or filament inside the vacuum chamber. Once the vacuum is established, the electron gun emits a high-energy electron beam directed at the material source. This bombardment of electrons causes rapid heating of the material, leading to its sublimation from solid to vapor phase.

The material that has been vaporized travels in straight paths within the vacuum chamber and then condenses onto an adjacent substrate, usually cooled to guarantee uniform film growth and property control. E-beam evaporation enables precise management of deposition rates and film thickness, facilitating the creation of top-quality films with exceptional adhesion and uniformity. This method is capable of depositing a wide variety of materials, encompassing metals, oxides, and semiconductors [9].

Nevertheless, E-beam evaporation has its constraints. It can potentially harm delicate substrates as a result of high-energy electron bombardment, and certain materials may demonstrate inadequate thermal stability or reactivity with the electron beam. Furthermore, the procedure may be relatively sluggish when weighed against alternative deposition methods like sputtering. Despite these limitations, E-beam evaporation continues to be a versatile and essential technique for thin film deposition, playing a substantial role in driving progress across various technological applications.

B. Molecular Beam Epitaxy (MBE):

Molecular Beam Epitaxy (MBE) stands as an advanced method employed for depositing thin films with precision at the atomic level. Below is an elaborate overview of MBE and its applications:

1) What is MBE?

MBE is a method utilized for precision deposition of thin films at the atomic level. This technique entails the deposition of individual atoms or molecules onto a substrate, leading to the creation of high-quality crystalline films.

2) Process of MBE:

- ***Evaporation:*** In MBE, the typical process entails heating solid source materials within a vacuum to produce a stream of evaporated atoms or molecules. Subsequently, these evaporated species are directed onto a heated substrate, where they condense and form a thin film.
- ***Control and Monitoring:*** The procedure necessitates accurate control and monitoring of the beam flux, substrate temperature, and additional parameters to attain the targeted characteristics of the film.
- ***Layer-by-Layer Growth:*** MBE enables incremental layering in the growth of thin films, allowing for meticulous regulation over the composition, thickness, and structure of the deposited material.

3) Applications:

a) Semiconductor Devices: MBE is widely employed in the fabrication of semiconductor devices, including quantum wells, heterostructures, and superlattices, because it can precisely engineer material properties at the atomic scale.

***b) Quantum Dots and Nanowires*:** It is applied in methods such as MBE for the fabrication of quantum dots and nanowires, requiring precise management of material properties crucial to their functionality.

c) ***Topological Insulators*****:** MBE has contributed to the advancement of topological insulators, a class of materials with unique electronic properties.

4) Advantages of MBE:

a) ***Precise Control:*** MBE provides exceptional control over the deposition process, resulting in high-quality films with atomic precision.
b) ***Low Contamination*****:** The high vacuum environment minimizes contamination during film deposition, leading to pure, high-quality films.
c) ***Research and Development*****:** MBE is extensively utilized in material research and development for its capability to produce custom materials with specific properties. Thermal evaporation is another commonly used technique for depositing thin films, and it differs from Molecular Beam Epitaxy (MBE).

C. Thermal Evaporation:

Thermal evaporation entails heating a solid source material in a vacuum chamber until it vaporizes. The vaporized material then condenses onto a substrate, creating a thin film. This process usually occurs in a high-vacuum environment to avoid contamination and maintain the purity of the deposited film.

1. Process of Thermal Evaporation:

a) ***Heating Source Material*****:** The solid material (often a metal or semiconductor) is heated to its evaporation temperature, causing it to transition directly from solid to vapor phase.
b) ***Deposition onto Substrate:*** The vaporized material moves toward a substrate, where it condenses to create a thin film.
c) ***Controlled Thickness*****:** The film thickness is regulated by the duration of the deposition process and can be monitored in real-time using methods such as quartz crystal microbalances or film thickness monitors.

2. Applications:

a) ***Thin Film Coatings:*** Thermal evaporation is employed to create coatings with a range of properties, including optical coatings, protective layers, and conductive coatings.
b) ***Semiconductor Fabrication:*** It is used in the fabrication of thin film transistors, metal contacts, and various semiconductor devices.

3. Advantages of Thermal Evaporation:

a) ***Cost-Effective:*** Thermal evaporation presents a comparatively cost-effective approach for thin film deposition in contrast to methods such as MBE.
b) ***Uniform Coatings:*** It can produce uniform coatings over extensive areas, making it ideal for industrial-scale applications.

D. Arc Vapor Deposition (AVD):

1. Process of Arc Vapor Deposition:

a) ***Arc Generation:*** A high-voltage electrical discharge creates an arc between the target material (cathode) and an anode, leading to the vaporization of the target material.
b) ***Film Deposition:*** The condensed vapor material forms a thin film as it settles onto a substrate.
c) ***Controlled Fabrication:*** The procedure allows for exact regulation of parameters such as arc current, voltage, and deposition time to attain the targeted characteristics of the film.

2. Applications:

a) ***Wear-Resistant Coatings*****:** Arc vapor deposition is used to produce wear-resistant coatings on tools, machine components, and industrial equipment, enhancing their longevity and performance.
b) ***Decorative Coatings:*** This method is utilized in creating decorative coatings for architectural, automotive, and consumer goods, offering both aesthetic enhancement and protection.
c) ***Tribological Coatings:*** This method is employed in the fabrication of tribological coatings designed to minimize friction and wear on mechanical components and surfaces.

3. Advantages of Arc Vapor Deposition:

a) ***High Adhesion and Density:*** Arc vapor deposition yields dense and adherent coatings because the kinetic energy of the vaporized particles enhances their impact on the substrate.
b) ***Uniformity*****:** The process can produce highly uniform coatings over extensive substrate areas, making it well-suited for industrial-scale applications.
c) ***Range of Materials*****:** It can be utilized with a variety of target materials, including metals, ceramics, and certain polymers, providing versatility in film composition.

E. Sputtering:

Sputtering, widely employed for thin film deposition, entails bombarding a target material with high-energy particles to eject atoms and create a thin film on a substrate. The following presents a comprehensive examination of the sputtering process, its diverse applications, and its advantages.

Sputtering for Thin Film Deposition:

1. Process of Sputtering:

a) ***Bombardment of Target Material:*** High-energy ions or electrons are used to bombard a target material, causing atoms to be ejected from the target surface.

b) ***Thin Film Formation:*** The atoms that are ejected travel towards the substrate where they condense, resulting in the formation of a thin film that mirrors the composition of the target material.

c) ***Control over Properties*****:** The process of sputtering allows for meticulous control of parameters such as gas pressure, target material, and substrate temperature, thereby customizing the properties of the film.

2. Applications:

a) ***Optical Coatings:*** Sputtering is essential in the production of optical coatings on lenses, mirrors, and other optical components in applications like cameras, telescopes, and microscopes.

b) ***Solar Cells:*** The method is utilized in the fabrication of thin film photovoltaic cells, which requires precise control over material properties and film uniformity is crucial for efficiency.

3. Advantages of Sputtering:

a) ***Uniform Film Deposition*****:** Sputtering has the capability to produce highly uniform and conformal coatings, making it well-suited for applications that require precision in controlling both thickness and composition.

b) ***Material Versatility:*** This technique can be utilized across a diverse range of materials, encompassing metals, insulators, semiconductors, and transparent conductive oxides.

c) ***High-Density Films*****:** The sputtering process can produce dense, high-quality films that adhere well to the substrate.

F. Magnetron Sputtering:

This technique incorporates a magnetron to enhance the sputtering process, where atoms are ejected from a target material by high-energy particle bombardment. It can be applied with a wide range of materials.

1. Operation of Magnetron Sputtering:

a) ***Target Material:*** The material intended for deposition as a film is positioned as the target within the vacuum chamber.

b) ***Creation of Plasma:*** In magnetron sputtering, a magnetic field is employed to trap electrons, resulting in the creation of a high-density plasma. This boosts the sputtering process by elevating the kinetic energy of the sputtered atoms.

c) ***Sputtering Process:*** Argon gas is introduced into the chamber, where the plasma accelerates argon ions to bombard the target material, leading to the ejection of atoms from the target.

d) ***Film Deposition:*** The atoms that have been ejected travel towards the substrate and condense, resulting in the formation of a thin film. The substrate, positioned in front of the target material, collects the sputtered atoms, allowing them to accumulate and form the intended thin film.

2. Advantages of Magnetron Sputtering:

a) ***Uniform Coating:*** Magnetron sputtering generally produces a more uniform film thickness compared to other deposition techniques.
b) ***Control over Film Properties:*** The deposition parameters can be adjusted to control the properties of the deposited film, such as thickness, composition, and microstructure.

3. Applications:

Magnetron sputtering finds extensive use in various industries, including:

- Semiconductor manufacturing
- Solar cell production
- Display and touch panel coating
- Architectural glass and automotive glass coating
- Data storage media production

G. Ion Beam Sputtering:

Ion Beam Sputtering is a physical vapor deposition (PVD) method that entails bombarding a target material with a high-energy ion beam. Subsequently, the atoms or molecules ejected from the target are deposited onto a substrate to generate a thin film.

1. Operation of Ion Beam Sputtering:

a) ***Ion Source*****:** In Ion Beam Sputtering, an ion source generates a beam of ions, typically inert gases like argon or oxygen.
b) ***Target Material:*** The target material to be sputtered is positioned inside the vacuum chamber.
c) ***Ion Bombardment*****:** The high-energy ions generated by the source are directed towards the target material. The ions bombard the target surface, causing atom displacement and ejection of material.
d) ***Deposition:*** The sputtered atoms from the target material travel to the substrate and condense to create a thin film with the desired properties.

2. Advantages of Ion Beam Sputtering:

a) ***Controlled Energy*****:** Ion Beam Sputtering enables precise control over the energy of the ions used for bombardment, enabling tailored film properties.
b) ***High Purity Films:*** The process can produce high-purity films with low levels of impurities, suitable for applications requiring superior cleanliness.

3. Applications of Ion Beam Sputtering:

a) ***Precision Optics*****:** Used in fabrication of precision optical coatings for lenses and mirrors.

b) ***Semiconductor Industry:*** Used in manufacturing of semiconductor devices and thin film transistors.

H. Pulsed Laser Deposition (PLD):

Pulsed Laser Deposition is an exceptionally precise physical vapor deposition (PVD) method that employs a high-energy pulsed laser to ablate a target material and subsequently apply it as a thin film onto a substrate. Let's explore the details of Pulsed Laser Deposition.

1. Operation of Pulsed Laser Deposition:

a) ***Pulsed Laser:*** A high-energy laser is directed at the target material within a vacuum chamber, leading to the rapid vaporization and ionization of the material.
b) ***Plume Formation*:** This process creates a plume of vaporized target material, consisting of energetic atoms, ions, and clusters.
c) ***Film Deposition:*** The energetic species from the plume moves across the vacuum chamber and condenses onto the substrate, creating a thin film.

2. Advantages of Pulsed Laser Deposition:

a) ***Stoichiometric Control:*** PLD enables accurate control of stoichiometry, making it ideal for depositing complex compounds and multicomponent materials with the desired composition.
b) ***Versatility*:** It can apply a broad variety of materials.

I. Direct current (DC) sputtering:

Let's delve into the specifics of DC sputtering:

1. Operation of DC Sputtering:

a) ***Target Material:*** The material intended for deposition as a thin film is positioned as the target inside a vacuum chamber.
b) ***Gas Introduction*:** In DC sputtering, an inert gas, like argon with low pressue is introduced into the chamber.
c) ***Ionization of Gas:*** A direct current is applied to the target material, producing a potential difference that leads to the ionization of the inert gas.
d) ***Sputtering Process:*** The positively charged ions of the inert gas bombard the target material, causing atoms to be ejected from the target.
e) ***Deposition:*** The ejected atoms move through the vacuum chamber and deposit onto the substrate, creating a thin film with the desired characteristics.

2. Advantages of DC Sputtering:

a) ***High Deposition Rate:*** DC sputtering can achieve relatively high deposition rates, making it suitable for industrial-scale production.

b) ***Simple Setup:*** The equipment required for DC sputtering is relatively simple, making it cost-effective and easier to maintain.

3. Applications of DC Sputtering:

a) ***Semiconductor Industry:*** It is used to deposit thin films in integrated circuit manufacturing.
b) ***Glass Coatings:*** It finds application in depositing transparent conducting oxide (TCO) coatings on glass for applications in solar panels, display technologies, and architectural glass.
c) ***Data Storage:*** DC sputtering is employed in the manufacturing of thin film magnetic recording media for data storage.

J. RF Sputtering:

RF sputtering, also known as radio frequency sputtering, is a physical vapor deposition (PVD) technique that employs radio frequency energy to sputter a target material and then deposit it as a thin film onto a substrate. Renowned for its ability to provide exact control over film properties, this method is widely embraced across various industries. Here, we will outline the key characteristics of RF sputtering:

1. Operation of RF Sputtering:

a) ***Target Material:*** The material intended for deposition as a thin film is positioned as the target within a vacuum chamber.
b) ***Gas Introduction:*** An inert gas, typically argon, is introduced into the chamber at a low pressure.
c) ***Application of Radio Frequency*****:** A radio frequency (RF) power source is employed to ionize the inert gas, creating a plasma within the chamber.
d) ***Ion Bombardment:*** The positively charged ions in the plasma are driven towards the target material by the applied electric field. These ions collide with the target, causing atoms to be ejected from it.
e) ***Deposition:*** The ejected atoms move through the vacuum chamber and deposit onto the substrate, forming a thin film with the desired characteristics.

2. Advantages of RF Sputtering:

a) ***Controlled Film Properties:*** RF sputtering provides precise control over film composition, structure, and thickness, making it ideal for various applications.
b) ***High Uniformity*****:** It can provide high uniformity in coating thickness across large substrate areas, ensuring consistent film properties.
c) ***Low Substrate Heating:*** The minimal substrate heating during RF sputtering makes it ideal for depositing thin films on heat-sensitive materials.

3. Applications of RF Sputtering:

a) ***Semiconductor Devices:*** RF sputtering is widely employed in production of integrated circuits, diodes, and transistors.

b) ***Optical Coatings:*** It is used for depositing optical coatings on lenses, mirrors, and other optical components.
c) ***Solar Cells:*** *RF sputtering is employed in the manufacturing of thin film solar cells, which play a vital role in renewable energy technologies.*

K. Evaporation:

1. ***Mechanism:*** In evaporation, the source material is heated to produce vapor, which subsequently condenses onto a substrate to create a thin film.
2. ***Energy Source:*** Heat energy is primarily used to vaporize the source material, either by resistive heating, electron beam heating, or thermal evaporation.
3. ***Directionality:*** The vapor stream moves in straight lines from the source to the substrate, leading to line-of-sight deposition, which can be less effective for coating substrates with complex geometries.
4. ***Uniformity:*** Evaporation may exhibit less uniform film thickness distribution for complex or large-area substrates due to its line-of-sight nature.
5. ***Applications:*** It is frequently used for depositing metals, metal oxides, and organic materials in applications like optoelectronics, decorative coatings, and semiconductor devices.

L. Sputtering:

1. ***Mechanism:*** Sputtering involves bombarding a target material with energetic particles, typically ions, to eject and deposit atoms onto a substrate.
2. ***Energy Source:*** The bombardment energy is commonly delivered through various methods, including direct current (DC), radio frequency (RF), magnetron, or ion beam sputtering.
3. ***Directionality:*** Sputtering can offer more isotropic (non-line-of-sight) coverage, enabling more effective coating of complex and three-dimensional substrates.
4. ***Uniformity:*** Because it can eject atoms from a target in multiple directions, sputtering can achieve greater film thickness uniformity across different substrate geometries.
5. ***Applications:*** Sputtering is extensively used in the semiconductor industry, optical coatings, precision optics, photovoltaics, and magnetic storage media due to its capability to deposit a diverse range of materials while maintaining precise film properties.

IV Conclusion:

In summary, although both evaporation and sputtering are physical vapor deposition (PVD) techniques for applying thin films, they differ in their mechanisms, directionality, and uniformity. Evaporation uses heat to vaporize the source material, often leading to line-of-sight deposition, while sputtering ejects atoms from a target using energetic bombardment, resulting in more isotropic coverage and better performance on complex substrates. Each method has its advantages and is selected based on the specific needs of the thin film deposition process.

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46. Designing the Arduino Based Nutrition Feeding Hydroponic System

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ABSTRACT:

Hydroponics, a modern farming technique that eliminates the need for soil, employs water enriched with nutrients to facilitate plant growth. This study focuses on developing an automated system for distributing water and nutrients to plants, equipped with sensors to monitor water levels and nutrient concentrations. The system includes a TDS sensor for measuring electrical conductivity, an Arduino UNO R3 for processing, and a proximity sensor for detecting water levels.

KEYWORDS:

Hydroponics, TDS, Arduino UNO.

I. Introduction:

The Extreme weather changes and polluted soil and air can cause problems for plants grown in open fields. To tackle this, hydroponics is becoming popular in farming. It doesn't use soil; instead, it uses water mixed with nutrients for plants to grow. These nutrients are important for plant growth and are measured using something called Electrical Conductivity (EC). EC tells farmers how much nutrients are in the water for plants to absorb. If EC is too low, plants won't grow well, but if it's too high, plants might not be able to absorb the nutrients properly, causing problems like poisoning. Monitoring EC helps farmers make sure plants get the right amount of nutrients to grow well

For plants to grow well, they need the right water, nutrients, and enough air. These factors help plants absorb nutrients, which they use to make energy. Roots use this energy to take in water and more nutrients from the water they're in. This whole process helps plants grow better. But if there's too much water, there might not be enough oxygen for the roots, which can slow down growth.

Using technology, like computers, helps make things easier. Automated systems can help monitor and control these factors, making sure plants get what they need to grow healthy and strong.

The development of science and technology, especially computer technology occurs rapidly. The scope of application of technology is also increasingly widespread, covering various aspects of human life so that efforts to meet human needs are increasing and complex. Computer technology can be positively correlated to improving the quality of life and human well-being. Rapid and accurate system automation is an important requirement that encourages the creation of automated tools. Devices that are integrated with various peripherals and other supporting devices make the performance of these technologies become more applicable and functional

In 2014, Qalyubi, Pudjojono and Widodo [8] conducted an experiment on the effects of water discharge and the provision of nutrients to the growth of kale plants (*Ipomoea aquatica forsk*) in the hydroponics NFT system. The results revealed that the EC or the concentration of hydroponic nutrition is very influential on the growth of kale plants. EC amounted to 460 ppm indicates the deficit of solution concentration, so that the kale plants grow slowly.

II. Method:

This section talks about how to make a system, like the one for hydroponics. There are four main steps: figuring out what the system needs to do, designing it, building it, and testing it.

First, you gather all the information about what the system should do, like picking the right sensors. This step also includes looking at experiments and research. The outcome of this step is a list of what the system should do, both the main things (functional) and other details (non-functional).

The main things the system should do include keeping the right level of nutrients in the water, adding water when needed, and reading data from sensors. It should also automatically add the right fertilizers and check the levels of nutrients in the water. Plus, it should adjust things like how much fertilizer to add.

The other details include what parts to use, like a specific microcontroller and power supply. The system should also work without needing a person to control it, and it should connect directly to the hydroponic system.

The second step is designing the system. This means taking all the information from the first step and figuring out how to put it together, both in hardware (like the physical parts) and software (like the computer programs). The result of this step is a plan showing how everything will work together.

In simple terms, during the third stage of system development, called system implementation, the actual hardware and software are put together and made ready to work. In this specific project, they're using an Arduino Uno R3 board, which is like the brain of the system. It has a microcontroller, which is like a tiny computer, along with some special sensors like the SHARP GP2Y0A21 and TDS sensor, and a servo motor actuator. These sensors help to detect things like the water level and the quality of the hydroponic nutrient solution in a container. Based on this information, the system decides when to turn on or off the water or fertilizer faucets using the servo motor.

To put it simply, "close the faucet head" means to shut off the water or fertilizer flow. In this project, they're using a software called Arduino IDE, which is like a tool to tell the system what to do. It's installed on a computer running Windows 10, and it helps to program the hardware, like telling the system when to open or close the faucets based on the information from the sensors.

The last stage of system development is called system testing. Here, they collect data to check if both the hardware and software are working correctly. They look at the information gathered from earlier stages, like the design and implementation phases, and see if everything matches up. They run tests to make sure input devices, like sensors, and external devices, like the servo motor, are working properly. They also check if the system does what it's supposed to do based on its requirements, like turning on or off the faucets at the right times.

III. Results and Analysis:

After going through all the steps of building the system, the next thing to do is to gather all the data from the tests and describe what happened. This includes discussing and analysing the results. Beforehand, the system's design was made, which includes diagrams showing how the hardware parts are connected and how the software works.

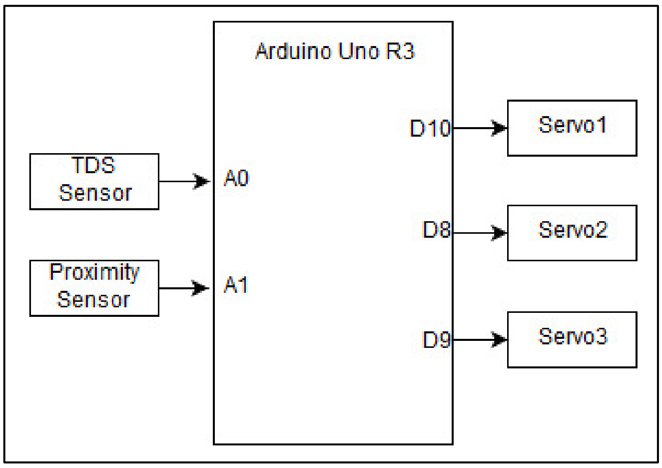

Figure 1: Block diagram of hydro phonics

The software part also has diagrams, like flowcharts, to show how different parts of the program work. For instance, Figure 2 shows a flowchart for the setup part of the software, which is called "void setup ()". It's like setting up the stage before the play begins.

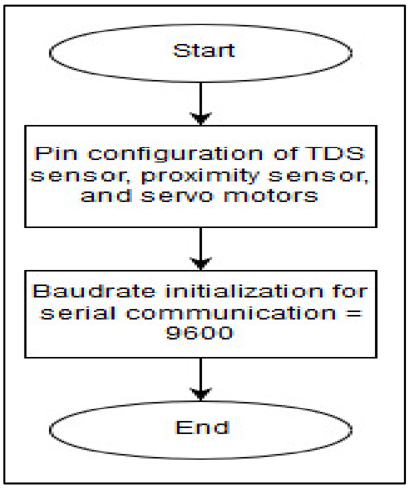

Figure 2: Flowchart of system initialisation

Next, the void loop () function, which is a function that will run continuously, contains a call to drive the main function of the system. Figure 3 shows the flow chart of the function of the void loop () system.

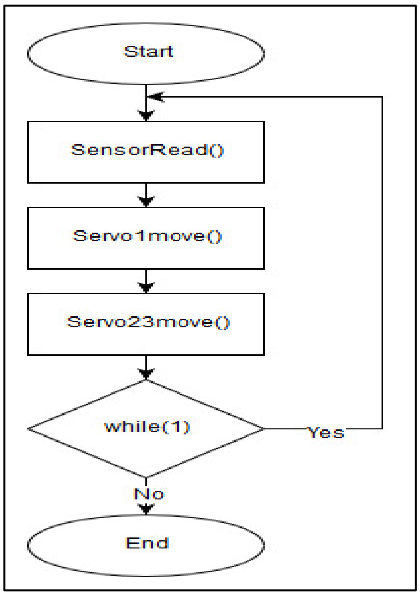

Figure 3: Flow Chart of Hydro Phonics System

The hardware implementation means putting together all the physical parts that have been made. So, in this case, they've used an Arduino Uno R3 board, which is like the brain of the system. It's connected to different sensors: one to measure how much stuff is in the water (TDS sensor), another to see how high the water is (distance sensor), and three actuators that move things around (servo actuators). So, basically, they've built a system using these parts to control and monitor things.

Set up the hardware directly onto a small-scale model of a hydroponic system with 12 holes for plants. To connect everything, they've used a prototype shield that plugs into the Arduino Uno R3 board. This shield has enough pins to attach all the parts they need for the system. They've put the Arduino board and the prototype shield on top of the container that holds the nutrients for the plants. So, everything is connected and mounted in one place, like in the picture they've shown in Figure.

Figure A: Hydroponics System Setup

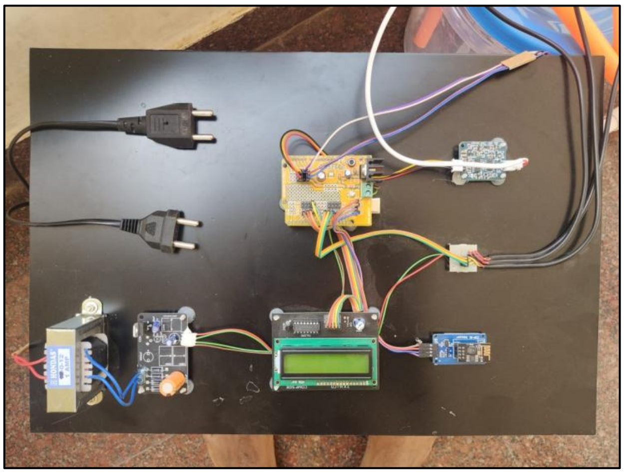

Figure B: Circuit Diagram of Hydro Phonics

Figure C: Seedling Setup

Implementing software like building a robot using a special toolkit called Arduino IDE version 1.6.5. You use a language called C to tell the robot what to do. The software is made by writing instructions for the robot in three main parts:

1. Initial declaration This part sets up everything the Arduino needs, like the tools it will use.
2. Void setup () function Here, you tell the Arduino what to do when it starts up, like turning on its sensors.
3. void loop () function This is where you tell the Arduino what to do over and over again, like moving around or checking for obstacles.

So, when you implement software, you're basically giving instructions to a system, step by step, to make it do what you want.

Initializing and declaring global variables Before we start, we need to set things up and tell our system about some important stuff that we'll be using throughout the process.

Void setup () function This is like the setup phase where we get everything ready. In this case, it's about connecting our device (like the Arduino) and making sure it can talk to the computer. This part also includes:

- Declaring which pins on the Arduino will be connected to different things.
- Turning on communication with sensors and motors, like TDS sensors, GP2Y0A21 sensors, and a servo motor.

Testing the system First, we check each sensor and input devices to make sure they're working correctly. Then, we test the output devices to see if they respond as expected. Finally, we do an overall test to make sure the whole system does what it's supposed to do.

Testing the TDS sensor to check the TDS sensor, we compare its readings with a known device called a TDS meter. We convert the sensor's analog voltage into parts per million (PPM) using a formula.

This formula uses the sensor's voltage output and compares it with the value measured by the TDS meter. We repeat this test 10 times, placing the sensor and the TDS meter close together. Then, we plot the data on a graph to see how well the sensor matches the TDS meter readings

Testing the outlet device (servo motor) We check if the output of the servo motor matches what we told it to do. In this system, we only have one outlet device, which is a servo motor. This motor controls the faucet of containers for water and fertilizer.

Servo motor testing We want to make sure the servo motor works correctly. We test it by commanding it to move to two positions:

- Open the faucet (move to position 30 degrees).
- Close the faucet (move to position 100 degrees).

Testing the whole system: After checking the inlet (like sensors) and outlet (like motors) devices separately, we test the entire system altogether. The whole system is made up of parts that we've already tested individually. Once we put all these parts together, we can test how well they work as a complete system.

Comparative Analysis:

Table 1: Hydroponic Averages Compared with Ordinary Soil Yields

Name of Crop	Hydroponic Equivalent per Acre	Agricultural Average per Acre
Wheat	5,000 lb.	600 lb.
Oats	3,000 lb.	850 lb.
Rice	12,000 lb.	750-900 lb.
Maize	8,000 lb.	1,500 lb.
Soybean	1,500 lb.	600 lb.
Potato	70 tons	8 tons lb.
Beet root	20,000 lb.	9,000 lb.
Cabbage	18,000 lb.	13,000 lb.
Peas	14,000 lb.	2,000 lb.
Tomato	180 Tones	5-10 Tones
Cauliflower	30,000 lb.	10-15,000 lb.
French bean	42,000 lb. of pods for eating	-
Lettuce	21,000 lb.	9,000 lb.
Lady’s finger	19,000 lb.	5-8,000 lb.
Cucumber	28,000 lb.	7,000 lb.

IV Conclusion:

This study aims to explore how to make a small-scale automatic NFT hydroponic system using TDS sensors. The research found that this system can accurately measure the level of solutes in the nutrient solution using TDS sensors, which are measured in parts per million (PPM). The system can automatically add nutrients to maintain a minimum concentration of 800 ppm in the solution. The TDS sensor, when converted from voltage units to PPM, showed an accuracy of 97.8%. The researchers also developed software to control the hardware components based on the system's requirements, Overall, the designed system meets all the planned functional requirements for automated nutrient delivery in NFT hydroponic

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47. Multilingual Regional Speech Classification Using Recurrent Neural Networks

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ABSTRACT:

This study addresses the classification of ten regional languages using Recurrent Neural Networks (RNNs) based on Mel-Frequency Cepstral Coefficients (MFCCs) extracted from audio recordings. The languages under consideration include Kannada, Hindi, Marathi, Telugu, Malayalam, Bengali, Gujarati, Punjabi, Tamil, and Urdu. Motivated by the need for robust multilingual speech recognition systems that can accommodate linguistic diversity, this research aims to explore the effectiveness of RNNs in handling diverse language datasets. Despite advances in speech recognition, there remains a research gap in the development of models that accurately classify a wide range of regional languages using limited training data. This study addresses this gap by leveraging deep learning techniques and extensive data preprocessing to enhance classification accuracy. The RNN architecture comprises two LSTM layers augmented with batch normalization and dropout layers for regularization. Experimental results demonstrate promising outcomes with a training accuracy of 73.00% and a test accuracy of 64.33%, showcasing the model's capability to distinguish between the diverse phonetic and linguistic features of the selected languages. Applications of this research include enhanced speech recognition systems for diverse linguistic communities, automated language identification in multilingual environments, and preservation of linguistic heritage through technology-driven approaches. This study underscores the potential of RNNs in advancing the field of multilingual speech processing and contributes valuable insights into addressing the challenges of language diversity in artificial intelligence applications.

KEYWORDS:

Regional Languages, Recurrent Neural Networks (RNNs), Mel-Frequency Cepstral Coefficients (MFCCs), Speech Recognition and Multilingual Classification.

I. Introduction:

The rapid advancement of speech recognition technology has significantly transformed the way we interact with machines and digital systems. From voice-activated assistants to automated customer service systems, speech recognition has become an integral part of our daily lives. However, the majority of these systems are predominantly tailored to handle a limited number of globally dominant languages, such as English, Spanish, and Mandarin. This limitation poses a significant challenge in linguistically diverse regions where a multitude of languages and dialects are spoken.

India, for instance, is a country with a rich tapestry of languages, each with its unique phonetic and linguistic characteristics. The inability of current speech recognition systems to effectively process and classify regional languages limits their applicability and utility in such multilingual environments. There is a pressing need for robust multilingual speech recognition systems that can accurately recognize and classify a wide range of regional languages. This study aims to address this gap by exploring the potential of Recurrent Neural Networks (RNNs) in the classification of ten regional languages using audio recordings.

In the contemporary world, security remains a paramount concern across various sectors, particularly in financial institutions such as banks. The rise in theft incidents and sophisticated intrusion techniques necessitates the development of advanced security systems that can effectively safeguard valuable assets. Traditional security measures, although essential, often fall short in providing real-time detection and prevention capabilities. Consequently, there is a compelling need for innovative security solutions.

The primary objective of this research is to develop and evaluate a robust RNN-based model for the classification of ten regional languages, namely Urdu, Kannada, Hindi, Marathi, Telugu, Malayalam, Bengali, Gujarati, Punjabi, and Tamil. The study leverages Mel-Frequency Cepstral Coefficients (MFCCs) as the primary feature extraction technique from audio recordings. The specific objectives of this research are:

To design and implement an RNN architecture that can effectively classify audio recordings of ten regional languages.

To preprocess and augment the audio data to enhance the performance of the RNN model.

To evaluate the model's performance in terms of training and test accuracy.

To identify potential applications of the developed system in multilingual speech recognition and other related domains.

Despite the significant strides made in the field of speech recognition, there remains a noticeable gap in the development of models that can accurately classify a wide range of regional languages using limited training data. Most existing models are either not trained on diverse language datasets or lack the necessary robustness to handle linguistic variations effectively. This research seeks to fill this gap by employing deep learning techniques, specifically RNNs, which are well-suited for sequence modeling tasks such as speech recognition. The study also emphasizes extensive data preprocessing and augmentation to overcome the challenges posed by limited and diverse training data.

The contributions of this research are manifold. Firstly, it provides a comprehensive evaluation of the effectiveness of RNNs in the classification of regional languages, offering valuable insights into the potential and limitations of such models. Secondly, it highlights the importance of data preprocessing and augmentation in enhancing model performance, which can serve as a reference for future studies in this domain.

The applications of this research are far-reaching. Enhanced speech recognition systems that can cater to diverse linguistic communities will significantly improve accessibility and user experience in multilingual environments. Automated language identification systems can be employed in various sectors, including customer service, education, and healthcare, to provide tailored services based on the detected language. Furthermore, the preservation of linguistic heritage through technology-driven approaches will ensure that regional languages continue to thrive in the digital age.

II. Literarure Survey:

Burchi et al. [1] introduced a model that sets a new state-of-the-art performance on the LRS3 dataset, achieving a Word Error Rate (WER) of 0.8%. Additionally, on the newly established MuAViC benchmark, their model demonstrates an absolute average-WER reduction of 11.9% compared to the original baseline. Notably, this model is capable of performing audio-only, visual-only, and audio-visual speech recognition during testing, showcasing its versatility and effectiveness.

Gupta et al. [2] developed a CNN-based Automatic Speech Recognition System (ASRS) that models raw speech signals. The speech corpus, created by the researchers, includes recordings in Hindi, English, Punjabi, and Bengali, performed by 50 male native speakers of Hindi and Punjabi who could also speak English and Bengali. Using Mel-Frequency Cepstral Coefficient (MFCC) for feature extraction, they designed a 2D CNN model with six layers to recognize speech samples in each language.

Praveen et al. [3] describe the SRI-B systems proposed for task-1 of the inaugural MERLIon CCS challenge in both closed and open domains. For the closed task, they used an end-to-end conformer architecture trained for automatic speech recognition (ASR) with RNN-T loss, later adapted for language classification. This system achieved a 13.9% Equal Error Rate (EER) and 81.7% Balanced Accuracy (BAC) on the evaluation set. For the open track, an ensemble of OpenAI's Whisper model and one of the ASR models from the closed track was used, achieving 9.5% EER and 78.9% BAC. Compared to the challenge baseline, the closed track system showed a 35.9% relative improvement in EER, and the open track system showed a 56.2% improvement.

Parashar et al. [4] present a system for multilingual speech sentiment recognition using spiking neural networks (SNNs), trained with Mel-frequency cepstral coefficients (MFCC) features. Experiments were conducted on a combined dataset of SAVEE (English), EMO-DB (German), EMOVO (Italian), and CaFE (French). The results show that SNNs achieved 76.85% accuracy, outperforming traditional artificial neural networks (ANNs) like MLP and RNN on this task.

Nuthakki et al. [5] proposed a method to address the complexities of voice synthesis with minimal aperiodic distortion, making it suitable for communication recognition models. Despite some audible flaws, the model closely mimics human speech. They emphasize the need for incorporating sentiment analysis into text categorization using natural language processing, considering the varying intensity of emotions across countries. To enhance voice synthesis, more hidden layers and nodes should be added to the mixture density network. The proposed algorithm requires a robust network foundation and optimization methods for optimal performance. The paper aims to provide both experienced researchers and beginners with insights into developing a deep learning approach, highlighting progress in overcoming fitting issues with limited training data and the need for more input parameter space in DL-based methods.

Abdal et al. [6] utilize a BiLSTM architecture to effectively capture both contextual and sequential dependencies in text data. Their model combines word embeddings with character-level embeddings to encapsulate semantic and morphological information in comments. The model's performance is compared with several advanced methods, including RNN and LSTM. Experimental results indicate that the proposed model excels in classifying multilingual toxic comments, achieving a superior accuracy of 94.21%.

Athish et al. [7] aim to enhance transcription accuracy by addressing challenges like speaker accents, background noise, and audio quality. They will test the system with diverse audio sources to ensure reliable transcription of various speech types. A report will detail the system's performance and limitations, accompanied by a working prototype. The findings will benefit industries relying on voice recognition and transcription technologies, improving communication, accessibility, and productivity.

Malik et al. [8] developed a framework comprising data preprocessing, RoBERTa-based data representation, fine-tuning, and hope speech classification into two labels. They created a new Russian corpus for hope speech detection from YouTube comments and conducted experiments using semi-supervised bilingual English and Russian datasets. The framework achieved benchmark performance, surpassing baseline methods. Specifically, the translation-based approach using Russian-RoBERTa achieved the highest accuracy of 94% and an F1-score of 80.24% in their experiments across English and Russian languages.

Mussakhojayeva et al. [9] developed a fine-tuning strategy for the Whisper model to enhance performance specifically for the Turkic language family and maintain high accuracy across high-resource languages. Their Soyle model demonstrated superior performance across 11 Turkic languages and official United Nations languages. They also introduced the first large open-source speech corpus for the Tatar language, TatSC, which significantly improved Tatar speech recognition accuracy. Emphasizing noise robustness, they have open-sourced both the model and TatSC to foster further research.

Their approach sets a precedent for creating multilingual speech recognition models tailored to low-resource language families.

Gutha et al. [10] outline the Code Fellas team's strategies for HASOC 2023 Task 4: Annihilate Hate, focusing on extending hate speech detection to Bengali, Bodo, and Assamese languages. Their methods leverage Long Short Term Memory (LSTM) with Convolutional Neural Networks (CNN), alongside pre-trained Bidirectional Encoder Representations from Transformers (BERT) models such as IndicBERT and MuRIL. Their findings highlight the effectiveness of these approaches, achieving notable results: IndicBERT attains a significant F1 score of 69.726% for Assamese, MuRIL achieves 71.955% for Bengali, and a BiLSTM model with an added Dense Layer achieves an impressive 83.513% for Bodo.

III. Methodology:

The audio data set [11] with ten Indian languages comprises of audio recordings in Kannada, Hindi, Marathi, Telugu, Malayalam, Bengali, Gujarati, Punjabi, Tamil, and Urdu is used for training the model. Among the total 1300 audio files of ten regional languages, 1000 audio files are used for training the model and 300 files are used for testing. This dataset is designed for tasks related to speech recognition and language processing. Each language category includes various audio samples recorded under different conditions, providing a diverse set of speech patterns and accents. The dataset is structured to facilitate research and development in multilingual speech analysis, with potential applications in automatic speech recognition, sentiment analysis, and dialect identification. Its availability on Kaggle ensures accessibility and encourages collaborative efforts in advancing speech technology across diverse linguistic contexts.

A. Input: The process begins with a collection of audio files encompassing diverse languages such as Kannada, Hindi, Marathi, Telugu, Malayalam, Bengali, Gujarati, Punjabi, Tamil, and Urdu. Each audio file serves as the raw input for subsequent processing stages aimed at classifying these languages effectively.

B. Data Preprocessing: Upon receiving the audio files, the first step involves loading each file into the system. This ensures that the audio data is accessible for further manipulation and feature extraction. Additionally, data augmentation techniques may be applied to enhance the robustness and variability of the dataset. Techniques such as pitch shifting or adding noise simulate different acoustic environments, thereby improving the model's ability to generalize across varied conditions.

C. Feature Extraction (MFCC): The heart of the preprocessing phase lies in extracting Mel-Frequency Cepstral Coefficients (MFCCs) from the audio signals. MFCCs are computed to capture the spectral characteristics of each audio segment. This involves breaking down the audio signal into short frames and computing the spectrum of each frame. The resulting coefficients represent the power spectrum of the audio signal, quantifying its frequency components. The Figure 1 illustrates the sequential steps of the proposed method for multilingual regional speech classification using Recurrent Neural Networks (RNNs). It starts with input audio files, undergoes data preprocessing including loading, augmentation, and feature extraction using Mel-frequency Cepstral Coefficients (MFCC), resulting in a structured MFCC feature matrix. The RNN model architecture, comprising LSTM layers with batch normalization and dropout for regularization, is trained using the feature matrix. Model evaluation is performed with performance metrics, and classification results in predicted language labels are obtained as output. This flowchart provides an overview of the methodology employed to classify audio samples into their respective regional languages.

D. Feature Extraction: The extracted MFCC features are structured into a matrix format. Each audio sample is represented as a sequence of MFCC vectors, where each vector contains coefficients representing different frequency bands. This structured representation forms the input data that will be fed into the Recurrent Neural Network (RNN) for language classification.

E. RNN Model Architecture: The RNN model architecture is designed to effectively process the structured MFCC features. It begins with an Input Layer that accepts the sequence of MFCC vectors. This is followed by two LSTM (Long Short-Term Memory) layers, chosen for their ability to model sequential dependencies in temporal data like speech. Batch Normalization layers stabilize and accelerate training by normalizing the activations of the LSTM outputs. Dropout layers are introduced to prevent overfitting by randomly dropping neurons during training. A Dense layer performs the final classification based on the learned features, with another Dropout layer for regularization, and an Output Layer produces predictions for the language labels based on the extracted features.

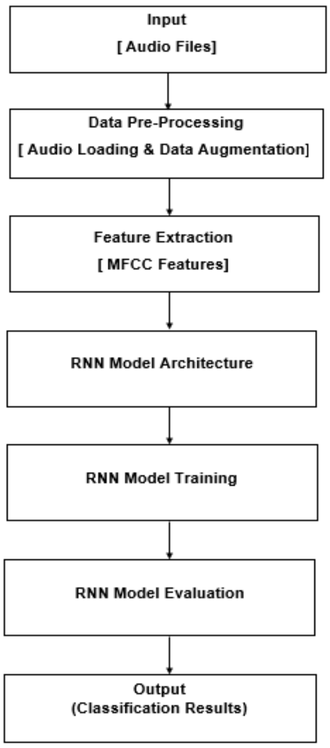

Figure 1: Flowchart of RNN Model

This architecture is designed to effectively capture temporal dependencies in audio data (MFCC sequences) and classify them into one of the ten regional languages considered in your dataset. Adjustments in dropout rates, LSTM units, or dense layer sizes can further optimize performance based on specific requirements and constraints of the dataset.

F. Model Training: Once the model architecture is established, it is trained using the structured MFCC features and corresponding language labels. During training, the model adjusts its parameters to minimize a specified loss function (such as categorical cross-entropy) using an optimizer (e.g., Adam optimizer). This iterative process fine-tunes the model's weights and biases to optimize its ability to classify the language of audio samples accurately.

G. Model Evaluation: After training, the model's performance is evaluated using a separate validation or test set of audio samples. Performance metrics such as accuracy, precision, recall, and F1-score are computed to assess how well the model classifies the language of the audio samples. These metrics provide insights into the model's effectiveness and its ability to generalize to unseen data.

H. Output: Finally, the model produces classification results where each audio file is assigned a predicted language label based on its MFCC features and the trained RNN model. These predicted labels provide actionable insights into the linguistic content of the audio files, demonstrating the efficacy of the RNN-based approach in multilingual speech classification tasks.

Table 1: Performance of RNN Model on Regional Language Classification

Sl. No.	RNN Model	Accuracy
1.	Training	73.00 %
2.	Testing	64.33 %

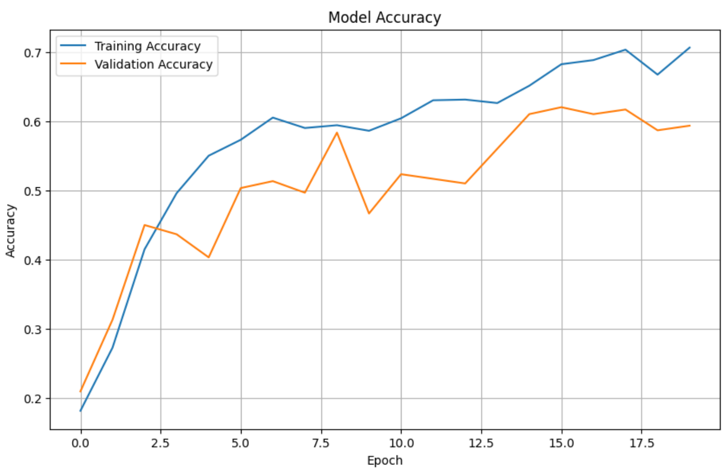

Figure 2: Training Accuracy vs. Validation Accuracy

This detailed explanation outlines each step of the flow chart diagram as shown in Figure 1, from initial data preprocessing and feature extraction to model architecture, training, evaluation, and final classification output. Each component plays a crucial role in achieving accurate and robust language classification using Recurrent Neural Networks (RNNs) and Mel-Frequency Cepstral Coefficients (MFCCs) extracted from audio recordings.

IV. Results and Discussion:

The table 1 summarizes the performance of the RNN model in terms of accuracy for both the training and testing datasets. The training accuracy is 73.00%, indicating that the model performs well on the data it was trained on. The testing accuracy is slightly lower at 64.33%, reflecting the model's performance on unseen data.

The Figure 2, shows the training and validation accuracy of the model over 20 epochs. The training accuracy (blue line) steadily increases from around 0.2 to 0.7, indicating effective learning.

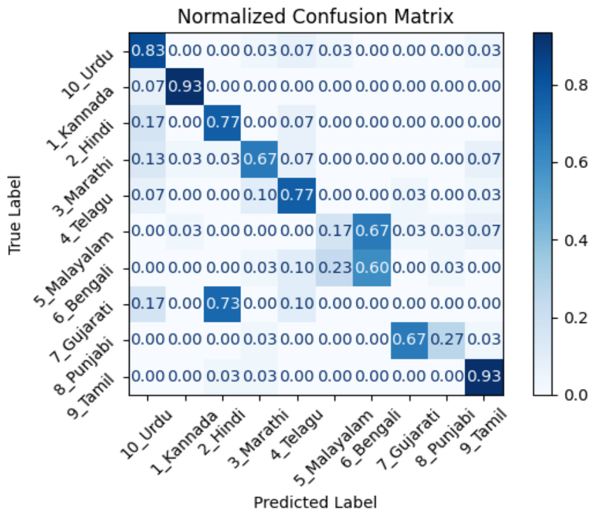

Figure 3: Confusion Matrix of Implemented Model

The validation accuracy (orange line) also improves but with more fluctuations, reaching about 0.6 by the 20th epoch. The gap between the two curves suggests some overfitting, where the model performs better on the training data than on the validation data.

The Figure 3, presents a normalized confusion matrix that visualizes the performance of the model in classifying 10 different languages. Each row represents the actual language, while each column represents the predicted language. The diagonal elements show the percentage of correct predictions for each language, with values close to 1.0 indicating high accuracy. For example, Tamil (10) has the highest accuracy at 0.93, followed by Kannada (1) at 0.93. The off-diagonal elements indicate misclassifications, where some languages like Bengali (6) and Telugu (4) show notable confusion with others. This matrix helps in understanding the strengths and weaknesses of the model in distinguishing between different languages.

V. Conclusion and Future Scope:

This study focuses on classifying ten regional languages using Recurrent Neural Networks (RNNs) based on Mel-Frequency Cepstral Coefficients (MFCCs) from audio recordings, including Kannada, Hindi, Marathi, Telugu, Malayalam, Bengali, Gujarati, Punjabi, Tamil, and Urdu. Despite advances in speech recognition, there remains a gap in models that accurately classify a wide range of regional languages with limited training data. This research leverages deep learning and data preprocessing to enhance classification accuracy, achieving a training accuracy of 73.00% and a test accuracy of 64.33%. The proposed RNN model, with two LSTM layers, batch normalization, and dropout layers, effectively distinguishes the diverse phonetic and linguistic features of the selected languages. Applications include improved speech recognition systems, automated language identification, and the preservation of linguistic heritage.

Future work should expand the dataset to include more languages and dialects, integrate advanced data augmentation techniques, and explore alternative architectures like transformers. Addressing limited training data with transfer learning and semi-supervised learning, and implementing real-time speech recognition systems could significantly impact education, customer service, and accessibility tools. Collaborations with linguists and cultural experts will ensure technological advancements support linguistic and cultural preservation.

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48. Contactless Care Systems: A Review

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ABSTRACT:

Contactless care systems have gained significant attention in the healthcare industry due to their ability to monitor vital signs and detect abnormalities without physical contact. This paper aims to provide a thorough examination of the current landscape of contactless care systems, with a particular emphasis on three key areas: fall detection, breathing rate monitoring, and heart rate monitoring. The review delves into the various smart sensors and wireless technologies employed in these systems, such as cameras, radar, and motion detectors, and explores how they facilitate the continuous tracking of an individual's movement, breathing patterns, and heart rate without the need for wearable devices.

The aging population and the increasing cost of healthcare have driven the need for advanced monitoring systems that can provide continuous, real-time data on an individual's health status. Wearable devices have emerged as a promising solution, as they can interact with the human body and monitor various physiological parameters. However, the adoption of wearable devices has been hindered by issues such as comfort, user compliance, and potential data privacy concerns [1][2].

I Introduction:

The aging population and rising healthcare costs have driven the demand for advanced monitoring systems that can provide continuous, real-time data on an individual's health status [3]. Wearable devices have emerged as a promising solution, as they can interact with the human body and monitor various physiological parameters [2][1].

However, the adoption of wearable devices has been hindered by issues such as comfort, user compliance, and potential data privacy concerns [4].

In contrast, contactless care systems have been developed to address these limitations by leveraging a suite of sophisticated sensors that can capture vital signs and detect anomalies without any physical contact with the individual. These systems utilize a variety of sensors, including cameras, radar, and motion detectors, to track an individual's movement, breathing patterns, and heart rate [1][3].

One of the key applications of contactless care systems is fall detection. Falls are a significant concern for the elderly population, particularly those living independently, as they can result in serious injuries, hospitalization, and even mortality [5]. By continuously monitoring an individual's movement and quickly identifying potential falls, contactless fall detection systems can enable a rapid response and increased safety for vulnerable populations, such as the elderly living independently [5].

In addition to fall detection, contactless care systems also play a crucial role in the monitoring of vital signs, such as breathing rate and heart rate. These systems can provide valuable insights into an individual's overall health status and help healthcare professionals detect potential issues before they escalate into more serious conditions.

This paper presents a comprehensive review of the current state of contactless care systems, with a focus on fall detection, breathing rate monitoring, and heart rate monitoring. The review covers the various smart sensors and wireless systems used in these systems, their detection mechanisms, and the advantages of contactless monitoring.

II Contactless Care Systems:

A. Contactless Care Systems for Fall Detection:

One of the primary applications of contactless care systems is the detection of falls, which is a major concern for the elderly population, particularly those living independently. Falls are a significant risk factor for the elderly, as they can lead to serious injuries, hospitalization, and even mortality. Contactless fall detection systems can continuously monitor an individual's movement and quickly identify potential falls, allowing for a rapid response and increased safety. Ongoing research in fall detection contactless systems utilizes a range of sensors, including cameras, radar, and motion detectors, to track an individual's movement and identify potential falls [6]. These systems can analyze an individual's gait, posture, and sudden movements to detect the characteristic patterns associated with a fall [7].

B. Contactless Care Systems for Breathing Rate Monitoring:

Contactless care systems are also widely used for the continuous monitoring of breathing rate, a vital sign that can provide valuable insights into an individual's overall health status. These systems utilize a variety of sensors, such as cameras and radar, to track changes in an individual's chest and abdominal movements, which are directly correlated with their breathing patterns [4]. Traditional wearable devices for breathing rate monitoring can be bulky, uncomfortable, and may interfere with the individual's daily activities, leading to poor user compliance. These limitations have hindered the widespread adoption of wearable technology in healthcare settings, highlighting the need for more seamless and user-friendly monitoring solutions. Contactless care systems can provide continuous, non-invasive monitoring of breathing rate without the need for physical contact, making them a more convenient and user-friendly solution.

III Contactless Care Systems for Heart Rate Monitoring:

In addition to fall detection and breathing rate monitoring, contactless care systems have emerged as a promising solution for the continuous monitoring of heart rate. By leveraging advanced sensors and signal processing algorithms, these systems can accurately track an individual's heart rate without the need for physical contact.

A. Types of Contactless Care Systems based on Technology:

- **Vision-Based Systems:** Rather than relying solely on video footage, some contactless care systems incorporate advanced computer vision algorithms and specialized cameras to capture and analyze an individual's physical movements, breathing patterns, and even subtle changes in skin tone that can be used to infer vital signs such as heart rate [8].
- **Radar-Based Systems:** Radar-based contactless care systems utilize radio waves to detect and track an individual's movement, breathing, and heart rate.
- **Motion-Based Systems:** Motion-based contactless care systems employ a variety of sensors, such as accelerometers and gyroscopes, to detect and analyze an individual's movement and physical activity.
- **Acoustic-Based Systems:** Some contactless care systems utilize acoustic sensors, such as microphones, to monitor an individual's breathing and heart rate by detecting subtle variations in the sounds produced by the body.
- **Camera-Based Systems:** These systems utilize visual information captured by cameras to monitor an individual's movements, breathing patterns, and heart rate [8].

B. Advantages of Contactless Care Systems:

Contactless care systems offer several advantages over traditional wearable devices and manual monitoring methods, including improved user comfort and compliance, continuous monitoring, enhanced privacy, and reduced healthcare costs [8][9].

- **User Comfort and Compliance:** Contactless care systems do not require the user to wear any physical devices, eliminating the discomfort and potential skin irritation associated with wearable sensors.
- **Continuous Monitoring:** Contactless care systems can provide 24/7 monitoring of an individual's vital signs and physical activity, enabling the early detection of potential health issues [9].
- **Enhanced Privacy:** Contactless care systems can monitor an individual's health without the need for physical contact, preserving their privacy and reducing the risk of data breaches associated with wearable devices [10].

- **Reduced Healthcare Costs:** By enabling continuous, remote monitoring, contactless care systems can help reduce the need for frequent in-person visits and hospital stays, leading to decreased healthcare costs.

C. Disadvantages and Limitations:

While contactless care systems offer many advantages, they also have some limitations, such as accuracy, interference, and limited coverage.

- **Accuracy:** Contactless systems may not always achieve the same level of precision as wearable devices or manual measurements, particularly in challenging environments or situations where the individual's movement is erratic [1].
- **Interference:** Factors such as environmental conditions, ambient noise, and interference from other electronic devices can impact the performance of contactless care systems, leading to inconsistent or unreliable data.
- **Limited Coverage:** Contactless care systems are typically designed to monitor individuals within a specific area, such as a room or a designated living space, limiting their ability to provide continuous monitoring during outdoor activities or when the individual is away from the monitor [1] [11] [12].

IV Conclusion:

In conclusion, contactless care systems have emerged as a promising solution for the monitoring of vital signs and the detection of abnormalities, such as falls, without the need for physical contact. These systems utilize a variety of sensors, including cameras, radar, and motion detectors, to track an individual's movement, breathing patterns, and heart rate, providing a comprehensive and user-friendly approach to healthcare monitoring. The advantages of contactless care systems, such as improved user comfort, continuous monitoring, enhanced privacy, and reduced healthcare costs, make them a valuable tool in the ongoing efforts to address the challenges faced by the aging population and the increasing demand for accessible and affordable healthcare solutions.

The review of contactless care systems has highlighted the significant advancements in this field, particularly in the areas of fall detection, breathing rate monitoring, and heart rate monitoring. Contactless care systems offer a range of advantages over traditional wearable devices, including improved user comfort, increased data privacy, and continuous monitoring capabilities. As the healthcare industry continues to seek innovative solutions to address the challenges posed by the aging population and rising costs, contactless care systems are poised to play an increasingly crucial role in the delivery of personalized, proactive, and cost-effective healthcare.

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49. Design and Modelling of Droop Control for Small Wind Turbine Generator in µGrid

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ABSTRACT:

Energy management through control strategies plays a significant role for efficient operation of micro grid. Most of the control techniques concentrate on generation of gate signals to operate power electronics devices. Energy management and load sharing of various sources according to variable loads is done through power electronic devices. Also, renewable sources mainly small wind turbine generator (SWT) is always intermittent in nature and wind speed in some of the location is lesser. Further, efficient utilization of energy available from SWT is done from conventional control strategy. Droop technique in dc micro grid provides droop setting so power supplied from sources is proportional to total load. In this project mathematical modelling of droop control system for SWT in micro grid is implemented, including two sources and load using MATLAB/SIMULINK. To obtain linear droop relation between small wind turbine and varying the load reference current is modelled with respect to bus voltage. The droop control applying in micro grid system is more efficient and increases the reliability of the system.

KEYWORDS:

Microgrid, droop control, Small Wind Turbine generator, battery, loads, MATLAB/simulation.

I Introduction:

Micro grid (µGrid) is low voltage power grid that can operate independently with other low voltage distribution system. Droop is common working method used in power system to sharing the load between the various resources. Basically this is load sharing, generating units running in parallel, for multiple generators on the same electrical grid. Droop control is some kind of control which senses the current drawn by the load, because this current would tend to pull down the level of the output voltage, increases some operating parameter in the generator such as the field current, output voltage.

The concept of droop control is the value of the actual DC outcome voltage linearly reduces with increasing DC outcome energy for each system. Micro grids are power distribution system including loads, small wind turbine, Diesel Generator (DG), battery with utility system. It includes various low rated power generating sources that makes it highly flexible and efficient. It allows more efficient and efficient battery, so produced power need not to have to transfer long ranges along transmitting power for customers to receive. The literature on control and operation of micro grids, particularly DC micro grids, offers diverse approaches and innovations aimed at improving system stability, efficiency, and reliability. However, several lacunae exist in the current body of research that future studies could address. Bunker and Weaver (2014) presented an optimal geometric control strategy for DC micro grids, focusing on precise control methods to enhance operational performance. However, their study lacks consideration of real-world implementation challenges and scalability of the proposed control technique across larger, more complex µGrid systems [1]. Goudappanavar, Raghuram, and Jangamshetti (2013) proposed a simple control strategy for a UPF power conditioner connected to a wind turbine, emphasizing effective integration of renewable energy sources. While the control strategy is straightforward, the study does not address the impact of varying wind conditions on system performance and the potential need for adaptive control mechanisms [2]. Xu and Chen (2011) explored the control and process of DC µGrids with different generation and energy storage, providing insights into managing fluctuations in power supply. However, their work does not fully explore the economic implications of the proposed system and the cost-benefit analysis of integrating such control mechanisms in different grid scenarios [3]. Atur, Goudappanavar, and Jangamshetti (2017) introduced a novel control algorithm for storage systems in small wind turbine generators, highlighting the importance of efficient energy storage solutions. This study, however, does not consider the long-term durability and maintenance requirements of the storage systems, which are critical for practical deployment [4].

Chung et al. (2010) explored different control strategies for distributed generators in micro grids that are interfaced with inverters., contributing to the optimization of power distribution in interconnected systems. The study, though comprehensive, overlooks the potential cybersecurity threats to inverter-interfaced systems and the need for robust protective measures against such threats [5]. De Brabandere et al. (2007) created a technique for controlling the voltage and frequency droop in parallel inverters., a foundational technique for managing multiple inverters in micro grid environments. Despite its importance, the paper does not address the limitations of droop control under highly variable load conditions and the potential need for supplementary control strategies [6].

Prabhakaran, Goyal, and Agarwal (2018) proposed non-linear droop control methods to address voltage regulation and issues in DC µGrids, offering solutions for improved system stability. However, their research does not sufficiently explore the real-time performance of these techniques under different load profiles and grid conditions [7]. Wei et al. (2015) examined the impact of line resistance on load sharing and proposed an improved droop control method for DC micro grids, further refining control strategies for effective power distribution. The study, however, lacks a detailed analysis of the effects of long-distance power transmission on load sharing and overall system efficiency [8]. Goudappanavar and Vijayalaxmi (2024) designed an SVC for dynamic compensation to improve LVRT in SWTG, enhancing the robustness of wind energy systems. Nonetheless, the paper does not address the cost-effectiveness and potential economic barriers to implementing SVC systems in small-scale wind turbines [9].

Savaghebi et al. (2013) centered on droop-controlled, autonomous voltage imbalance adjustment in islanded micro grids, presenting a method for maintaining voltage stability in isolated systems. While effective, the study does not consider the integration of this compensation method with other existing control systems in micro grids, potentially limiting its applicability [10].

Katiraei, Iravani, and Lehn (2005) investigated micro grid autonomous operation during and after islanding, providing crucial insights into micro grid resilience. However, their work does not sufficiently address the coordination challenges between multiple micro grids or the scalability of the proposed methods [11]. Salomonsson, Soder, and Sannino (2009) discussed protection strategies for low-voltage DC micro grids, emphasizing the need for robust protective measures. Despite its thoroughness, the study overlooks the impact of emerging technologies, such as advanced sensors and AI-based protection systems, on the effectiveness of protection strategies [12].

Goudappanavar and Jangamshetti (2020) conducted stochastic power flow analysis of unbalanced distribution systems using clusters of small wind turbine generators and solar PV systems, contributing to the understanding of power flow dynamics under uncertainty. The study, however, does not explore the integration of stochastic analysis with real-time monitoring systems for enhanced operational decision-making [13].

Chen et al. (2015) introduced a nonlinear droop method to improve voltage regulation and load sharing in DC systems, advancing control strategies for better system performance. Nonetheless, the research lacks a comprehensive evaluation of the long-term stability and resilience of the nonlinear droop method under varying operational conditions [14]. Guerrero et al. (2011) proposed a hierarchical control approach for droop-controlled AC and DC micro grids, aiming at standardization and improved control architecture. While significant, the study does not address the interoperability issues between different hierarchical control systems and the potential need for global standards [15].

Lastly, Goudappanavar, Jangamshetti, and O (2021) developed a method for identifying fault areas in distribution systems based on the rotor angle behavior of diesel generators, enhancing fault detection and localization capabilities in power distribution networks. Nevertheless, the impact of incorporating renewable energy sources is not taken into account in this work. on the proposed fault identification method, which could affect its effectiveness in modern power systems [16].

Category-2 information required for droop control system with micro grid modelled, WTG, Energy storage device, loads equations of the proposed system. Category-3 includes simulation model of proposed system for constant and variable loads. Category-4 provides the simulation results and discussion. Category-5 includes conclusion and future scope.

II Mathematical Modelling of Micro Grid:

The droop control numerical approach is modelled and developed using MATLAB/ SIMULINK.

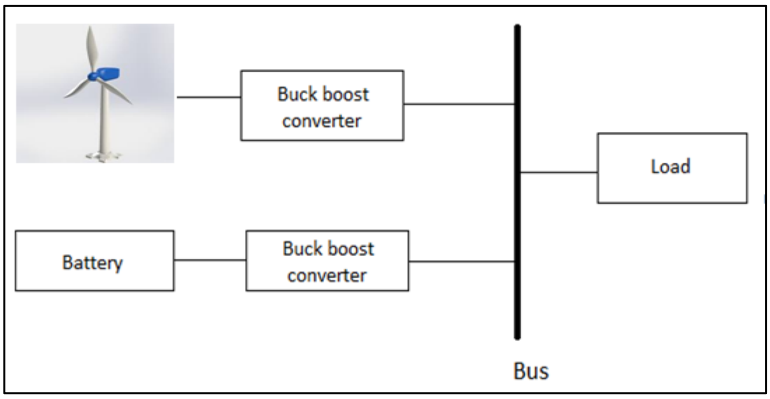

Figure 1: Block Diagram of Micro Grid System

Figure 1 shows block diagram of micro grid system, including small wind turbine, Battery and various loads. In the proposed system, a buck-boost converter based circuit topology is considered for analysis. In proposed system, a buck boost converter based circuit topology is considered for analysis. In this system the small wind turbine is DC source is connected to the bus through buck boost converter it converts the DC to DC voltage to get the load. The bus voltage is DC voltage. Load is consisting of R-C load. Battery is storage device in this system battery is considered as lead-acid battery. It is also connected to the bus through buck boost converter for step down the voltage.

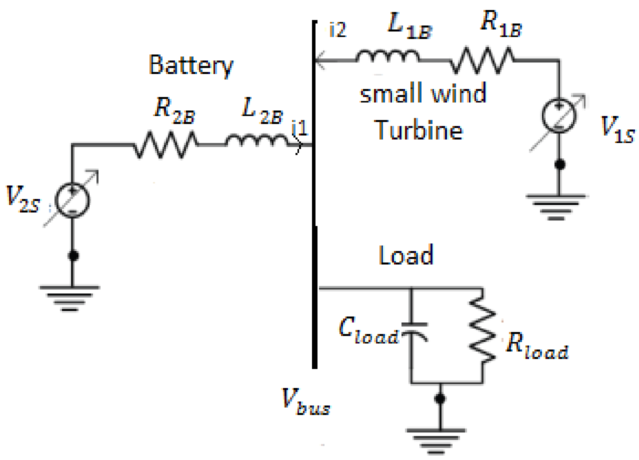

Figure 2: Simple Micro Grid System

Figure 2 shows circuit of micro grid for this is design based droop control. The simple small micro grid example with two resources and one load. Both resources and load linked with the common bus. In this micro grid system battery is act as source. When the load differs causes modify the bus voltage. Source one is small wind turbine is connected to the bus, source two is battery connected to the common bus and R-C load is connected to same bus. Here bus is common for both sources and load.

Applying KVL (Kirchhoff's Voltage Law), and KCL (Kirchhoff's Current Law) on both sources and load. Current equation [1] for small wind turbine, the air particles having mass m and velocity v, the kinetic energy carried by the wind particles by the equation:

$E_{Kin} = \frac{1}{2}mv^2$	(1)
$m = \rho\pi r^2 \mathrm{vt}$	(2)
$E_{Kin} = \frac{1}{2}\rho\pi r^2 v^3 t$	(3)

Wind power at time as,

$P_{Wind} = \frac{1}{2}\rho\pi r^2 v^3$	(4)

Charging voltage from source,

$\frac{dV_{ch}}{dt}C_h = i_{lh} - (K_{pv}\left[K_{pi}\left(\frac{V_{ref} - V_{bus}}{R_{d1}} + \frac{V_w}{R_{d2}} - i_{out}\right) + K_{ii}error_1 - V_{cl}\right]$ $+K_{iv}error_2)i_{ll}$	(5)

The reference current of source is

$i_{ref} = \frac{V_{ref} - V_{bus}}{R_{d1}} + \frac{V_w}{R_{d2}}$	(6)

Here reference current improves with wind speed.

$\frac{dV_{ch}}{dt}C_h = i_{lh} - (K_{pv}\left[K_{pi}(i_{ref}) + K_{ii}error_1 - V_{cl}\right] + K_{iv}error_2)i_{ll}$	(7)

Output current i_{out} is,

$\frac{di_{out}}{dt} L_B = V_{cl} - R_B i_{out} - V_{bus}$	(8)

Constant error from source,

$\frac{derror_1}{dt} = \frac{V_{ref} - V_{bus}}{R_{d1}} + \frac{V_W}{R_{d2}} - i_{out}$	(9)
$\frac{derror_2}{dt} = K_{pi}\left(i_{ref} - i_{out}\right) + K_{ii} error_1 - V_{cl}$	(10)

Battery, charging voltage equation [1] is

$\frac{dV_{ch}}{dt} C_h = i_{lh} - Di_{ll}$	(11)

Output current is,

$\frac{di_{out}}{dt} L_B = v_{cl} - R_B i_{out} - V_{bus}$	(12)

Battery voltage is,

$\frac{dV_{cbatt}}{dt} C_{batt} = i_{lh}$	(13)

Loads, Variable and constant loads are two types of loads. The load voltage equation is,

$\frac{dV_{ch}}{dt} C_h = i_{in} - Di_{ll}$	(14)

Apply P-I controller, the constant error is,

$D = K_{pl}(V_{nom} - V_{cl}) + K_{il} error$	(15)

Where D is duty cycle changed to P-I Controller,

For complete micro grid, Bus voltage is common for both sources and load,

$$\frac{dV_{bus}}{dt}C_{load} = i_1 - i_2 - \frac{V_{bus}}{R_{load}} \tag{16}$$

Control P-I loop for source one (small wind turbine),

$$V_{1S} = K_p\left(i_{ref1} - i_1\right) + K_i i_{error,1} \tag{17}$$

For source two (Battery) the control P-I loop is,

$$V_{2S} = K_p\left(i_{ref2} - i_2\right) + K_i i_{error,2} \tag{18}$$

The reference current for source two conventional straight line droop control will be implemented,

$$i^{*}{}_{ref1} = \frac{-V_{bus} + \sqrt{4PR_{1B} + V^2{}_{bus}}}{2R_{1B}} \tag{19}$$

III Modelling and Simulation of Proposed System:

A. ***Modelling of µGrid in MATLAB/Simulink:*** The system is simulated using droop management strategy and modelled in MATLAB/SIMULINK as shown in Figure 3.1 Further, droop control connection between bus voltages and reference current to complete given object.

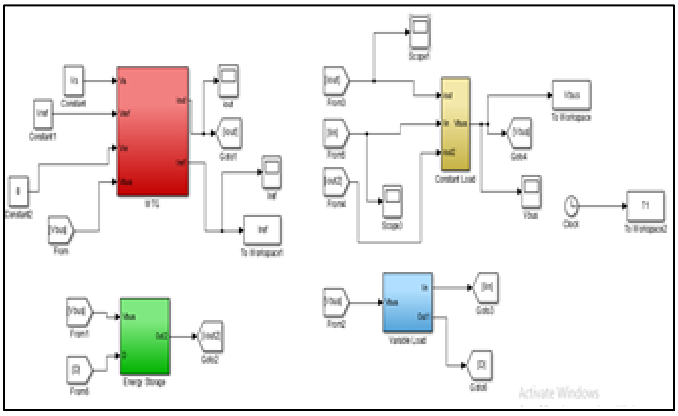

Figure 3: Simulation Model of Micro grid

Figure 3 represents the simulation model of micro grid system containing small wind turbine, battery, constant load and variable loads are modeled. In this model all the sources are combined from equations [1]. Mathematical model is consisting of four subsystems are small wind turbine generator, battery, constant and variable loads. Each system modelled by mathematical equations [1] shown in above figure. 1.5 kW wind turbine powered generator is modelled in MATLAB using equations [1], which research has been taken with continuous wind speed of 8 m/s and varying load from wind turbine at 20m at BEC Bagalkot.

B. µGrid for Variable Load:

In this micro grid system variable loads are considered. Change in load simulation also implemented. Figure 3.5 power curve graph shows the load data with time for every 1 hr., taken from BEC SCADA for Distribution and Automation Research Center on 5th July 2018.

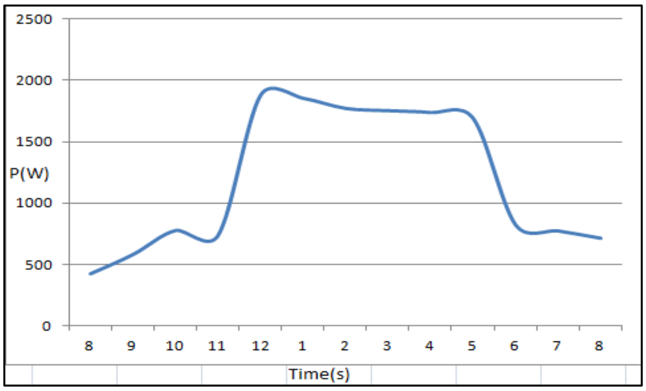

Figure 4: Shows The Power Curve for Variable Load.

IV Simulation Results:

The suggested droop management strategy, the µGrid is modelled applying MATLAB/SIMULINK. The system is simulated using straight line droop management for both sources droop control relationships. The wind powered generator and battery same straight line droop management for both models, Using maximum droop management relationship for both sources. For this, a simulation model of the µGrid is implemented. Power electronics (Buck boost converter) connected source to the bus. The droop control relationship constant output of 2.1 kW from small wind turbine.

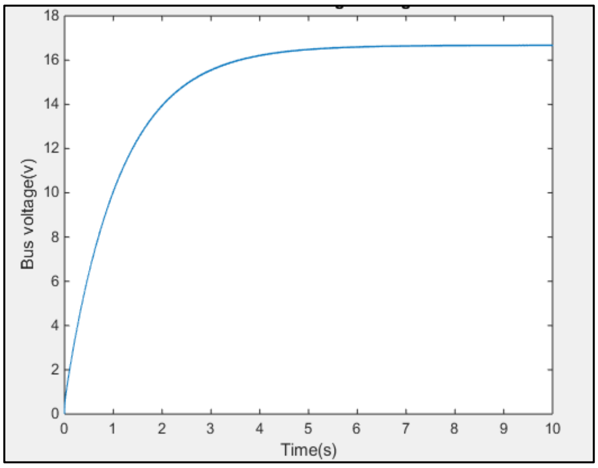

Figure 5: Bus Voltage of Proposed Micro grid System

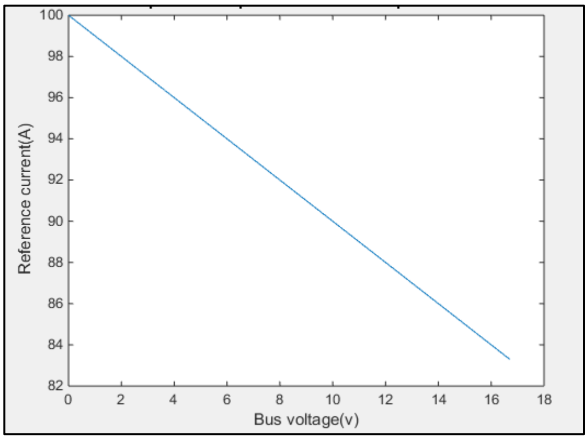

Figure 6: Relationship of Droop control of micro grid System for WTG

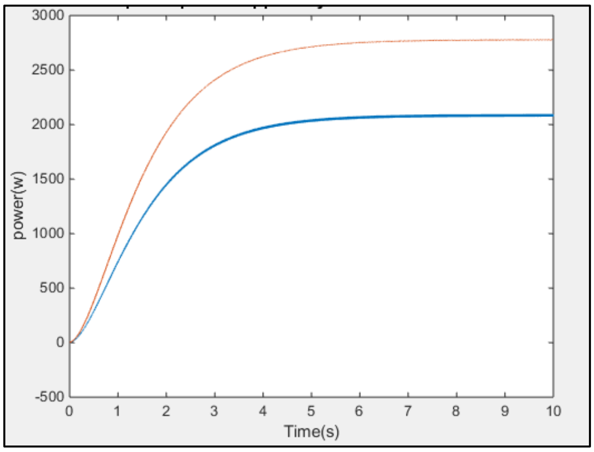

Figure 7: Optimal Power Provided by WTG and Battery

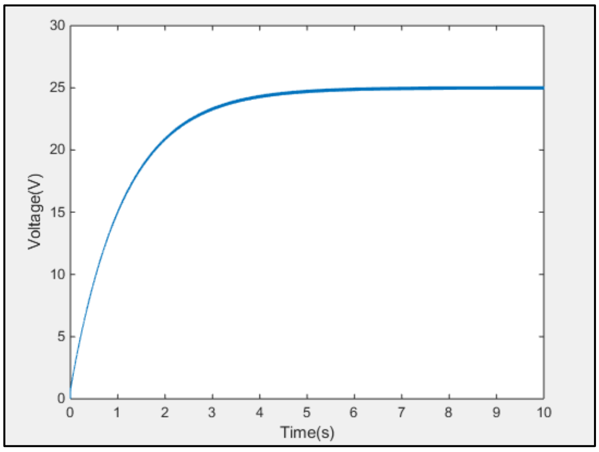

Figure 8: Output Voltage for WTG

Case Study:

A. Micro grid control for variable Load:

Micro grid considered above is carried out for variable loads taken from BEC SCADA on 5th July 2018.

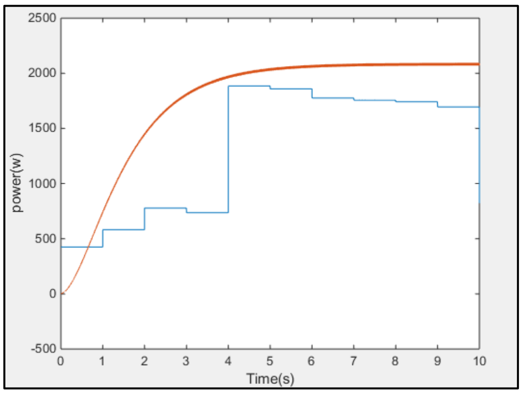

Figure 9: Power Output with of WTG Corresponding to Variable Load

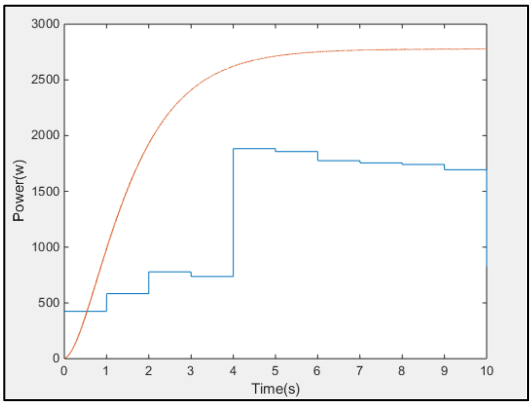

Figure 10: Power Provided with Load By Battery

V Conclusion:

µGrid model is simulated using MATLAB/SIMULINK. The simulation complete design of the µGrid is applied such as power electronic devices elements that are linked source to bus. The simulation of complete design of the micro grid is applied such as power electronic devices elements that are linked source to bus. The goal is to keep the source's output power constant. It was used once more with wind resources, where the load and WTG determine the desired output power. The proposed control method is implemented. Two sources and a battery are included in a grid simulation that uses optimal droop management. Using measured load data, simulation results were shown to illustrate how the system operated over the course of a day. Then, the bus voltage and wind speed determine the droop control reference current.

Implement droop control for wind energy conversion system, and also find the droop relationship to optimize the source operation. The work presented in this project method for to obtain linear droop relation between small wind turbine and varying load. with simulation results would certainly help in improving voltage stability. The control technique does not need connections between system elements.

The implementing of additional features preferred power from source is a function of another photo voltaic (PV) system, fuel cell with using small wind turbine generator.

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50. LoRa based Smart Energy Meter for Theft Detection

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ABSTRACT:

LoRa (Long Range) is a wireless communication technology designed for long-range, low-power, low-data-rate applications. It is commonly used in Internet of Things (IoT) devices due to its ability to communicate over distances of several kilometers while consuming minimal power. LoRa technology is ideal for creating efficient, low-power, and long-range communication networks, especially for IoT applications. It enables the deployment of a wide variety of smart applications, from smart cities to industrial monitoring, making it a key technology in the advancement of the IoT ecosystem. The growing need for efficient and secure energy management systems has led to the development of smart energy meters. This paper presents a novel LoRa-based smart energy meter designed to detect and prevent electricity theft. Utilizing the LoRa (Long Range) communication technology, the proposed system offers a reliable, long-range, and low-power solution for real-time monitoring of energy consumption and theft detection. The smart energy meter integrates a digital energy meter with a microcontroller and LoRa module, which transmits data to a central server. The server processes the data using advanced algorithms to identify irregular consumption patterns indicative of theft. This system enhances the traditional energy meter by providing continuous, wireless data transmission over long distances, making it suitable for deployment in both urban and rural areas. This paper presents a LoRa-based smart energy meter designed for theft detection and remote meter reading. The proposed LoRa-based smart energy meter offers significant benefits, including improved theft detection accuracy, reduced power consumption, and extended communication range. This makes it a cost-effective and scalable solution for energy providers seeking to enhance the security and efficiency of their power distribution networks. The implementation details, including the hardware setup, and software algorithms are discussed to provide a comprehensive overview of the system's functionality and performance.

KEYWORDS:

LoRa, Smart Energy Meter, Electricity Theft Detection, Long-Range Communication, Low Power Consumption, Real-Time Monitoring, Energy Management, Anomaly Detection, Wireless Data Transmission.

I Introduction:

The advent of smart technologies has revolutionized various sectors, including energy management. Traditional energy meters, while essential for measuring consumption, often fall short in terms of real-time monitoring and theft detection. Electricity theft remains a significant challenge for energy providers worldwide, leading to substantial economic losses and operational inefficiencies. In this context, the integration of advanced communication technologies, such as LoRa (Long Range), with smart energy meters presents a promising solution.

LoRa is a wireless communication technology known for its long-range capabilities and low power consumption, making it ideal for Internet of Things (IoT) applications. It operates in the unlicensed ISM bands, providing a cost-effective means of communication over large distances. By leveraging LoRa technology, smart energy meters can continuously monitor and transmit data on energy consumption, enabling real-time detection of anomalies and potential theft.

The deployment of smart meters equipped with Low-Power Wide-Area Network (LPWAN) technologies, particularly LoRa (Long Range), is revolutionizing utility infrastructure by enhancing data collection, transmission, and analysis. LoRa technology offers a unique combination of long-range transmission capabilities and low power consumption, making it ideal for extensive utility networks. This technology's robust performance in challenging environments and its ability to maintain stable communication over vast distances contribute to reduced implementation costs and increased network reliability. By integrating LoRa-enabled smart modules into energy meters, utility providers can efficiently monitor and manage utility usage, benefiting from real-time insights and operational efficiencies.

One of the key advantages of LoRa technology is its programmability, which allows for scheduled notifications and updates, thereby enhancing the responsiveness of utility management systems. This feature enables timely interventions and accurate meter readings, consumption alerts, and system diagnostics, providing both providers and consumers with actionable data. Compared to traditional communication technologies like Zigbee, Wi-Fi, and Bluetooth, which are limited by their range and power requirements, LoRa excels in providing long-range, energy-efficient connectivity. This makes it particularly suitable for applications in smart cities, smart grids, and other large-scale IoT implementations where reliable, cost-effective communication is essential.

LoRa's use of a patented chirped spread spectrum modulation technique distinguishes it from other LPWAN technologies like Sig fox, enhancing data transmission reliability even in congested environments. The LoRa WAN protocol, built on LoRa technology, further optimizes network performance with adaptive rate capabilities.

LoRa networks typically utilize a star topology, where smart meters communicate directly with gateways that relay data to central servers via standard IP protocols. This architecture simplifies deployment and reduces costs, making LoRa a compelling choice for utility providers seeking to modernize their infrastructure efficiently. Overall, LoRa technology is driving a significant transformation in utility management, offering a scalable, cost-effective solution that meets the evolving demands of an interconnected world.

Motivation:

Communication channels such as Wi-Fi, Zigbee, and Bluetooth require high power and have limited range. However, Low Power Wide Area Network (LPWAN) technology utilizes minimal power and enables data transmission without internet connectivity. Existing energy meters provide real-time data on energy consumption, voltage, and current, but they lack the capability to track previous months' energy usage. Consequently, meter readers visit each household at the beginning of every month to deliver energy bills Implementing a system for transmitting energy consumption data from existing meters to a central substation can eliminate the need for meter readers and facilitate the generation of bills directly on a website hosted by the substation. This data can be stored both at the consumer's premises and in the substation. This approach aids in load estimation on the distribution side and enhances demand-side management. By comparing the energy consumption of individual consumers with the aggregate consumption at the distribution level, instances of energy theft can be identified. If the total energy consumption of all homes matches the reading from the distribution energy meter, accounting for some percentage of transmission losses, then no theft has occurred. However, any disparities indicate potential energy theft.

Objectives:

The primary objective of this research is to develop a LoRa-based smart energy meter system that enhances the accuracy and reliability of electricity theft detection. The proposed system combines a digital energy meter with a microcontroller and a LoRa module to facilitate long-range wireless communication. Data collected from the energy meter and sensors are transmitted to a central server, where advanced algorithms analyze the data for irregularities indicative of theft.

This system addresses the limitations of conventional energy meters by providing continuous monitoring and immediate alerts in the event of suspicious activity. The use of LoRa technology not only extends the communication range but also ensures low power consumption, making it suitable for deployment in both urban and rural areas. Moreover, the scalability of the system allows for widespread adoption, providing energy providers with a robust tool for improving the security and efficiency of their power distribution networks.

This paper discusses the design and implementation of the LoRa-based smart energy meter system, including the hardware components, software algorithms, and communication protocols. The potential benefits, such as enhanced theft detection accuracy, reduced operational costs, and improved energy management, are also highlighted.

Through this research, we aim to demonstrate the effectiveness of integrating LoRa technology with smart energy meters in mitigating electricity theft and fostering more efficient energy utilization.

II Literature Review:

LoRa (Long Range) is a low-power, wide-area network (LPWAN) technology that supports long-range communication, making it ideal for IoT applications in various sectors, including energy management. LoRa operates in the unlicensed ISM bands, offering a cost-effective solution for long-distance data transmission. Key features of LoRa include its ability to provide robust communication over several kilometers, low power consumption, and support for a large number of devices in a single network. These characteristics make LoRa particularly suitable for applications requiring reliable, long-range connectivity and extended battery life. this section provides the overall literature available at present.

The paper "Wireless Data Transmission Using LoRa" by H. Venkatesh, M. Lakshmanna, and B. Mansoor discusses the implementation and advantages of using LoRa (Long Range) technology for wireless data transmission. The authors focus on the technical aspects, performance benefits, and potential applications of LoRa in various fields. The paper provides an overview of LoRa technology, highlighting its ability to support long-range communication with low power consumption. LoRa operates in the unlicensed ISM bands, making it a cost-effective solution for wireless communication. The authors delve into the technical specifications of LoRa, including its modulation technique (Chirp Spread Spectrum), which allows for robust communication over long distances. The paper explains how LoRa can achieve long-range communication (up to 15 kilometers in rural areas) while maintaining low power usage, making it suitable for battery-powered devices. A practical implementation of a LoRa-based wireless data transmission system is presented. The authors describe the setup, which includes LoRa modules, microcontrollers, and the necessary interfacing components. Details on the coding and configuration required for establishing communication between the devices are provided. The paper evaluates the performance of the LoRa system in various environments, such as urban and rural settings. Metrics such as range, data rate, and power consumption are analyzed to demonstrate the effectiveness of LoRa technology. The authors conclude that LoRa technology offers a promising solution for long-range, low-power wireless communication. The paper suggests that further research and development could enhance the capabilities and applications of LoRa, making it an integral part of the growing IoT ecosystem [1].

The paper "IoT Based Smart Energy Meter for Efficient Energy Utilization in Smart Grid" by B. K. Barman, S. N. Yadav, S. Kumar, and S. Gope explores the development and implementation of a smart energy meter leveraging IoT (Internet of Things) technology. The focus is on enhancing energy utilization and efficiency within the framework of a smart grid. The paper introduces the concept of smart grids and the role of IoT in modernizing energy management systems. Emphasis is placed on the need for efficient energy utilization to reduce wastage and improve the reliability of power distribution. The authors describe the architecture of the IoT-based smart energy meter, which includes components such as microcontrollers, communication modules, and sensors. The smart meter is designed to measure and monitor electricity consumption in real-time, providing detailed usage data to both consumers and utility providers.

The paper highlights the integration of IoT technology, enabling the smart meter to transmit data wirelessly to a central server or cloud platform. Various communication protocols and technologies, such as Wi-Fi, Zigbee, and cellular networks, are discussed in the context of data transmission. The authors conclude that IoT-based smart energy meters represent a significant advancement in energy management, contributing to the overall efficiency and reliability of smart grids. The paper calls for further research and collaboration between industry and academia to address the challenges and fully realize the potential of IoT in smart energy systems [2].

The paper "Development of a Low-cost LoRa based SCADA system for Monitoring and Supervisory Control of Small Renewable Energy Generation Systems" by C. Ndukwe, M. T. Iqbal, and J. Khan discusses the creation and implementation of a Supervisory Control and Data Acquisition (SCADA) system that uses LoRa (Long Range) technology.

The system is designed for the efficient monitoring and control of small-scale renewable energy generation systems, providing a cost-effective solution suitable for remote and resource-constrained environments. The paper begins by highlighting the importance of monitoring and controlling renewable energy systems to ensure optimal performance and reliability. Traditional SCADA systems are often expensive and complex, posing challenges for small-scale and remote renewable energy projects.

The authors propose a low-cost alternative using LoRa technology. The paper provides an overview of LoRa technology, emphasizing its long-range communication capabilities, low power consumption, and suitability for remote monitoring applications. LoRa's ability to operate in the unlicensed ISM bands makes it a cost-effective choice for implementing wireless SCADA systems. The authors describe the implementation process, including the setup of LoRa communication modules, integration with sensors for monitoring parameters such as voltage, current, and temperature, and the configuration of microcontrollers for data acquisition. Data is transmitted wirelessly to a central server where it is processed and stored. The paper concludes that the development of a low-cost LoRa-based SCADA system offers a practical and effective solution for monitoring and controlling small renewable energy generation systems. The proposed system addresses the limitations of traditional SCADA systems, making advanced monitoring and control accessible to a wider range of renewable energy projects [3].

The paper "Smart Energy Metering and Power Theft Control Using Arduino & GSM" by A. S. Metering, S. Visalatchi, and K. K. Sandeep explores the design and implementation of a smart energy metering system aimed at monitoring electricity usage and detecting power theft. The system utilizes Arduino microcontrollers and GSM (Global System for Mobile Communications) technology to provide real-time data transmission and alerts. The paper introduces the problem of power theft and its significant impact on the energy sector, including financial losses and reduced system efficiency. The authors propose a smart energy metering system that leverages modern technologies to enhance the accuracy of energy usage measurement and prevent unauthorized electricity consumption. The smart energy meter is built around an Arduino microcontroller, which serves as the central processing unit. Key components include current and voltage sensors for measuring power consumption, a GSM module for wireless communication, and an LCD display for local data visualization.

The paper provides a detailed description of the hardware setup, including the interfacing of sensors with the Arduino microcontroller and the configuration of the GSM module for data transmission.

Software algorithms for data processing, theft detection, and communication are also discussed. The paper concludes that the integration of Arduino and GSM technology in smart energy meters offers a practical and efficient solution for accurate energy monitoring and effective power theft control. The proposed system has the potential to significantly reduce energy losses and improve the overall efficiency of power distribution networks [4].

In existing systems, either an electronic energy meter or an electro-mechanical meter is installed on the premises for measuring consumption. These meters currently in use are only capable of recording kWh units. The kWh units still have to be recorded monthly by meter readers, who must walk from building to building. The recorded data needs to be processed by a meter reading company. For processing the meter reading, the company must first link each recorded power usage datum to an account holder and then determine the amount owed by means of the specific tariff in use. Wireless smart energy meters are replacing traditional meters to ensure accurate tariff calculation and reduce errors caused by human beings. readers. These smart energy meters utilize GSM, Wi-Fi, and other wireless technologies. The main drawback of these systems is the necessity for network access on the consumer side for the smart energy meter to connect wirelessly.

III Proposed System:

The current system of electricity consumption billing has some errors in recording and also is very time consuming. Errors are likely to be introduced at every stage due to electro-mechanical meters, human errors while noting down the meter reading and errors while processing the paid bills and the due bills.

Smart energy meter is a novel technique which can reduce these problems associated with billing and also reduces the deployment of manpower for recording meter readings. It has many advantages from both the distributor side as well as the consumer's point. This smart energy meter has been developed based on LoRa technology.

While using the LoRa technology, the disadvantages that are associated when using the GSM, Wi-Fi like wireless networks can be overcome. It does not require any additional towers or network access in the consumer side for these smart energy meters to connect in wireless mode. So, these smart energy meters have the data that is transmitted wireless from the consumer to the distributor and the Substation side using LoRa technology.

The block diagram as shown in Figure 1, consists of energy meter, LDR, Arduino, LoRa module and display. The energy meter is connected to the transformer, and an LDR (Light Dependent Resistor) is connected to the energy meter. This setup is linked to an Arduino, which processes the data. The processed data is then transmitted and received via a LoRa module. Finally, the Arduino further processes the received data and displays it.

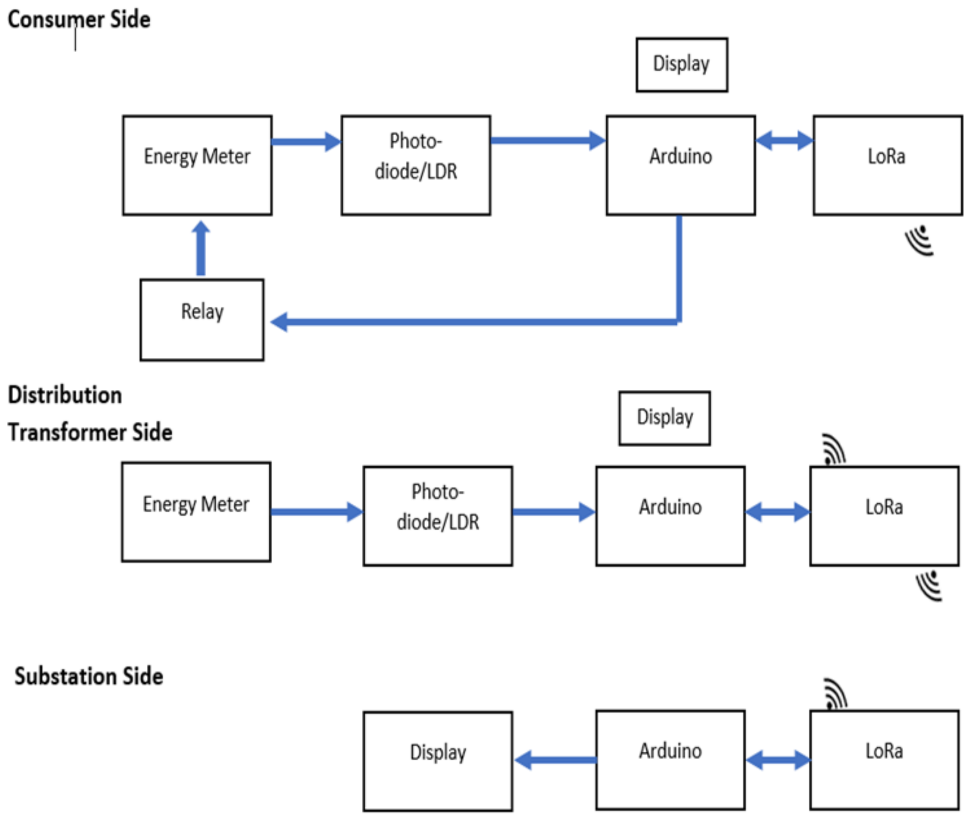

Figure 1: Block Diagram of the Proposed System

- In this proposed model the energy meter is connected to the low voltage (LV) side of the transformer, while a Light Dependent Resistor (LDR) is linked to the energy meter to detect the blinks or pulses emitted by the meter.
- An Arduino board is employed to count these pulses and subsequently transmit the data via a LoRa (Long Range) module.
- This transmitted information is then wirelessly received by another Arduino acting as a LoRa receiver at substation.
- This second Arduino is interfaced with a PC, facilitating data acquisition.
- The transmitted data is meticulously compared with the energy meter data of the distribution transformer. Any disparities detected are indicative of potential energy theft, prompting the system to issue an alert to the substation for further action.
- This setup thus ensures efficient monitoring and detection of unauthorized energy consumption, enhancing the overall integrity of the electrical distribution system.

IV Results and Discussions:

The image depicts a setup for interfacing utility meters with a laptop using microcontrollers, as part of a project to read meter data programmatically. The connection diagram of the proposed model is shown in Figure 2.

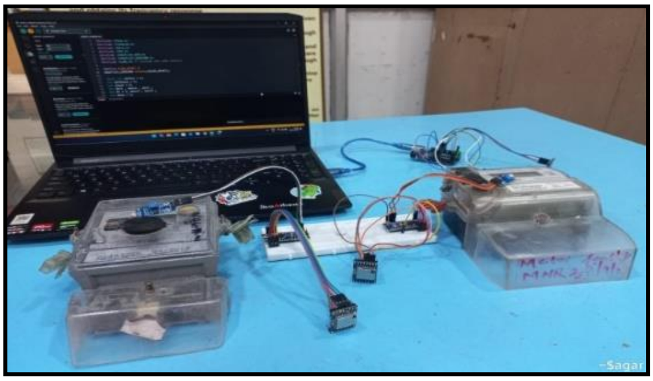

Figure 2: Connection Diagram of the Proposed Model

The image in Figure 3 shows a breadboard setup with an OLED display connected to a sensor, displaying date, time, and temperature readings.

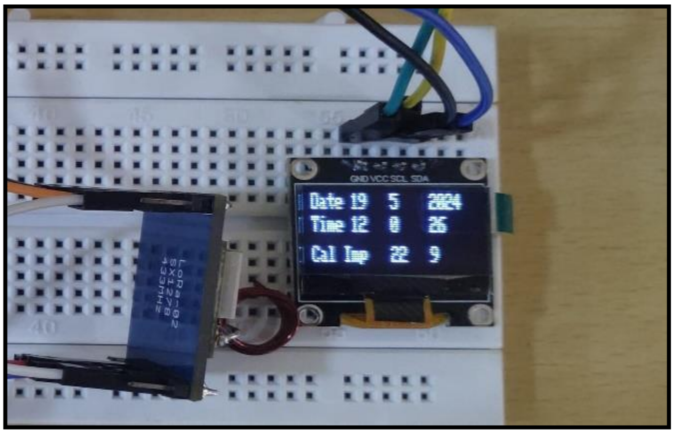

Figure 3: Display Module to Calculate Count pulses

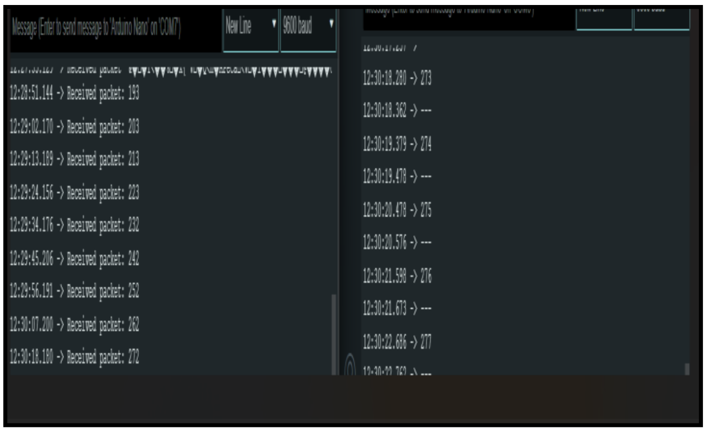

Figure 4: Data Transmission from Sender to Receiver Module

The image in Figure 4 shows the serial monitor data transmission from sender to receiver, where packets of data are being received and logged with timestamps.

The LoRa-based smart energy meter system can be further enhanced by incorporating advanced machine learning algorithms to predict and detect more sophisticated energy theft patterns. Integration with smart grid technology can enable real-time energy management and dynamic tariff adjustments, improving grid efficiency and consumer engagement. Expanding the system's compatibility with various IoT platforms will facilitate seamless data analysis and remote monitoring. Additionally, incorporating renewable energy sources and storage solutions can optimize energy distribution and contribute to sustainable energy management. Future iterations could also include enhanced security protocols to safeguard data transmission and prevent cyber threats, ensuring a more robust and secure energy distribution network.

V Conclusion:

The presented LoRa-based smart energy meter system offers a comprehensive solution for efficient meter reading and theft detection in energy distribution networks. By seamlessly integrating with existing infrastructure, the system minimizes disruption while enhancing operational efficiency. Through the utilization of components like LDR sensors, Arduino microcontrollers, and LoRa modules, the system effectively captures energy consumption data and transmits it to the substation for billing purposes. Moreover, the incorporation of theft detection mechanisms, including comparison of household and distribution transformer data, enables timely identification of irregularities, enhancing security and revenue protection for energy providers. Tested with a bulb load, the system demonstrates promising effectiveness in detecting theft and generating accurate billing information. Overall, the project showcases significant potential in addressing challenges related to meter reading and theft detection, offering a scalable and reliable solution for energy management in communities.

The proposed system builds upon the existing digital energy meter, enhancing its capabilities without requiring the replacement of all current meters with smart energy meters. While the installation of smart meters may generate electronic waste by rendering existing meters obsolete, this system mitigates such waste and is more cost-effective in comparison. It optimizes the functionality of current meters, offering an efficient and economically viable solution for energy management.

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1. K. Barman, S. N. Yadav, S. Kumar, S. Gope, "IoT Based Smart Energy Meter for Efficient Energy Utilization in Smart Grid,"*2nd International Conference on Power, Energy and Environment: Towards Smart Technology* (ICEPE), Shillong, India, 2018, pp. 1-5, doi: 10.1109/EPETSG.2018.8658501
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51. UV-C Based Plate Sterilizer

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ABSTRACT:

The aim of this paper is to reduce the transmission of sickness among the people through the unclean plates used in large gatherings, marriage functions, temple fairs, etc. In large gathering of people at fairs and marriages requires huge number of plates where cleaning becomes the big task. This may lead to retain some microorganisms on plates which causes infections with manual cleaning process. Due to the lack of cleaning, bacteria build up and cause the spread of sickness. This proposed model works as both dish washer and sterilizing unit which can be used in large gatherings.

KEYWORDS:

Dish washer, sterilizer, UV-C band, COVID, Infection.

I Introduction:

In today's society, automation of everyday tasks has a large impact on people's lives. India is heavily populated country and has many traditional activities carried like, temple fairs, marriages where food is served in large quantity. In such large gatherings the plates used are just dipped in soap water to clean and served to the next people. This leads to retention of microorganism on plates and further may cause infection. Due to the lack of proper cleaning process, there is chance of spread of many viral diseases. After, COVID it is very much necessary to maintain hygiene in such situation. Hence a low cost Ultra Violet (UV) light based plate sterilizer is proposed in this paper.

The UV light C band based plate sterilizer is the ultimate solution for clean and sterilized plates. This innovative home appliance is perfect for caterers, residences, and hostels alike.

With a water spray, dish soap inlet, hot air drier, and sterilizer in one convenient unit, it effectively removes any pathogens, ensuring hygienic and infection-free plates. Say goodbye to worries about spreading infections and hello to a healthier dining experience.

Large gathering of people at fairs and marriages requires huge number of plates where cleaning becomes the big task. This may lead to retain with some microorganisms on plates which causes infections with manual cleaning process. Due to the lack of cleaning, bacteria build up and cause the spread of sickness. This proposed model works as both dish washer and sterilizing unit which can be used in large gatherings. Model consists of three main units viz, washing unit, heating unit, drier and sterilizing unit.

A UV-C based Plate Sterilizer, utilizes UV-C sanitization to kill bacteria on any flat surface. This process will eliminate any harsh chemicals required to sanitize and clean the plate surface. This process will eliminate any harsh chemicals required to sanitize and clean a surface.

II Literature Survey:

The literature survey covers the work done by researchers on the design and efficiency of the dishwashing machines.

1. Hoak, D. Parker, D. Hermelink, A. American Council for an Energy Efficient Economy, Washington, DC, August 2008. This Journal helps that present measurements of three recent vintage dishwashers are very different efficiencies showing that while they substantially more efficient than older dishwashers, those tested will still use electric resistance elements for supplement heat, even when supplied by solar water heating system producing very hot water.
2. Shilpa N Dehedkar- “Design of basic model of Semi-Automatic Dishwasher machine”. (2016): This paper use brief idea and analysis of the Semiautomatic Dishwasher machine. It also states the mechanisms incorporated in this model for process of washing the dish. In this research the dishwashers operate with help of DC motor, Universal motor, Conveyor belt and Microcontroller for time delay.
3. Shaila S. Hedaoo- “Design and Fabrication of Semi-Automatic Dish and Utensil washing machine”. This paper discuss the main objective of Semi-Automatic Dishwashing machine is to reduce the cost of fully automatic dishwashing machine and giving good Cleaning Performance. It requires less energy and less water consumption. Time of washing dish can be adjusted as per customer requirements.
4. PranaliKhatake- “Design of gears in semiautomatic dishwashing machine”. This paper discusses about design of gear in semiautomatic dishwashing machine. The result indicates that in India semiautomatic dishwashing machine are used than fully automatic dishwashing machine as it is cheap, preferably gears are used in this semiautomatic dishwashing machine with the belt drive for better life and high efficiency.
5. Dhale A. D.- “Design and Development of semiautomatic dishwasher”. This paper discusses about the design, construction and evaluation of dishwashing machine. The capacity of machine was 20 plates per min (i.e. 1880 plates per hour). The design dishwasher is very efficient and easy to operate.

6. J. G. Gochran- "Dishwashing machine". The paper gives brief idea describe about improvement of dishwashing machine. It related to improvement in machine washing a dishes in which continuous stream of either soap-soda or clean water is supply to crate holding the rack or cage hot water is supplied to crate is rotate so as to bring the greater portion thereof under water.
7. International Journal for Scientific Research and Development Vol.4, Issue 05,2016 | ISSN (online): 2321- 0613. This journal explains that using Galvanized iron material for inner and outer part, the overall weight of the assembly is also reduced. The capacity of machine is to wash 24 pieces of dinner set at a time by using two rotary jet controlled by single pump using parallel connection.
8. International Journal for Scientific Research and Development| Vol. 3, Issue 11,2016 | ISSN (online):2321- 0613. This Journal represents the modified design of utensils automatic washer machine. In this, the adjustable conveyor containing utensils tends to rotate, and passing these utensils under three section scrubbing, water sprinkler and cleaner. The dishwasher has made cleaning and drying dishes much easily and more efficiently. Conveyor is rotated by using motors. This leads to making the design simpler and better than the present dishwashers.
9. International Journal for Scientific Research and Development 2016 IJEDR | ISSN: 2321-9939.This journal suggests that this system multi jet technology is used to clean Utensils. Any type of Utensils will be washed in our system; no electronic circuit will be used. Multi jet system will be used to clean utensils from all side

III Problem Identification:

In India, washing of plates at large gatherings is done at least care Used plates are simply dipped in soapy water and washed, which may cause pathogens or other bacteria to accumulate on the plates. Following the effects of COVID, it is crucial to exercise caution and keep oneself clean. An UV-C based plate sterilizer is proposed in this research work by considering the following parameters.

1. **Washing Time:** The amount of time required for washing plates depends on factors such as the type of dishwasher used, how dirty the plates are, and the efficiency of the machine. On average, a standard dishwasher cycle takes approximately 1 to 2 hours to complete. However, some industrial dishwashers can complete a cycle in 5 to 10 minutes.
2. **Soap Consumption:** The amount of soap needed to wash plates depends on the type of soap or detergent used, the hardness of the water, and the dishwasher's settings. Typically, a domestic dishwasher uses 3 to 6 liters of water per wash cycle and needs roughly 15 to 30 grams of detergent. Industrial dishwashers may need larger amounts of detergent depending on their capacity and the number of plates being washed.
3. **Sterilization:** Plates may not be totally sterilized even though dishwashers clean them thoroughly. Typical operating temperatures for domestic dishwashers range from 113°F to 167°F (45°C to 75°C), which is hot enough to effectively eliminate certain bacteria as well as grease and grime. Nevertheless, additional techniques like high-temperature rinsing or chemical sanitization might be necessary for total sterilization.

4. **Number of Plates:** The amount of plates that can be cleaned in a single cycle depends on the dishwasher's or sink's capacity that is being used for manual washing. 12 to 14 standard-sized dishes can normally fit in a cycle of a domestic dishwasher. In commercial or industrial settings, depending on the size and kind of dishwasher, the capacity can range from a few dozens to several hundred plates every cycle.

IV Proposed System:

The main concept of this proposed model is to reduce the transmission of sickness among the people through the unclean plates used in large gatherings, marriage functions, temple fairs, etc. For example, in large gathering of people at fairs and marriages requires huge number of plates where cleaning becomes the big task. This may lead to retain with some microorganisms on plates which causes infections with manual cleaning process. Due to the lack of cleaning, bacteria build up and cause the spread of sickness. This proposed model works as both dish washer and sterilizing unit which can be used in large gatherings.

Objectives:

- The primary objective of a UVC-based plate sterilizer is to inactivate or destroy microorganisms, such as bacteria, viruses, and fungi, present on the surface of plates.
- The model objective is to effectively clean plates with less usage of water and detergents.
- UVC-based plate sterilization in a dishwasher can save time and labor compared to manual methods of plate sterilization.

A UVC-based plate sterilizer with a dishwasher is a system that is designed to clean and sterilize plates using ultraviolet light

(UVC) and a dishwasher. The working of the proposed model is as shown in Figure 1:

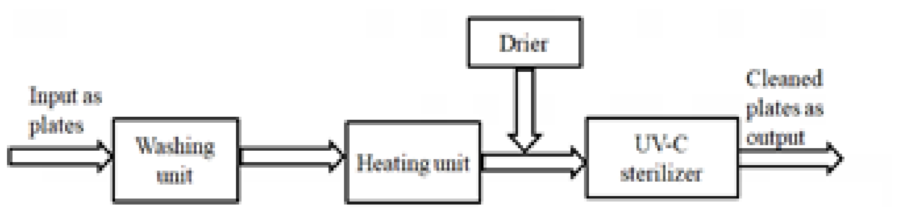

Figure 1: Block Diagram

1. **Pre-rinse:** The plates would be pre-rinsed to remove any visible debris or food particles.
2. **Loading:** The plates would then be loaded into the model.
3. **Washing:** The model would wash the plates using hot water and detergent, as is typically done in a dishwasher.
4. **Rinsing:** After washing, the plates would be rinsed with clean water to remove any remaining detergent.

5. **Drying:** Before sterilization, the plates should be dried using hot air, as is typically done in a dishwasher.
6. **UVC Sterilization:** Once the rinsing and drying process is complete, the plates would be subjected to UVC light to sterilize them. UVC light has been shown to be effective at killing a wide range of microorganisms, including bacteria and viruses. The UVC light would be generated using special UVC lamps that are designed to emit a specific wavelength of light that is effective at killing microorganisms.

The proposed system would be designed to be easy to use and efficient. It would be ideal for use in commercial kitchens, restaurants, hospitals, and other environments where hygiene is of the utmost importance. The UVC-based plate sterilizer with a dishwasher would help to ensure that plates are thoroughly cleaned and sterilized, reducing the risk of foodborne illnesses and infections.

V Flow Chart:

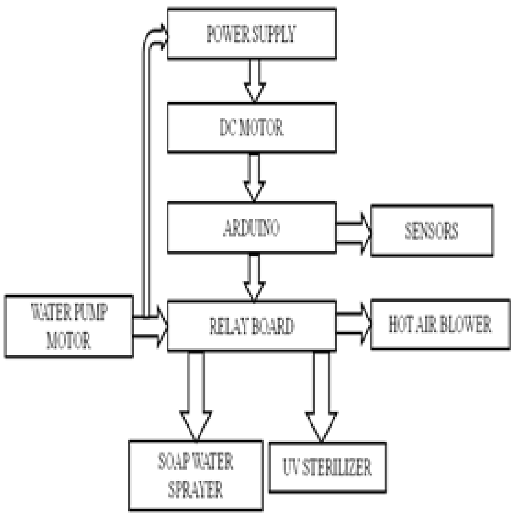

Figure 2

The UV-C based plate sterilizer's flow chart is shown in figure 2 above. First, plates will be provided as the input to the washing machine, where any residual food on the plates will be cleaned away using water.

Following that, plates are cleaned with clean water and soap. The sterilizing device receives the clean plates, which are then sterilized by all germs on the surface of the plates. The use of a hot air blower allows for the drying of plates before submitting them to the sterilizing equipment. The clean, sterilized plates are received as an output from the sterilizing unit uniqueness of the innovation:

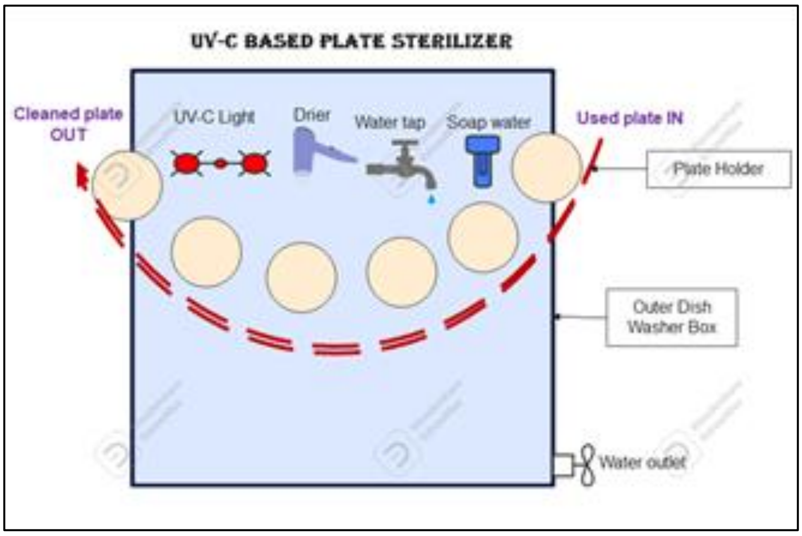

Figure 3: Internal Design of the Model

The above figure 3. shows the internal design of the proposed model. The UVC-based plate sterilizer with a dishwasher is an advanced appliance that combines the functionality of a dishwasher with the disinfecting power of UV-C (Ultraviolet-C) light technology. Using UV-C technology, this sterilizer utilizes UV-C lamps that emit a specific wavelength of light. This light effectively destroys bacteria, viruses, and other harmful microorganisms. By integrating these UV-C lamps into the dishwasher, the sterilizer ensures that plates receive an additional layer of disinfection during the cleaning process. Operating the UVC-based plate sterilizer with a dishwasher is similar to using a regular dishwasher.

First step is to load dirty plates into the holder, then passed through spraying unit and when the dishwasher cycle starts, the UV-C lamps are activated. The UV-C light penetrates the surfaces of the plates, eliminating pathogens present on them. This proposed model is an efficient and convenient solution for maintaining cleanliness and hygiene. Additionally, this appliance is designed with energy efficiency and environmental considerations in mind.

Overall, the proposed UVC-based plate sterilizer with a dishwasher combines the cleaning capabilities of a dishwasher with the disinfecting power of UV-C light technology. It offers an effective and efficient solution for maintaining a high level of hygiene and cleanliness by ensuring that the plates and dishes are sanitized and safe for use.

VI Application:

The UV-based plate sterilizer integrated with a dishwasher has the potential to find applications in various industries and markets where hygiene, convenience, and efficiency plays vital role. Some of the applications are as listed below:

1. **Residential Kitchens:** The residential kitchen market is a natural fit for this innovation, as it caters to health-conscious families and individuals seeking convenient and comprehensive solutions for dish cleaning and sterilization.

2. **Restaurants and Food Service:** In the food service industry, where rapid turnaround and stringent hygiene standards are crucial, this appliance could offer a highly efficient and reliable means of cleaning and sterilizing dishes, utensils, and kitchen tools.
3. **Healthcare Facilities:** Hospitals, clinics, and other healthcare facilities require strict sterilization protocols. The UV-based plate sterilizer with dishwasher could be used to ensure that medical instruments and utensils are not only cleaned but also thoroughly disinfected.
4. **Catering and Event Planning:** The catering and event planning industry often involves handling large volumes of dishes. This appliance could streamline dishwashing and sterilization processes for these businesses.
5. **Educational Institutions:** Schools, colleges, and universities could benefit from this invention to maintain a higher level of hygiene in their cafeterias and dining halls.
6. **Hospitality and Accommodation:** Hotels, resorts, and cruise ships could integrate this appliance to offer guests a heightened level of hygiene and cleanliness during their stay.

In each of these applications, the UV-based plate sterilizer with dishwasher could stand out due to its unique combination of functions, providing enhanced hygiene, time savings, and user convenience.

VII Conclusion:

In conclusion, UV-C based plate sterilizer is an effective and eco-friendly way of sterilizing small objects such as plates, utensils, and other kitchen equipment. It uses ultraviolet light to kill bacteria, virus, and other pathogens without the use of chemicals or harmful emissions. The disinfection process is quick and efficient, taking only a few seconds to complete, and it does not produce any harmful by-products. However, it is important to note that UV-C light can be harmful to human skin and eyes, so precautions must be taken when using the sterilizer. Overall, the UV-C based plate sterilizer provides a safe and efficient way of sterilizing kitchen equipment and is a valuable addition to any household or commercial kitchen.

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52. Development of PD-PWM Technique for 5-Level Cascaded H-Bridge Inverter using FPGA for SPV Systems

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ABSTRACT:

In the recent years, multilevel inverters (MLI) are gaining importance in various industrial applications and distributed energy sources due to its good waveform quality and low switching stress for medium voltage to high power applications. Among different topologies of MLIs, Cascaded H Bridge (CHB) is more suitable converter for SPV system as it provides isolated DC input compared to other topologies. The conventional pulse width modulation (PWM) control techniques have been used to control the CHB inverter. However, these techniques are operated at higher switching frequency results in higher switching loss that leads in harmonic content into the output voltage. In view of this, the paper presents Phase Disposition Pulse Width Modulation (PD-PWM) technique to operate MLIs at fundamental frequency with low harmonic content and less switching losses employed for SPV based applications. The proposed model is implemented using Matlab/Simulink and FPGA Xilinx tool box. Further, the model is validated on hardware test bench consisting of IGBT based inverter connected through three phase uncontrolled rectifier and FPGA based controller. It is observed from simulation and experimental results that the total harmonic distortion content for voltage waveforms found to be 38.10% and 5.36 % respectively. Finally, it is inferred that filtering requirement for 5-level is less as compared to that of two level or three level inverters.

KEYWORDS:

Multilevel inverter, PWM technique, cascaded H bride inverter, SPV systems, FPGA processor.

I. Introduction:

In recent years, people showing more interest in harnessing renewable energy sources over the conventional sources of energy. Solar PV is one of the supreme gifted renewable energy sources. Owing to pollution and noise-free nature, solar PV is extensively adopted to satisfy the increasing energy needs [1]. Generally, the solar PV systems are connected either to utility grid or isolated systems. Grid-connected systems are highly preferred among them because of their various advantages. Usually, an inverter is employed to transfer the power from solar PV to the ac grid. Generally, a low-frequency transformer is used between the inverter and ac grid while processing solar PV's power to the grid [2]. Various thyristor-based grid tied inverters are reviewed in [3]. However, the inverters are preferred only to a low power solar energy conversion system. An IoT enabled solar smart inverter is proposed which is designed and carried out for 2-way communication between the environment and end-user using Wi-Fi [4]. The inverter output is conveyed to the user. The end user having the feasibility to manage the loads using mobile, allowing for more efficient energy use and increased human comfort. Nevertheless, the smart system is applicable only for a stand-alone system and it fails miserably for grid connected system. A novel solar inverter is developed to mitigate the problems associated with conventional inverters such as high switching losses, low efficiency and costly [5]. The designed converter is suited only for distributed generation. MLIs have gained more attention in the field of high voltage and medium power applications due to its advantages such as low voltage stress on semiconductor devices, lower harmonic distortions, good electromagnetic compatibility and reduced switching losses [6-10]. As the number of levels in inverter increases, the total harmonic distortion in the output voltage reduces. The multilevel inverter has 3 topologies such as diode clamped multilevel inverter, flying capacitors multilevel inverter, Cascaded H-Bridge Multilevel Inverter. Among three topologies cascaded H Bridge Multilevel inverter is more advantageous [11]. In Cascaded H bridge multilevel inverter, H-bridges are connected in series and each H-bridge has separate DC source which can be obtained from any natural sources like fuel cells or batteries to produce inverted ac output. Cascaded H Bridge multilevel inverter is simpler than diode clamped and flying capacitor topologies because of advantages such as automatic voltage sharing, smaller dv/dt stress, switching redundancy, requirement of least number of components, no high rated capacitors and diodes [12]. Cascaded H bridge multilevel inverter is suitable for battery, PV based applications where isolated DC source is required [10].

The design of five level Cascaded H Bridge multilevel inverter using PD-PWM technique for harmonic reduction is presented [13]. The THD content of the 5 level Cascaded H Bridge Multilevel Inverter for different modulation index is compared by using mathematical approach and MATLAB/SIMULINK. The performance of symmetrical and asymmetrical single phase cascaded H bridge nine level inverter with respect to harmonic content, number of switches and voltage stress across the switches with SPV panels is simulated using MATLAB/SIMULINK [14]. It is observed from simulation result that, THD and voltage stress across the switches is less in symmetrical type as compared to asymmetrical cascaded H bridge nine level inverter. A detailed discussion on various MLI control schemes is presented in [15]. A novel PWM technique to overcome the problems associated with conventional PWM inverters is depicted in [16]. From aforementioned literatures, following observations are made;

- Cascaded H-Bridge multilevel inverter is suitable for as it provides isolated DC source.
- Voltage stress and total harmonic distortion is less in symmetrical multilevel inverter compared to asymmetrical multilevel inverter.

- Phase Disposition Pulse width modulation technique is more convenient as it generates less harmonic distortion in line to line voltage.
- Quality of the output voltage improves as the number of level increases.

In connection to this, a PD-PWM technique is implemented in this paper for 5-level cascaded bridge MLIs employed for SPV based applications. This work has been performed using FPGA processor as it offers more flexibility in designing of PWM generators for power converters.

II. PWM techniques for 5-level CHB inverter:

The concept of MLI is based on connecting H bridge inverters in series to synthesize desired voltage from separate DC source. A 5-level inverter can be developed to reduce switching losses, THD and electromagnetic interference caused by the switching operation of the power electronic devices. The circuit diagram of cascaded 5-level inverter is as shown in Figure 1.

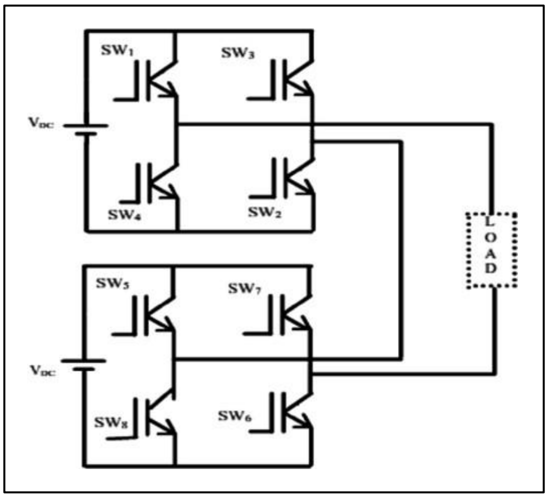

Figure 1: Single phase 5-level CHB inverter

Various PWM techniques are applied for CHB inverters. The most widely used PWM techniques are Phase Disposition- PWM technique, Phase Opposition and Disposition PWM technique (POD-PWM) and Alternate Phase Opposition and Disposition PWM technique [16].

A. POD-PWM Technique:

In the POD-PWM pulse generation technique, n number of triangular carrier signals are compared with a reference sine wave as shown in Figure 2. The generated output pulses produce n-level output voltage waveform.

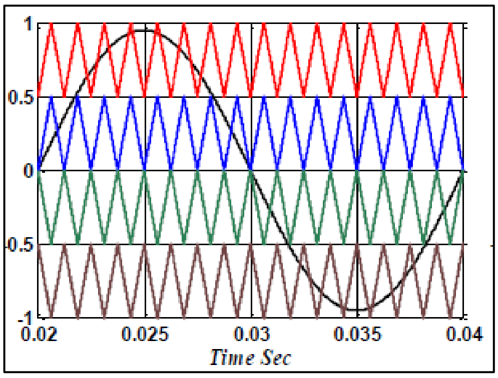

Figure 2: Arrangement of Carrier Wave and Sine Wave

In this strategy, the triangular carrier signals above the zero reference are referred as upper triangular and are represented as T_{un} = [T_{u1}, T_{u2}, T_{u3}]. The carrier signals below the zero reference are referred as lower triangular and are represented as T_{ln} = [T_{l1}, T_{l2}, T_{l3}]. Figure 3 illustrates the control logic schematic of the POD PWM scheme. If the magnitude of the upper carrier is less than the reference sine wave, the comparator generates u_n and generates (u_n – 1) if the condition is not satisfied. On the other hand, for the lower carrier being lower than the reference signal, the comparator produces −(ln −1) and generates −ln if the condition is not satisfied. The output waveforms have the same number of steps as of the aggregated signal. The gate pulses are further acquired by decoding the aggregated signal as per the switching sequence [17].

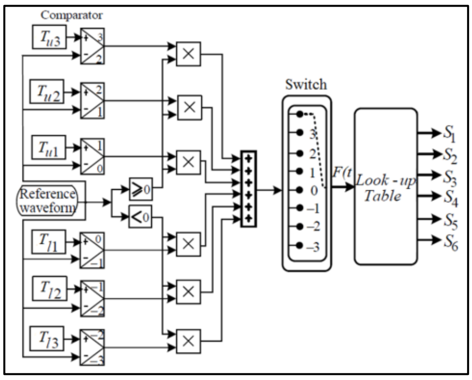

Figure 3: PWM signals generation by POD-PWM technique

B. Phase Opposite Disposition PWM Technique:

In this strategy, the triangular signal compares with sinusoidal reference signal to generate the PWM signals [18]. In this method, multicarrier triangular signals are opposite to each other as shown in Figure 4.

The PWM signals produces if sine wave is larger or equal to the carrier wave on the upper side. Similarly, PWM generates if sine wave is lesser or equal to the carrier wave in the lower side.

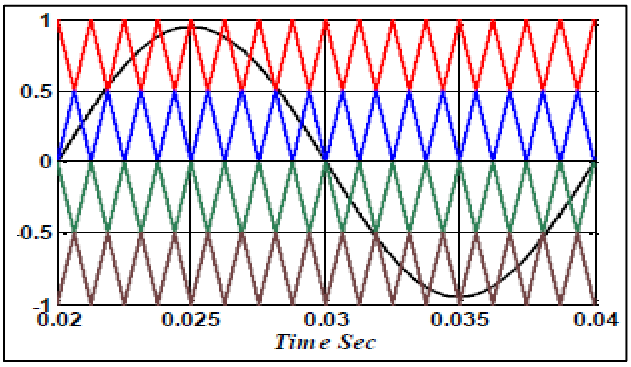

Figure 4: Arrangement of carrier wave and sine wave

III. PD-PWM for 5-level CHB inverter:

PD-PWM is highly preferrable technique compare to others as it generates lowest harmonic distortion in line-to-line voltage and hence PD-PWM strategy is presented in this paper. The switches of cascaded H-bridge inverter operate as er the switching mechanism of PD-PWM technique tabulated in Table-1 to achieve 5-level output voltage.

Table 3.1: Switching mechanism for 5 level CHB inverter as per PD-PWM technique

S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	Output Voltage
1	1	0	0	1	1	0	0	$+ 2V_{dc}$
1	1	0	0	0	1	0	1	$+V_{dc}$
0	1	0	1	0	1	0	1	0
0	0	1	1	0	1	0	1	$- V_{dc}$
0	0	1	1	0	0	1	1	$- 2V_{dc}$

PD-PWM signals for power electronic switches are generated by comparing the modulating sinusoidal wave with the fixed amplitude reference signals. Further, generated pulses used to control the state of switches used in the inverter. Figure 5 shows the controlling scheme for gate pulse generation for H-bridge cells.

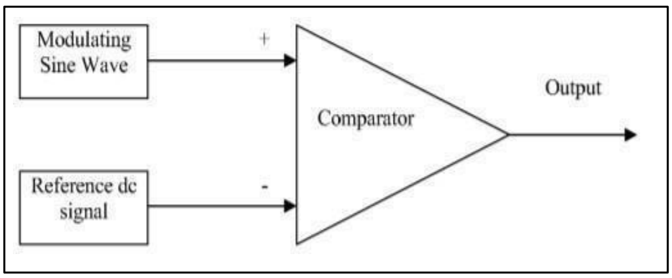

Figure 5: Control Scheme

The generation of 5-level output voltage waveform requires comparison of sine wave with the four fixed DC reference signals to obtain the pulses for all the switches of CHB inverter as shown in the Figure 6.

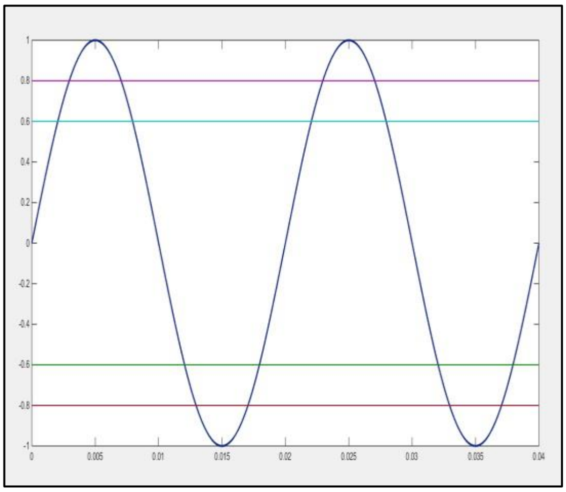

Figure 6: Simulation model of PWM signals for 5-level voltage waveform

Simulation model of PD-PWM technique for 5-level cascaded H-bridge inverter is as shown in Figure 7. It comprises of two isolated H-bridge inverters supplied by separate 20 W SPV panels each are cascaded to generate 5-level voltage output. The output of inverter is connected to 1 KVA R-L load.

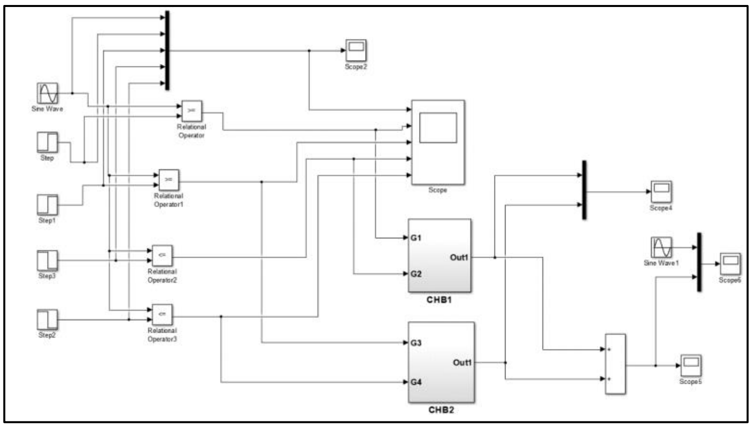

Figure 7: Simulation model of PD-PWM signals for 5-level voltage waveform

IV. Results and Discussions:

SPV based 5-level CHB inverter consists of two independent solar panels having power rating of 20 W each connected to the IGBT based two H bridge MLI separately. The specifications of two solar panels used in this work are as shown in Table-2.

Table-2: Specifications of SPV panel

Sl. No	Particulars	
1	Maximum Power (P_{max})	20 W
2	Current at P_{max} (I_{max})	1.11 A
3	Voltage at P_{max} (V_{max})	18.10 V
4	Short-Circuit Current (I_{sc})	1.25 A
5	Open Circuit Voltage (V_{oc})	21.98 V

The simulation model of PD-PWM technique for the generation of 5-level output voltage for CHB inverter is illustrated in Figure 7. The output voltage of the inverter measured across a load of 1 KVA is as shown in Figure 8.

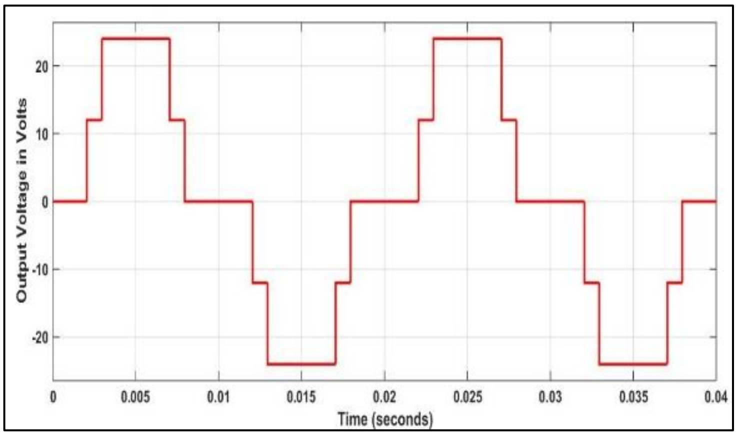

Figure 9 represents the harmonic spectra of load current and voltage of 5 level Cascaded H-Bridge inverter respectively. Harmonics of the output is analyzed and simulated using FFT block in simulink toolbox of Matlab. Output voltage of the proposed modulation technique exhibits half wave odd symmetry. Hence only the positive half cycle need to be analyzed.

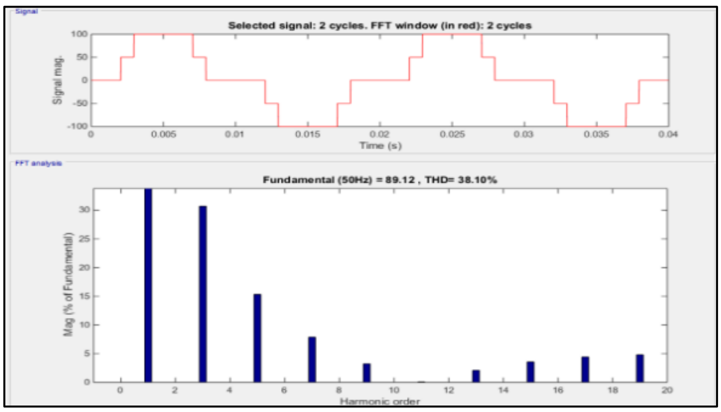

Figure 9: Harmonic spectra of voltage of 5 Level CHB

According to the Fig.8 from the simulation result, the THD content for voltage observed is 38.10%. The simulation result is then validated by conducting an experiment using Xilinx based FPGA processor. The experimental test bench is comprised of two isolated H bridge inverters powered by two independent SPV panels of 20 W capacity. These inverters are cascaded to achieve 5-level voltage across 1 KVA load. The switching signals by PD-PWM technique is obtained by FPGA processor for the operation of IGBT switches in the inverter. The generated switching signals are illustrated in Figure 10.

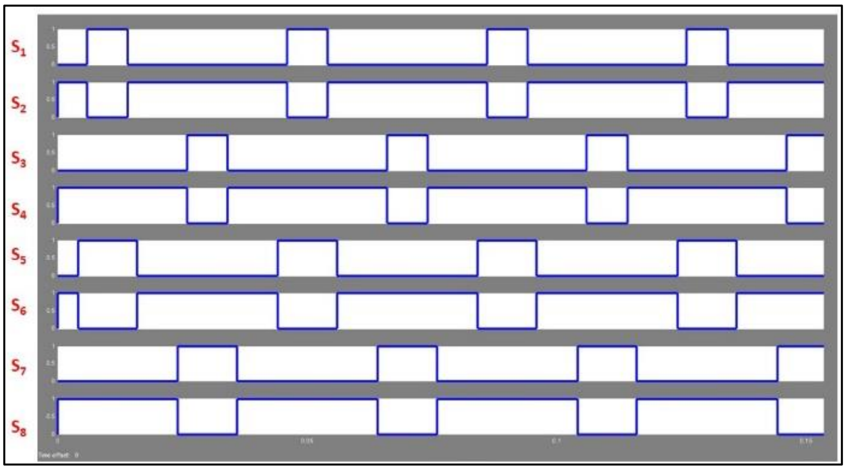

Figure 10: PWM signals generated by FPGA

The generated pulses are given to the gate terminals of IGBT switches for their operation in the CHB inverter. The experimental test bench for conducting this experiment is installed in the research laboratory of BEC, Bagalkot as shown in Figure 11.

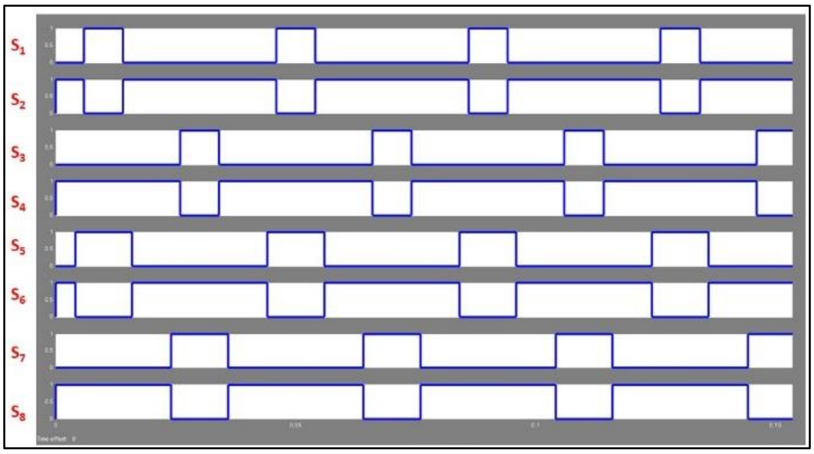

Figure 11: Experimental test bench installed in BEC, Bagalkote

The experiment conducted when the solar radiation was measured to be 950 W/m2 at 12.30 pm on 20th May 2024. As the solar radiation was high, 5-level voltage waveform was recorded across 1 KVA load as shown in Figure 12.

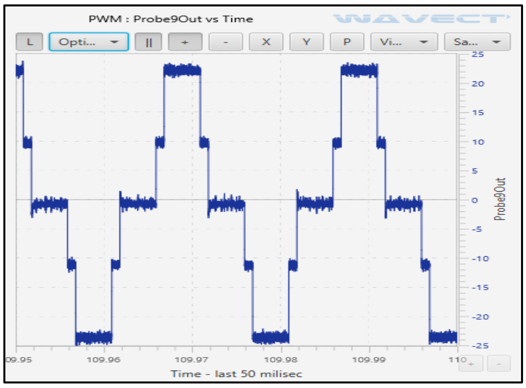

Figure 12: Experimentally obtained 5-level voltage waveform

It is observed from the result that experimentally obtained voltage waveform is very close to the simulated result. Smaller value of ripples was observed in experimentally obtained voltage waveform owing to the variation in the solar radiation. However, ripple is too small that do not affect the load performance. Harmonic analysis is also carried out for one cycle of output voltage waveform achieved by PD-PWM technique. Output voltage of proposed modulation technique exhibits half wave odd symmetry. Hence only positive half cycle was analyzed. It is noticed that higher order harmonics are not severe as a lower, because of the presence of inductance that causes higher order harmonics to damp out more quickly. THD for the experimentally obtained waveform was found to be 5.36%.

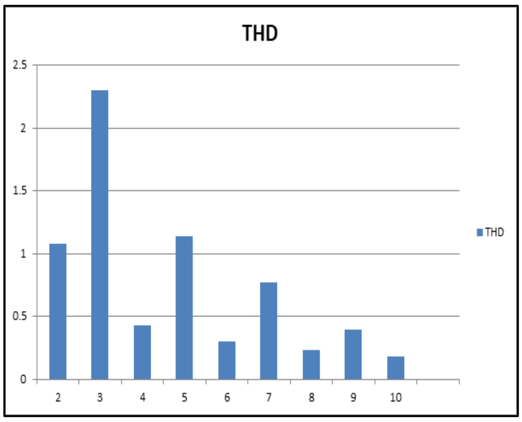

Figure 13: THD of 5-level Voltage Waveform

V. Conclusion:

PD-PWM technique is designed and implemented for 5-level cascaded H-bridge inverter employed for SPV based applications. The simulation of the proposed technique is carried out using MATLAB/SIMULINK platform. In order to carry out the hardware implementation, the entire algorithm is designed in xilinx tools using digital block sets. The developed model is validated on hardware test bench consisting of IGBT based inverter for 1 KVA R-L load.

From the FFT analysis it was observed that as the number of levels of CHB inverter increases THD decreases. THD for 5 level CHB inverter is 38.10% from simulation and THD content obtained from the experimental results is 5.36%. Both the results are compared and validated. From the above results it is concluded that 5 level CHB is more suitable for isolated DC inputs such SPV system.

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53. A Review of Various Attacks and Detection Methods in Internet of Medical Things (IoMT) Systems

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ABSTRACT:

The Internet of Medical Things (IoMT) revolutionizes healthcare by connecting medical devices and enabling seamless data exchange. However, this connectivity introduces significant security risks. This review paper discusses various attacks targeting IoMT systems and the corresponding detection and correction methods leveraging Machine Learning (ML), Deep Learning (DL), Artificial Intelligence (AI), and Blockchain technologies. Recent advancements from 2022 to 2024 are emphasized, highlighting their contributions to enhancing the security and resilience of IoMT systems.

I Introduction:

The Internet of Medical Things (IoMT) offers transformative potential in healthcare by enabling real-time monitoring, efficient data management, and improved patient outcomes. However, its interconnected nature also introduces significant security challenges. This review has highlighted various cyberattacks targeting IoMT systems, including malware, phishing, Denial of Service (DoS), Man-in-the-Middle (MitM), data breaches, device hijacking, side-channel attacks, supply chain attacks, physical attacks, and exploitation of vulnerabilities. To mitigate these threats, advanced detection methods leveraging Machine Learning (ML), Deep Learning (DL), Artificial Intelligence (AI), and Blockchain technologies have been developed. ML algorithms, such as Random Forest and Support Vector Machines, along with DL models like Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN), provide robust capabilities for detecting anomalies and suspicious patterns.

AI techniques, including heuristic analysis and Natural Language Processing (NLP), enhance the detection of complex threats, while Blockchain ensures data integrity and security through immutable logs and secure identity verification.

Effective correction methods are crucial for maintaining the security of IoMT systems. These include regular patch management, antivirus software, network segmentation, user training, multi-factor authentication (MFA), traffic filtering, load balancing, rate limiting, strong encryption, access control, regular audits, firmware updates, secure supply chain practices, and physical access controls.

The ongoing development and implementation of these advanced technologies are essential to address emerging threats and ensure the resilience of IoMT in the evolving cyber landscape. As the IoMT ecosystem continues to expand, a comprehensive approach to security, integrating advanced detection and correction methods, will be vital to safeguarding patient data and maintaining the integrity of healthcare system.

II Attacks and Detection Mechanisms in IoMT:

The Internet of Medical Things (IoMT) refers to the interconnected ecosystem of medical devices and applications that communicate health data over networks. IoMT facilitates real-time monitoring, improves patient outcomes, and enhances the efficiency of healthcare delivery. However, the increased connectivity also introduces vulnerabilities, making IoMT systems prime targets for cyber-attacks. Various Attacks on IoMT are as follows.

Malware Attacks: Malware infiltrates IoMT devices, compromising their functionality and data integrity. Common malware types include viruses, worms, trojans, and ransomware [1].

- **Phishing Attacks:** Phishing attacks deceive users into providing sensitive information through fraudulent emails or websites, leading to unauthorized access to patient data and systems [2].
- **Denial of Service (DoS) Attacks:** DoS attacks overwhelm IoMT networks with excessive traffic, rendering devices and services unavailable to legitimate users [3].
- **Man-in-the-Middle (MitM) Attacks:** MitM attacks intercept and alter communication between IoMT devices and servers, compromising data integrity and confidentiality [4].
- **Data Breaches:** Data breaches occur when unauthorized individuals gain access to sensitive health information due to weak security protocols [5].
- **Device Hijacking:** Attackers take control of IoMT devices, potentially disrupting services or launching further attacks [6].
- **Side-Channel Attacks:** Side-channel attacks exploit physical characteristics of IoMT devices, such as power consumption or electromagnetic emissions, to extract sensitive information [7].
- **Supply Chain Attacks:** Compromises within the supply chain can introduce vulnerabilities into IoMT devices before deployment [8].
- **Physical Attacks:** Physical attacks involve direct access to IoMT devices, leading to tampering and unauthorized data access [9].

- **Exploitation of Vulnerabilities:** Unpatched software and hardware vulnerabilities can be exploited to gain unauthorized access or control [10].
- **Detection Methods:** Machine Learning (ML): ML algorithms like Random Forest, SVM, and K-Means Clustering are used to detect anomalies and suspicious patterns in IoMT data [11].
- **Deep Learning (DL):** DL models such as CNN, RNN, and Auto encoders provide advanced pattern recognition capabilities for detecting sophisticated attacks [12].
- **Artificial Intelligence (AI):** AI techniques, including heuristic analysis and Natural Language Processing (NLP), enhance the detection of complex threats [13].
- **Blockchain:** Blockchain technology ensures data integrity and security through immutable logs, secures identity verification, and decentralized filtering [14].

Correction Methods: Possible correction methods for these attacks are as follows.

- **Patch Management:** Regular updates to software and firmware address vulnerabilities and improve security [15].
- **Antivirus Software:** Antivirus software protects IoMT devices from known malware threats [16].
- **Network Segmentation:** Network segmentation isolates different segments of the network to contain and mitigate attacks [17].
- **User Training:** Educating users on security best practices helps prevent phishing and social engineering attacks [18].
- **Multi-Factor Authentication (MFA):** MFA adds layers of security for accessing IoMT systems [19].
- **Traffic Filtering:** Traffic filtering blocks malicious traffic to prevent DoS attacks [20].
- **Load Balancing:** Load balancing distributes network load to mitigate the impact of DoS attacks [21].
- **Rate Limiting:** Rate limiting controls the rate of requests to prevent system overload [22].
- **Strong Encryption:** Strong encryption ensures secure communication channels and data transmission [23].
- **Access Control:** Access control restricts access to authorized users only, ensuring data security and privacy.
- **Regular Audits:** Regular security audits maintain compliance and identify potential vulnerabilities.
- **Firm ware Updates:** Firmware updates keep device software up-to-date to protect against known vulnerabilities.
- **Secure Supply Chain Practices:** Secure supply chain practices ensure the integrity and security of IoMT devices throughout the supply chain.
- **Physical Access Controls:** Physical access controls prevent unauthorized physical access to devices.

Table I classifies various attacks and corresponding machine learning (ML), deep learning (DL) and artificial intelligence (AI) detection methods in IoMT:

Attack Type	Detection Method	Type	Description	Examples	References
Malware Attacks	Signature-Based Detection	Rule-Based	Uses predefined signatures to detect known malware.	Antivirus, IDS	[35][36][15]
	Anomaly Detection	ML	Detects deviations from normal behavior indicating malware.	Random Forests, SVMs	[5][6][1]
	Behavioral Analysis	ML	Monitors and analyzes device behavior for signs of malware activity.	User behavior analytics	[31][36][15]
Phishing Attacks	Heuristic Analysis	Rule-Based	Uses heuristic rules to identify phishing attempts.	Heuristic antivirus	[25][16][10]
	Natural Language Processing (NLP)	AI	Analyzes text in emails and messages for phishing indicators.	Spam filters, Email classifiers	[24][26][18]
Denial of Service (DoS)	Traffic Analysis	ML	Monitors network traffic to detect abnormal patterns indicating DoS attacks.	Neural Networks, SVMs	[35][36][15]
	Anomaly Detection	DL	Uses deep learning models to identify unusual traffic patterns.	Auto encoders, LSTM networks	[35][36][15]
Man-in-the-Middle (MitM)	Anomaly Detection	ML	Detects anomalies in communication patterns indicating MitM attacks.	Random Forests, Isolation Forests	[35][36][15]
	Encryption and Authentication	AI	Uses AI to enhance	Blockchain-based systems	[30][36][15]

Attack Type	Detection Method	Type	Description	Examples	References
			encryption and authentication mechanisms.		
Data Breaches	Behavioral Biometrics	AI	Uses biometric patterns to detect unauthorized access.	User behavior analytics	[10][31][36]
	Log Analysis	ML	Analyzes system logs to identify unusual access patterns.	SIEM systems	[36][31][35]
Device Hijacking	Anomaly Detection	ML	Monitors device behavior for signs of hijacking.	SVMs, Random Forests	[1][6][15]
	Behavioral Analysis	ML	Analyzes device usage patterns to detect hijacking attempts.	Device behavior analytics	[9][19][35]
Side-Channel Attacks	Anomaly Detection	ML	Detects abnormal side-channel signals.	Neural Networks, SVMs	[10][12][23]
Supply Chain Attacks	Blockchain Technology	AI	Ensures data integrity and traceability in the supply chain.	Secure data management	[31][36][27]
Physical Attacks	Anomaly Detection	ML	Monitors physical access and tampering attempts.	Random Forests, Isolation Forests	[3][24][29]
Exploitation of Vulnerabilities	Anomaly Detection	ML	Identifies exploitation attempts through unusual system behavior.	Neural Networks, Auto encoders	[35][36][15]
Brute Force Attacks	Anomaly Detection	ML	Detects repeated failed access attempts.	Random Forests, SVMs	[35][36][31]
Eavesdropping	Anomaly Detection	ML	Monitors network communication for unusual patterns.	Neural Networks, Isolation Forests	[5][6][15]

Attack Type	Detection Method	Type	Description	Examples		References
Replay Attacks	Anomaly Detection	ML	Detects repeated data transmission patterns.	SVMs, Forests	Random	[33][36][35]
Firmware and Software Attacks	Anomaly Detection	ML	Monitors software behavior for signs of malicious activity.	Neural Networks, Auto encoders		[17][3][5]

Table I: Various attacks and corresponding machine learning (ML), deep learning (DL) and artificial intelligence (AI) detection methods in IoMT

The IoMT ecosystem faces diverse cyber security threats that can compromise patient safety and data integrity. Advanced detection methods leveraging ML, DL, AI, and blockchain play a crucial role in identifying and mitigating these threats.

Effective correction methods further enhance the security of IoMT systems. Ongoing research and development are essential to address emerging threats and ensure the resilience of IoMT in the evolving cyber landscape. Table II presents summary of attacks its detection and correction mechanisms.

Table 2: Summary of Attacks, its detection and correction

Attack Type	Detection Methods	Correction Methods
Malware Attacks	ML: Random Forest, SVM DL: CNN, RNNAI: Heuristic Analysis Blockchain: Immutable Logs	Patch Management, Antivirus Software, Network Segmentation
Phishing Attacks	ML: Logistic Regression, Naïve Bayes DL: LSTM AI: NLP for Phishing Detection Blockchain: Secure Identity Verification	User Training, Multi-Factor Authentication (MFA)
Denial of Service (DoS)	ML: K-Means Clustering, Decision Trees DL: Auto encoders AI: Traffic Analysis Blockchain: Decentralized Filtering	Traffic Filtering, Load Balancing, Rate Limiting
Man-in-the-Middle (MitM)	ML: Anomaly Detection Models DL: Gated Recurrent Units (GRU AI: Encryption Protocol Analysis Blockchain: Secure Communication Protocols	Strong Encryption, Secure Communication Protocols, Certificate Pinning

Attack Type	Detection Methods	Correction Methods
Data Breaches	ML: Anomaly Detection, Isolation Forest DL: Variation Auto encoders (VAE), AI: Blockchain for Data Integrity	Data Encryption, Access Control, Regular Security Audits
Device Hijacking	ML: Support Vector Machines (SVM), DL: Deep Belief Networks (DBN), AI: Federated Learning, Blockchain: Device Authentication	Device Authentication, Firmware Updates, Network Segmentation
Side-Channel Attacks	ML: PCA for Anomaly Detection, DL: Recurrent Neural Networks (RNN), AI: Behavioral Analysis, Blockchain: Secure Data Transmission	Hardware Shields, Electromagnetic Isolation Power Management Strategies
Supply Chain Attacks	ML: Anomaly Detection, K-Means Clustering, DL: Convolutional Neural Networks (CNN), AI: Blockchain for Supply Chain Integrity	Secure Supply Chain Practices, Regular Audits, Firmware Verification
Physical Attacks	ML: Random Forests, DL: LSTM Networks, AI: Physical Security Analysis, Blockchain: Tamper-Evident Logs	Physical Access Controls, Tamper-Evident Seals, Surveillance Systems
Exploitation of Vulnerabilities	ML: Anomaly Detection, Decision Trees, DL: Auto encoders, AI: Heuristic Analysis, Blockchain: Secure Code Updates	Regular Software Updates, Code Reviews, Penetration Testing

III Conclusion:

The security of IoMT systems is crucial for maintaining patient safety and the integrity of medical data. A multi-layered approach, incorporating effective detection methods and robust correction strategies, is essential to protect against various types of attacks. As the IoMT landscape continues to evolve, ongoing vigilance and adaptation to emerging threats will be key to safeguarding these vital technologies.

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54. Hybrid SegAN Fuzzy–Unet and DKN Classification for Crop Field Change Detection using Satellite Images

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Abstract:

Changes in land-cover detection are important landscape characteristics that affect ecosystem conditions and function. Cropland detection is commonly used to find the agricultural area with the help of satellite images. The proposed approach detects the crop field using temporal change detection and satellite images. The satellite image-based crop field change detection is performed using the proposed hybrid DL-based segmentation, and deep Kronecker network (DKN) based crop field change detection.

Keywords:

Deep Kronecker Network, crop, satellite images, segmentation, U-net.

Introduction:

Remotely sensed satellite imagery has been widely used in agriculture, geology, forestry, regional planning, and many other fields to analyse and manage natural resources and human activities. The advancement of imaging technologies has resulted in satellite deployment in recent years with very high spatial resolution imaging systems, enabling satellite images to measure small things on the surface up to 0.5 m and give more precise earth observation [1].

Quantitative information was frequently extracted from satellite photos to monitor the Earth's environment on both a spatial and temporal scale [2]. Because of remote sensing can repeatedly and reliably scan the land surface across wide areas, it has been utilized over the past forty years to monitor land cover and changes [3]. Decision-makers have more and more access to satellite image processing for mapping vegetation and planning future expansion and development. More than ten years ago, remote sensing was discovered as a technique for performance evaluation [4]. For many practical applications, hyperspectral imaging (HSI) analysis is essential.

High spectral resolution images produced by HSI offer a greater amount of information. Numerous applications, including object segmentation and land cover categorization, have made use of this large amount of data. Many techniques for HSI classification rely on the use of manually created features, which lessens the undesirable impacts of pixels and enhances the accuracy of HSI classification [5]. A high-resolution satellite imaging system's architecture is developed through a series of trade-offs between various performance specifications and design trade-offs, such as speed of data transfer, picture compression, revisit time, and off-nadir viewing angle [6].

The availability of high-resolution Satellite Image Time Series (SITS) is a result of technological advancements in Earth observation instruments, as well as better temporal and geographical resolutions. [7]. Global change detection has been done by Land use and land-cover change detection [8]. However, due to trade, socioeconomic shocks, institutional frameworks, and land-use policies, agricultural land abandonment is also a regular land-use change process in many regions of the world [9]. Before and after the change are crucial for segmentation-based change detection, and the temporal information present in the full-time series has not been adequately utilized. Incorporating both spatial and temporal segmentation is advantageous as it aids in comprehending the dynamics of land-use systems, including agricultural abandonment [9].

Land cover detection reflects possible natural and social mechanisms in agricultural development. With the advent of several earth observation satellites, image quality is constantly being improved concerning spatial, spectral, and temporal resolutions [10]. Using remotely sensed data, land-use change analysis has been used at diverse scales and geographic resolutions throughout the world's ecosystems and nations. In addition, ten-year research of the dynamics of crop area, production, and pricing in the study area included farm-level surveys, regional crop areas, productivity evaluation using remote sensing techniques, and national statistics [11].

Deep Learning (DL) has gained popularity in the past few years for picture comprehension problems, such as remote sensing image comprehension. Supervised satellite image analysis has been conducted using DL-based change detection techniques. When the labelled multi-temporal training data are available, a supervised deep learning approach is selected for CD. Additionally, the architecture of a recurrent convolutional neural network (ReCNN) is used to extract joint spectral-spatial-temporal information [12]. Convolutional neural networks (CNNs) were used in several remote sensing applications, including HSI analysis and the classification of high-resolution images, which sparked interest in deep learning in the field of remote sensing [13].

I. Scientific Rationale / Relevance:

The rise of crop production depends mainly on the agricultural land cover. Any area's economic development must be measured and assessed, and identifying shifts in agriculture throughout time is crucial. Therefore, a lot of techniques were developed for crop field change detection. Still, various obstacles were faced such as lengthy processing time, uncertainty of satellite sensors, higher error rate, and so on. Meshkini, K., et al. [12], used Three-Dimensional (3D) CNN. The reliability of the model was high, and it offered a lower value of false alarms. This model could not forecast the other areas with various change classes by using the fine-tuning strategy used for 3D CNN feature extraction. Park, S., *et al.* [2] implemented High spatial resolution image fusion using object-based weighting (HIFOW).

To restore the detailed spatial patterns within crop fields with less spectral distortion and clear crop boundaries the HIFOW model was employed. However, HIFOW did not specify how to fix the multi-sensor images' radiometric discrepancy. Xi, W., *et al*. [3] developed a Spatiotemporal Cube (ST-Cubes) based Spatiotemporal Contextual method. The dense satellite image time series (SITS) data for the intra-annual land cover mapping was given by this model.

Thus, it allowed for more precise temporal scale land cover dynamics investigations. This approach manually determined the “trial-and-error” values. Therefore, the time consumption was high. Liu, W., *et al* [9] used Attention-based multiscale transformer network (AMTNet). It provided high-resolution optical remote sensing data analysis despite complicated textures, varying seasons, and shifting climates.

The AMTNet was not applicable for weakly supervised learning for change detection tasks. Maddala, V.K.S., *et al.* [14] implemented Multisensory Data and Cross-Validation Technique. To confirm the accuracy of the observation, this technique was employed to get feedback from several farms. It was devoid of the extra components that would have improved the overall administration of a wide range of agricultural operations. Tang, C., *et al.* [15] used the Hybrid Dilated HDC-Siam model was utilized for resolving the issues with pseudo-change and intra-class change in mining regions' change detection tasks.

This model did not consider the hybrid optimization approach to train the HDC-Siam to attain more accurate performance. Bhattacharjee, S., *et al.* [16] implemented Remote sensing (RS) and geographic information system (GIS) techniques. In this model, the gradual change of deep water into shallow water over time was enabled by the local community, and it expanded agricultural lands and activities during the dry season.

This approach failed to examine and mitigate the potential impacts of altering the hydrological feature. RF was created by Zhang, T., *et al.* [17] using Bayesian optimization of parameters. With reduced noise and incorrectly categorized pixels, this approach produced the most effective land cover visualization results. This model's shortcoming was that it evaluated the algorithms' performance using a limited number of training datasets. Furthermore, this model's performance in real-time was subpar.

Moreover, the following challenges are faced by the existing approaches:

- Diverse bandwidths along with spectral responses are observed in [2]'s multi-sensor images for identical spectral bands. The spatiotemporal image fusion (STIF) prediction ability was impacted by these various radiometric features of multi-sensor pictures.
- While the parameters in the temporal interaction potential's transition matrix were discovered empirically, the spatial interaction potential of ST-Cubes [3] was obtained using a trial-and-error method. To detect crop fields in other places with distinct change types, these criteria might not be suitable.
- The AMTNet model [9] provided channel attention for enhancing the feature representation of changed areas, while the transformer module provided the long-range dependencies with ease manner. Still, it failed to combine the CNNs, attention mechanisms, and transformers to attain even more precise estimation.
- The RF classifier with Bayesian hyper parameter optimization provided land cover classification performance in a fast manner. However, this model did not consider the hybrid Metaheuristic optimization for getting better performance.

The spatial and temporal features of crop growth status and production were revealed by the satellite-driven crop-field detection, which yielded cropland statistics at local, regional, and global scales. However, there has been a shift in the climate, and there were insufficient quantitative and reliable ways to guarantee the accuracy of crop data, which limited the application of crop field observation and had undetermined and unfavourable effects.

II. Significant Contribution Including Innovation:

In the proposed crop field change detection model, the satellite image collected from the dataset will be preprocessed using the Kaman filter, and the preprocessed image will be subjected to the proposed hybrid fuzzy SegAN fuzzy–Unet based segmentation process. Here, the SegAN Fuzzy–Unet will be created by the merging of SegAN, and Unet, where the layers will be modified by the fuzzy concept.

III. Methodology:

To comprehend and identify ecosystems, resources, and environmental processes, one must have a detailed grasp of land cover, which is provided by satellite images land covers provide essential information for understanding and detecting ecosystems, resources, and environmental dynamics, in which the satellite image provides a precise view of land cover.

Moreover, crop field detection is essential for smart agriculture. Therefore, this work develops the temporal changes in crop fields using satellite images. Initially, the satellite image at time 1 will be subjected to the image pre-processing stage, where the noisy as well as redundant data will be removed using the Kalman [18] filter. Afterward, the segmentation will be performed using the proposed hybrid SegAN. Moreover, the SegAN Fuzzy–Unet will be designed by the combination of SegAN [19] and Unet [20], where layers will be modified using the fuzzy concept. Therefore, the segmented image 1 will be obtained.

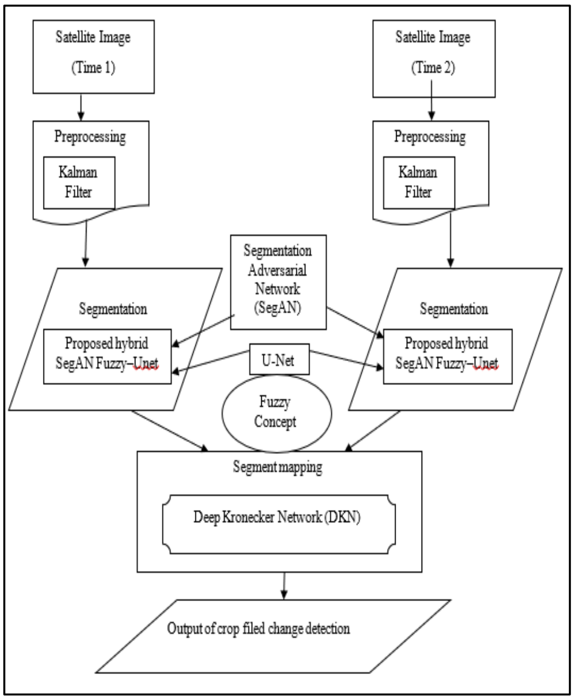

Figure 1: Block diagram of proposed hybrid SegAN Fuzzy–Unet-based crop field change detection model

Moreover, a similar process will be performed for the satellite images with time 2, in which the segmented image 2 will be obtained. Following that, the segmented images of 1 and 2 will be applied to the segment mapping process with the aid of the Deep Kronecker network (DKN) [21]. Finally, crop field change detection will be obtained. Moreover, the proposed model will be implemented in the **PYTHON tool** using the BHOONIDHI@NRSC/ISRO dataset [22]. In addition, metrics like error, accuracy, and Jaccard coefficient will be utilized to compute the model's performance. Figure 1 discusses the suggested model's block diagram.

IV Result:

This section demonstrates the experimental results of the crop change detection using a hybrid SegAN Fuzzy–Unet-based model using the images obtained from the dataset, BHOONIDHI@NRSC/ISRO dataset [22] Maps. Figure 2 shows the sample results of the experiment.

The proposed hybrid SegAN Fuzzy–Unet-based crop field change detection model offered good performance on agricultural fields. The crop field change detection is performed using the BHOONIDHI@NRSC/ISRO dataset. In the existing schemes, the major issue is the flawless results with better accuracy. However, the proposed method provides an accuracy of more than 98%. The proposed approach considerably reduced the computational complexity and thus offered enhanced accuracy in prediction. The hybrid DL network approach delivers an effective segmentation process of a crop field.

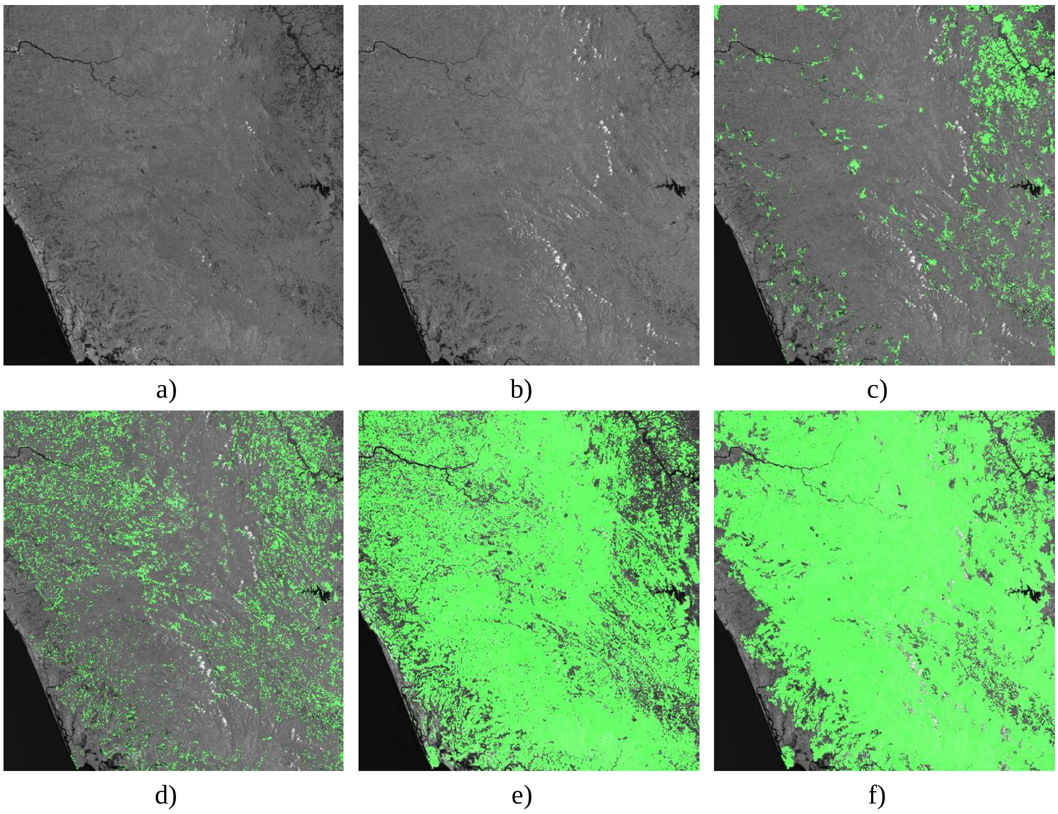

Figure 2: Sample results of the experiment using - a) Original image of reference image b) Original image test image, c) crop change reported in reference image d) crop change reported in test change, e) Segmented result using a reference image, f) Segmented result using a test image

Table I

Methods	Accuracy	Sensitivity	Specificity
STIF	0.948	0.954	0.764
ST-Cubes	0.936	0.962	0.624
AMTNet model	0.924	0.976	0.841
SegAN Fuzzy–Unet	0.981	0.985	0.887

V Conclusion:

Variations in the detection of land cover are significant features of the landscape that impact the state and functionality of ecosystems. Using satellite imagery, the agricultural region is frequently located using the process of "cropland detection." The suggested method uses satellite imagery and temporal change detection to identify the crop field. The suggested hybrid DL-based segmentation and deep Kronecker network (DKN) based crop field change detection are used to carry out the satellite image-based crop field change detection.

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55. IOT Based Pollution Monitoring and Controlling System

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Abstract:

Industrial pollution has become a major concern worldwide, and effective monitoring and controlling systems are needed to prevent environmental damage and protect human health. In this proposed system, the designing of an IoT based system for monitoring and controlling industrial pollution is carried out. The system consists of a network of sensors, a data acquisition unit, a cloud-based platform, and a user interface. The sensors are deployed at different locations in the industrial area to measure various pollutions such as air, water, and noise. The data acquisition unit collects the sensor data and sends it to the cloud-based platform for storage and analysis. The controlling unit is responsible for activating various controlling mechanisms that is intimation to Pollution Control Board (PCB) which is responsible to remove the power supply to the industry that is polluting based on the pollution levels. PCB re-enables the power only if a penalty is paid by polluting industry and once the power is re-enabled, the process/work of industry continues. The user interface that is Blynk IOT app provides a dashboard that displays the real-time data. The dashboard also allows users to configure the system, set threshold values, and generate reports. It can help industries to comply with environmental regulations, reduce pollution levels, and improve their sustainability.

Keywords:

Pollution, sensor, IoT, monitor, control.

I. Introduction:

The pollution, whether in the form of air, water and sound can have detrimental effects on human health. Monitoring pollution levels helps to identify areas with high concentrations of pollutants, enabling authorities that is Pollution Control Board (PCB) to take appropriate actions to reduce the emission of pollutants and thereby reduce the pollution [5]. By controlling pollution sources, such as industrial emissions or hazardous waste disposal, the risk of adverse health effects can be reduced.

Pollution poses a significant threat to the natural environment, including ecosystems, wildlife, and biodiversity. Monitoring pollution allows the identification of sensitive areas and ecosystems at risk. Controlling pollution helps to prevent ecological imbalances, habitat destruction, and the decline of species populations.

Industrial pollution is a major environmental challenge that affects the health of human being, animals, and ecosystems. To tackle this problem, many countries have established regulations and guidelines for monitoring and controlling industrial pollution. However, the implementation and enforcement of these regulations would be difficult without proper monitoring and control systems in place.

The proposed system aimed at developing a monitoring and control system for industrial pollution. This can help industries comply with regulations and reduce their impact on the environment. It involves sensors for monitoring and measuring air, water, and noise pollution. This system also includes implementation of control measures to eliminate pollution at the source.

The controlling unit is responsible for activating various controlling mechanisms that is intimation to Pollution Control Board (PCB) which is responsible to remove the power supply to the industry that is polluting based on the pollution levels. PCB re-enables the power only if a penalty is paid by polluting industry and once the power is re-enabled the process /work of industry continues.

Overall, a proposed system is focused on monitoring and controlling of three major pollutions i.e. air, water and noise that can have significant environmental, economic, and social advantages. It can help to protect human health, reduce the impact on ecosystems, and promote sustainable industrial practices.

II. Related Work:

K. Rambabu, et al in the year 2016 [1] proposed a system "Industrial pollution monitoring using Lab-View". Their system monitors pollution due to carbon monoxide and aimed at only one parameter i.e. air pollution monitoring and did not take the measures for control action.

Zumyla, et al in the year 2019 [2] proposed "IoT based Industrial Pollution Monitoring System a smart city pollution monitoring and control system using IoT and big data analytics. The system includes various sensors to monitor air pollutant. The collected data is transmitted to a cloud-based platform for further analysis and visualization. The system also includes an alerting mechanism to notify authorities of high pollution levels. This proposed system design aimed at only one parameter that is air pollution monitoring and did not take the measures for control action.

Demetillo, et al. in the year 2019 [3] proposed a system a system for monitoring water quality in a large aquatic area using WSN technology. This system measures dissolved oxygen temperature and pH of water. This system did not take the measures for control action also did not consider any control actions to reduce the pollution.

Increasing pollution day by day in atmospheric condition in the form of air water and noise leads to increase in global warming, destruction of Ozone layer and also creating a lot of health issues for the human being.

There are several steps taken to control the problem but the methods are not so effective because some designs included either of parameters, air, water or noise pollution monitoring and controlling and some included only monitoring and use huge amount of human interaction increasing the negligence which leads to the problem to be not solved in a systematic way.

The Pollution Control Board (PCB) department is not so active to visit each industry manually and to take the action of the particular industry who exceeds these predefined safe values of pollution limits. Hence this proposed system encompasses all three parameters air, water and noise pollution monitoring and controlling.

III. Proposed System:

The block diagram of proposed pollution monitoring and controlling system is shown in figure 1. The proposed system consists of Node MCU, CO_2 (MQ135) sensor module, water pollution detector (IR photo diode sensor), noise pollution detector (microphone sound sensor). These sensors are used to measure the levels of pollutants such as carbon monoxide, carbon dioxide, nitrogen dioxide, sulphur dioxide, and particulate matter in the air, water pollution and noise level.

The sensors are connected to a microcontroller that collects the data and transmits it to the controlling unit using a communication module such as Wi-Fi or Bluetooth. The controlling unit receives the data and processes it using a software program to determine the pollution levels.

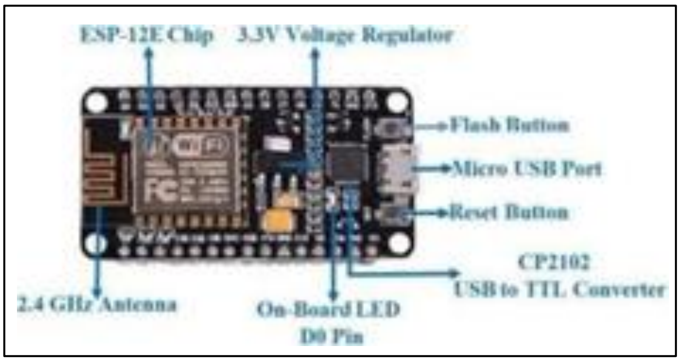

Figure 1: Blockdiagram of Pollution Monitoring and Controlling system

A. Node MCU:

Node MCU as shown in Figure 2 and 3 is an open-source development board specially used for IoT based Applications. It has firmware that runs on the ESP8266 Wi-Fi SoC, and hardware that is based on the ESP-12 module.

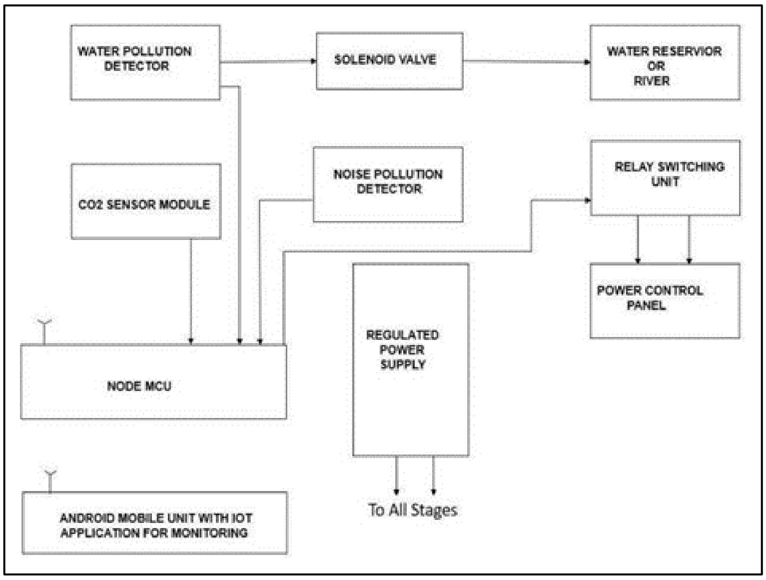

Figure 2: Node MCU

Figure 3: Node MCU (labelled)

B. MQ135 Sensor:

The MQ135 sensor shown in Figure 4 is based on metal oxide semiconductor (MOS) technology, where the sensing element is made of a thin film of tin dioxide (SnO_2) that is heated to a high temperature. When the sensor encounters a gas, the gas molecules are absorbed by the sensing element, causing a resistance change in the sensor (the change in resistance is then detected and converted into an electrical signal by the sensor) [4, 9, 15]. These changes are measured by the sensor's circuitry, which can provide an output voltage proportional to concentration of gas being detected.

The MQ-135 sensor is sensitive to a wide range of gases such as ammonia, carbon dioxide, nitrogen oxides, and benzene. It has a detection range of 10 to 1000 ppm (parts per million) for most gases, with a maximum sensitivity to carbon dioxide gas. The sensor has a response time of less than 10 seconds and a recovery time of around 30 seconds.

Figure 4: Air Pollution Sensor

C. IR Photo Diode Sensor:

An IR (infrared) photo diode sensor used as water pollution sensor shown in Figure 5 is a type of electronic component that is used to detect infrared light. The sensor comprises of a photo diode, which is a semiconductor device that generates a small electrical current when it is exposed to light [7, 8]. Infrared light has a longer wavelength than visible light and is not visible to the human eye. IR photo diode sensors are commonly used in these devices to detect the infrared signals and convert them into electrical signals that can be processed by the device. This Sensor module works on the principle of Reflection of Infrared Rays from the incident surface. A continuous beam of IR rays is emitted by the IR LED. Whenever a reflecting surface comes in front of the Receiver (photo diode), these rays are reflected and captured. Based on the amount of light that is reflected, amount of water polluted is decided. When the pollution level in industry exceeds the predefined safe value output goes high. This signal is connected to IOT NODE MCU unit to take further actions.

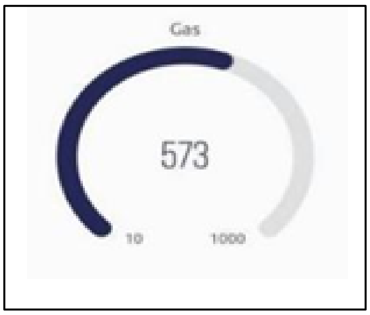

Figure 5: IR Photo diode sensor

D. Microphone Sound Sensor:

A microphone sound sensor used as noise pollution sensor shown in Figure 6 is a device that is designed to detect and measure sound waves in the environment. The sensor contains a small diaphragm that vibrates in response to sound waves, which is then converted into an electrical signal that can be processed by a processor [9, 12]. When noise inside the industry is detected by using the microphone, the sound signals are converted into electrical signals, because of this condition the potential difference between two inputs at comparator also changes and the comparator output goes from its low to high state. This signal is coupled to IOT Node MCU unit to take further actions.

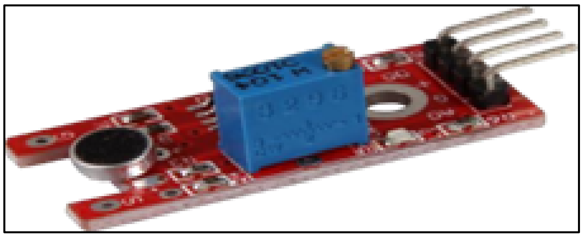

Figure 6: Noise Pollution Sensor

IV Results and Discussion:

The IOT based pollution monitoring and controlling system has yielded promising results in addressing air, water, and noise pollution. Through the implementation of various strategies and measures, significant progress has been noticed in reducing pollution levels and controlling its adverse impacts by removing the power supply to the industry which is polluting.

A. Air Pollution:

For detection of air pollution MQ135 sensor is used, which measures the concentration of gases in the atmosphere like benzene, ammonia, oxides of sulphur, oxides of nitrogen, and oxides of carbon, the major pollutant contributing for air pollution is CO2 and it is detected by this sensor. The output is analog voltage which is converted to ppm and is displayed in cloud interfaced platform used in this system that is Blynk app (Blynk IOT ESP8266). The concentration of CO2 level is displayed in Gauge as shown in Figure 7, the detection range of MQ135 sensor is 10-1000 ppm, if the value of concentration of CO2 exceeds 400 ppm (400ppm-threshold value), it is considered as polluted air and control measure of enable/disable of power supply control action is taken by pollution control board (PCB). This control action results in a noticeable decrease in pollutant concentrations in the environment. Stricter emission standards, and enforcement of regulations will contribute to improve air quality, reducing the risks of respiratory and cardiovascular diseases.

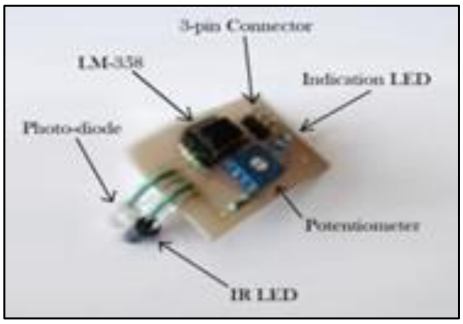

Figure 7: Air Pollution level indicator

The sensitivity range of MQ135 sensor is 10-1000ppm and the threshold value is 400ppm. If the gas concentration value exceeds 400ppm then it is viewed as air pollution.

B. Water Pollution:

For detection of water pollution "IR photo diode sensor" is used, which indicates the water quality. The detection of water quality is dependent on intensity of light received by the photo diode when IR LED transmits the light, this sensor is placed in the waste water outlet of the industry. The output of sensor is digital, if value is digital '1' then it is the indication of polluted water, for digital value '0' gives the indication of pure water as shown in Figure 8. This result will be displayed in the Blynk app (Blynk IOT ESP8266) in Gauge. Based on these results the Pollution Control Board (PCB) is responsible for taking the control action, that is to enable/disable the power supply. The Strict regulations on industrial effluents will lead to a significant improvement in water quality. Water bodies which will contaminate can be reduced, ensuring a healthier aquatic ecosystem and a safer water supply for communities.

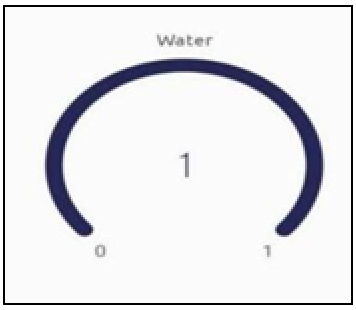

Figure 8: Water Pollution Level Indicator

C. Noise Pollution:

For the detection of noise, Microphone sound sensor is used, when sound in the air hits the diaphragm the plates of sensor vibrates and the distance between two plates varies, this gives the sound level in air. The sensitivity range of sensor is 48- 52 dB. The output of sensor is digital. If the output of sensor is digital '1' then it is the indication of noise pollution, digital value '0' indicates there is no noise pollution as indicated in Figure 9. This result will be displayed in the Blynk app (Blynk IOT ESP8266) in Gauge. Based on these results the Pollution Control Board (PCB) is responsible for taking the control action that is to enable/disable the power supply.

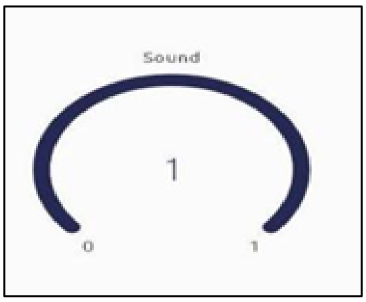

Figure 9: Noise Pollution Level Indicator

Measures to control noise pollution yields positive outcomes, leading to a quieter and more peaceful environment. Implementation of noise reduction measures, such as sound barriers and zoning regulations will contribute to improvement in quality of life for the people living near noisy areas.

Based on the above results, the Pollution Control Board (PCB) cut off the power supply to the polluting industry if the output of the sensor exceeds the values set by the PCB and the power supply is reconnected if the penalty is paid to the PCB.

The results of the pollution monitoring and controlling demonstrate the effectiveness of comprehensive strategies in protecting the environment. While significant progress has been made, continuous efforts, and ongoing monitoring are essential to sustain the achieved results and further improve environmental quality. Model of IOT based Pollution Monitoring and Controlling System is shown in Figure 10.

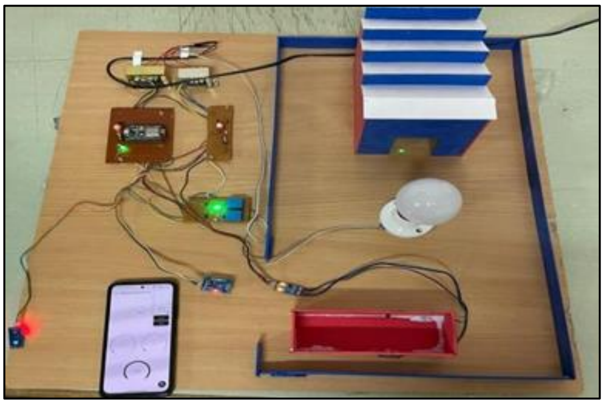

Figure 10: Model of IOT Based Pollution Monitoring and Controlling System

V. Conclusions:

The pollution monitoring and controlling has been a significant endeavor in addressing the growing concerns regarding pollution. The proposed system aimed at monitoring various forms of pollution such as air, water and noise and implement effective control measures to avoid the harmful effects on the environment and human health. This proposed system emphasizes the need for sustained monitoring and adaptation to ensure long term success in pollution monitoring and controlling. Regular monitoring and evaluation of pollution levels will help to identify emerging issues and allow for the implementation of timely interventions and adjustments of control measures. The control measure taken is to cut-off the power supply by Pollution Control board (PCB) for the industries which are polluting and re-enable the power supply if and only if the polluting industry has paid the penalty.

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56. Design and Implementation of Multi Prime Mover Coupled Novel Water Pump for Small Scale Irrigation Requirements

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Abstract:

The deficient in electricity and high diesel costs affects the pumping requirements of irrigation systems for small scale agriculture. Therefore, using solar energy and other sustainable water pumping methods is a promising alternative to conventional electricity and diesel based pumping systems. This paper presents a hand held & pedal driven novel type water pump for irrigation system, which can also be operated by solar PV systems and AC electric supply mechanisms. The proposed model includes solar panel, DC motor, hand operated driver & pedal operated driver and a novel pump mechanism. The proposed water lifting pump is coupled with 350 W, 36 V DC motor. This motor rating is selected for optimum water output for lower heads of 5-10 meters. Hand driven and pedalling activities by individuals can results in 20 litres per minute of water. Further, DC motor can be operated directly from solar panel is hot sunny days during bright sunshine hours. During lesser radiation conditions, pump can be operated via hand or pedal driven and by grid connected supply through rectifier circuits. The pumping mechanism is constructed using PVC pipe structure with water lifting structure along the pipe. The guy rope is located intact with lifting vanes and this is coupled to the shaft of the wheel connected to prime movers. The proposed model is tested with all the provision made for operation and the results are tabulated. The results revealed that the novel pump can be effectively employed for small scale agriculture. This will significantly save the electricity & diesel dependency and also provides the sustainable solution for water pumping for small scale agriculture.

Keywords:

Water pump, Centrifugal pump, Pipe Networks, Solar Panels, DC Motor

1. Introduction:

Small-scale farming accounts for a large percentage of agriculture in India. A sizable section of the population in India depends on small-scale agriculture for their livelihood, which is important to the country's economy and society. Approximately 86% of all operating holdings are categorized as small and marginal, or smaller than 2 hectares, according to the Agricultural Census. Fragmented Landholdings and Small & Marginal Farmers are indicators of Landholding Patterns in India. Due to population growth and inheritance restrictions, the average landholding size has been declining, resulting in farms that are less productive and more dispersed. In India, agriculture makes up about 17–18% of the country's GDP [1-3]. Even though small-scale farming frequently faces low productivity and income, it remains an essential component. About half of all Indian workers are employed in agriculture, with small-scale farmers accounting for a sizable share of this sector. Additionally, they deal with serious problems in the technique of irrigating their little area covered agriculture fields by using expensive irrigation systems. However, in order to assist small-scale farmers, the government offers incentives for irrigation equipment. To boost agricultural activity, efforts are being made to upgrade irrigation systems in rural areas. Small-scale farmers in India have a practical and sustainable option in hand-held water pumping systems, especially in areas with shallow water tables [4-8]. They support small farmers' general way of life by enhancing agricultural yields and streamlining irrigation techniques. In practice Monoblock and end suction centrifugal pumps pumps are employed in irrigation systems. The comparative analysis of monoblock and end suction centrifugal pumps pumps is presented in Table.1. Further, Tabe.2 presents the specifications and pumping parameters of a submersible pump.

Table 1: Comparison of Monoblock and End Suction Centrifugal Pumps

Parameters	Mono block pump	End suction centrifugal pumps
Suction size (mm)	50-125	65-100
Delivery size (mm)	40-125	50-100
Impeller diameter (mm)	185-300	109-300
Total head (m)	4-45	6-30
Discharge (l/sec)	1.4-73	4.2-38.0
Revolution per minute	1380-1430	1400-2870
Motor rating (kw)	1.5-7.5	0.75-6.5

Table 2: Specifications of A Submersible Pump

Parameters	Specifications		
Pump size (mm)	100	150	200 & above
Number of stages	20-30	7-30	3-12
Stage-hp	0.08-0.25	0.25-3.0	3.30-40.0
Total head per stage (m)	1.6-4.6	5.0-10.5	12.0-31.0
Discharge (l/min)	20-350	30-1200	300-650

In India's agricultural industry, centrifugal pumps are essential since they raise farming methods' sustainability and productivity. They do, however, have problems with maintenance and power supplies. Reliance on energy might provide difficulties in places with erratic power supplies. As a remedy, solar-powered centrifugal pumps are being investigated. Moreover, durability and effectiveness depend on routine maintenance, which can be difficult in isolated places [9-14]. In this connection many literatures presented the novel pumping mechanisms where water pumping is done independent of electricity.

II Background of Water Lifting Mechanisms:

Man's physical power production is limited and may be between 0.08 and 0.1 horsepower. For irrigation purposes, this power can be used to raise water from shallow depths. The gadgets that the average person powers are the paddle wheel and swing basket. The swing basket is a device consisting of a basket with four ropes attached that is built from inexpensive materials such as iron sheet, leather, or woven bamboo strips. When two people hold a basket with their backs to each other and dip it into a water source, the basket is lifted and filled with water from the watercourse where it flows into the fields by swinging. The gadget is functional down to 15 meters, and its discharge capacity ranges from 3500 to 5000 liters per hour. A paddle wheel is made up of tiny paddles that are radially mounted on a horizontal shaft. The shaft moves in a tightly fitted concave trough, forcing water in front of the paddles. The quantity of blades varies based on wheel size; 8 blades for 1.2 meters in diameter and up to 24 blades for 3 to 3.6 meters. The 12-bladed wheel can raise roughly 18,000 liters per hour from 0.45 to 0.6 meters of water. India had an abundance of animal power. Along with other field activities and processing jobs, they are utilized for raising water. Two bullocks could produce about 0.80 horsepower. They are capable of lifting water up to 30 meters deep. Naturally, as lift increases, the rate of discharge will decrease.

Around 3000 BC, water raising devices have been present in many places of the world. The energy needed to turn the wheels was provided by animals (muscle energy) in the construction of early devices like water wheels and chutes. Later on, pumps like the "Archimedean" helicoid pumps were created and are still in use today. Until the previous century, a variety of water-lifting machines known as "tympana" (drums) were extensively employed for mining and irrigation. Shaduf is recognized as the original water-lifting device in many ancient civilizations. It has been called shaduf (shadoof) in Egypt, zirigum in Sumer, kilonion or kelonion in Hellas, daliya in Iraq, picottah in Malabar, lat in India, gerani or geranos in Hellenistic Egypt, kilan (derived from the Greek word kilonion) in Israel, and tolleno in Latin countries, among other names. It is a manually powered wooden tool for raising water out of a canal, cistern, river, or well. Its most popular configuration consists of a long, nearly horizontal wooden pole that taper down to resemble a seesaw. On one end of the pole, a bag and rope are fastened, and on the other, a counterbalance.

Filling the container, the operator pulls down a rope that is tied to the long end, allowing the counterweight to hoist the filled container. Sometimes a sequence of shadufs was arranged one atop the other. 2.5 m3/d was a normal water lifting rate. Thus, 0.1 hectares of land might be irrigated in 12 hours by a single shaduf. Around 3000 BC, the Mesopotamians were known to use the shaduf to hoist water. The 18th Dynasty (c. 1570 BC) in Upper Egypt is when the shaduf, which was already in use in Mesopotamia, first debuted. This was sometime after 2000 BC.

This apparatus made it possible to irrigate farms close to canals and riverbanks during the year's dry spells. Later on, the system was improved by adding a pulley and animal traction to raise water levels from deep wells. It is still commonly used today to irrigate small land plots near wells and to provide drinking water. The Arabian Peninsula also saw adaptations of the gadget.

III Proposed Mechanism of Novel Pump:

The conceptual block diagram of proposed multi prime mover coupled novel pump is presented in Figure 1. The system consists of a solar panel, DC motor, water pump, hand driven and pedal operated driver. Between the solar panel, battery, and DC motor is a charge controller. Included is a set of rectifiers for feeding DC power from an AC source. The motor provides mechanical energy to the water pump's rising pulley. With the aid of an appropriate guide, the rope is pushed by a rising pulley at ground level, which draws it down into the water tank and up through rising pipe. To prevent piston slippage, pistons are kept at the ideal distance from one another and equally spaced. This allows water to be raised and collected in a tank or allowed to flow further as needed. In lower radiation environments, the water pump is manually operated or pedaled like a stationary bike.

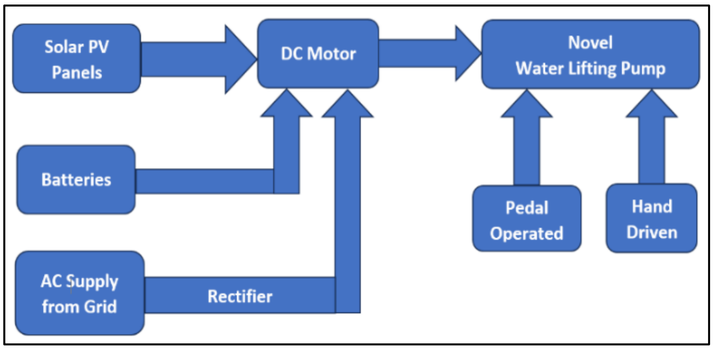

Figure 1: Block diagram of the proposed methodology

The suggested pump is made up of a closed looped rope pushed via a water-immersed conduit that has pistons attached at equal intervals. A guidance box is installed at the bottom of it. The main function of the guide box is to raise the rope that descends into the tank and steer it upward into the riser pipe. The water is raised by the pistons that enter the rising main pipe until it reaches the top, where there is a spout that allows it to exit. Rotation of the pulley wheel located at the top will pull the rope down. The water spout is raised by the piston being pulled through the rising main pipe by the friction between the pulley wheel and rope. The handle, which is housed in a pump structure atop the tank, doubles as the pulley wheel axle. A guide located close to the tank's bottom ensures that the rope with the piston enters the rising main smoothly. The bottom end of the riser pipe's edge prevents pistons from being hooked. Water is raised and held in the collecting tank. The proposed water lifting system consists of solar panels, DC motor, Frame, Pulley, Rope, Piston, Rising pipe, Discharge pipe and a Guide box. Figure 2 presents the conceptual diagram of the proposed pump. Figure 3 presents the constructed pipe structure to lift the water from the storage tank.

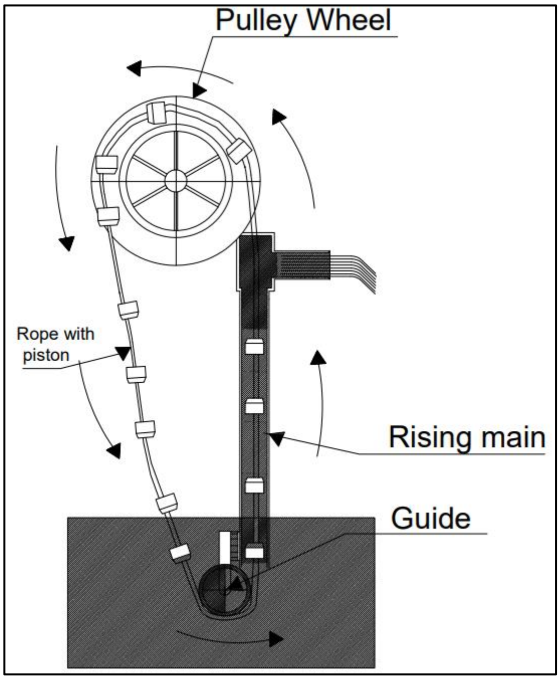

Figure 2: Block Diagram of the Proposed Methodology

Figure 3: Developed Model for Lifting the Water from The Source

Figure 4: Solar PV Panels Used for The Pumping

Table 3: Specifications of SPV panels

Parameters	Specifications
Model Number	HST72F330P
Pmax	330 W
Voc	46.12 V
Isc	9.32 A
Vmp	37.40 V
Imp	8.83 A

Figure 5: DC Motor Coupled to Pump Through Pulley

The torque in a DC motor can be calculated using the motor's electrical parameters. The equation (1) presents the torque developed by motor.

$$T = \frac{P_e}{\omega} \qquad \text{………(1)}$$

Where,

T is the torque developed by the motor in N-m

Pe is the electrical power in watts

ω is the angular velocity in radians per sec

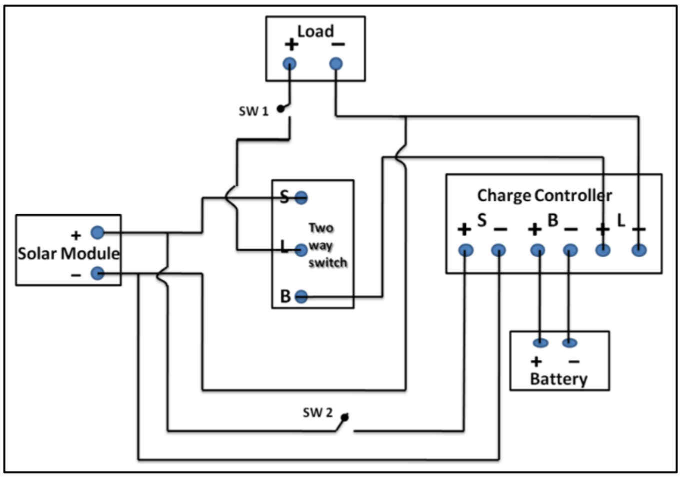

Figure 6: Connection Diagram with Charge Controller

A pulley, also known as a supporting shell or axle, is a wheel on an axle or shaft used to facilitate the movement and direction changes of a taut cable. A rope, cable, belt, or chain that passes over the pulley inside the groove or grooves can serve as the drive element of a pulley system. To apply significant forces, a block and tackle is constructed from pulleys to create a mechanical advantage. In belt and chain drives, pulleys are also built to transfer power from one rotating shaft to another.

Figure 7: Guided Pulley and Wheel Employed in The Model

While they work well for pulling and hoisting, ropes lack the compressive strength. They are therefore unsuitable for compressive applications such as pushing. Compared to cable, line, string, and twine that are formed similarly, rope is stronger and thicker. While wire rope is composed of wire, fiber rope is made of fiber. A rope's qualities include strength, durability, resistance to water, and non-stretching while use.

Additionally, it is not overly smooth to prevent wheel slipping. Rubber can be used to make pistons; for example, the side section of an old vehicle tire can be used. Wood and leather have also been used, though less successfully. High-density polyethylene pistons are effective and simple to manufacture in standard sizes. These ropes are not too long or too slack. Nylon ropes are an option, but they have a propensity to sag and slip. The ideal rope diameter is 6 mm. Knots or melting a piece of rope on both sides of the piston might be used to secure it to the rope. There is one meter separating the two pistons. There will be sliding between the pistons and the wheel if there are more pistons on the rope. Piston diameter varies with the size of the rising main. To secure the piston a knot is placed before and after each piston.

Figure 8: Piston with Rope

A vertical pipe that rises from the earth to feed water to the discharge pipe is called a rising pipe in this context. The tubes utilized here are low pressure types since the pressure in the rising main is low. The tube diameter at the top (the discharge and outlet) should be greater than the diameter of the ascending main tube. The pump structure or another fixed place should be where the discharge tube is fastened. The volume of water that may be raised is determined by the rising pipe's diameter; greater diameters allow for the lifting of heavier water. Thus, in order to avoid making the lifting excessively taxing, smaller diameter pipes must be used for very small wells. The pipe used to transfer fluid to the exit tank is referred as the discharge pipe. The discharge pipe is slightly angled in relation to the rising pipe to enhance fluid flow. The rope and pistons, which fit into the rising main with a 1 mm clearance, raise the water. The ascent major culminates with a to guarantee a maximum rate of discharge, the inclination is set at an angle of less than 90°. Another essential component of the pump is the guide. Its purpose is to prevent the pistons and rope from rubbing against the raising main's entry by guiding them into it. Using the guidance to determine the ideal blend of durable materials beneath the water rope—whether it be glass or glaze—is crucial.

Table 4: Proposed Systems Components and Specifications

Sl.	System Components	Specifications
1.	Piston	Diameter – 35 mm, Thickness - 4 to 5 mm, Material - HDPE (High density poly ethylene)
2.	Rope	Diameter – 6 mm, Material- Fiber

Sl.	System Components	Specifications
3.	Guide Pulley	Outer & Inner diameter – 65 mm & 22 mm, Width – 70 mm, Material: Nylon
4.	Rising pulley	Diameter – 66 cm, Material – Steel
5.	Rising and Discharge Pipe	Diameter – 3.8 cm, Material – PVC
6.	Guide box	Coupler - 4 inch, Eccentric Reducer – 110 X 75 mm, Material - PVC
7.	DC Motor	24 V, 350W
8.	Battery	26 Ah, 12 V Lead Acid Exide
9.	Solar Panels	250 W, 12 V polycrystalline

Figure 9: Guide Box Employed with Rope and Pulley

Figure 10: Assembled Model of the Water Lifting Pump

Figure 11: Hand Held Operation and Water Output of Pump

Figure 12: Side View of the Assembled Model with Peddling Mechanism

Figure 13: Peddling Operation and Water Output of Pump

IV. Results and Discussions:

The proposed pump is tested for its performance under different conditions. DC motor coupled to the pump, is tested under different solar radiations. It is observed that with 1000 W/m2 radiation water output was around 50 liters per minute and with decrease in solar radiation the performance was drastically reduced to 35 liters per minute with 700 W/m2 radiation. Further performance testing with hand driven and pedal driven operations were conducted. Four individual persons of different capabilities were made to pedal the water pump and it was observed that the water output per minute was in the range of 20 liters to 14 liters per minute. The performance details with pedaling operation is listed in Table.5.

Table 5: Results of Performance Testing by Hand and Pedal Driven Operations

Sl.	Weight (Kg)	Avg. Pedaling Speed (RPM)	Discharge Lit./min.
Person 1	68	83	20
Person 2	60	70	18
Person 3	55	72	18
Person 4	48	60	14

The suggested pump's working concept makes it possible to create an energy-efficient, economical, and low-energy water pumping system that meets irrigation needs with both renewable and human energy sources. There are relatively little radial stresses and static pressures in the pump pipe because the weight of the water column is evenly distributed over the pistons. The primary features of this pump are that its output is based on three factors: the crucial pump speed at which it begins to pump, the cross-sectional area of the pump pipe, and the rope speed. This pump is somewhat susceptible to rust and silt. It creates a constant, smooth flow without subjecting the pump pipe or rope to dynamic loading. These features lead to the conclusion that, when compared to centrifugal and piston pumps, the novel pump is a more efficient pumping mechanism.

V. Conclusions:

A new concept of water pumping for irrigation systems is presented in the paper. It is revealed from the experiments that the proposed model can be operated by solar PV, electric supply and by hand-pedal driven operations. Hand driven and pedaling activities by individuals resulted in 20 liters per minute of water. The proposed model is tested with all the provision made for operation and the results are tabulated. The results revealed that the novel pump can be effectively employed for small scale agriculture. This will significantly saves the electricity & diesel dependency and also provides the sustainable solution for water pumping for small scale agriculture. The operating principle of the novel pump enables a light-weight, cost-effective device for water supply and irrigation that can be used by families and small communities. It can be produced with locally available materials or recovered materials. Compared to other hand pumps, the novel pump has a high pumping capacity and can pump from wells of 1 to 10m deep. If properly produced, installed and maintained the pump can work efficiently upto 90%. Another great aspect of this model is that it is ecofriendly.

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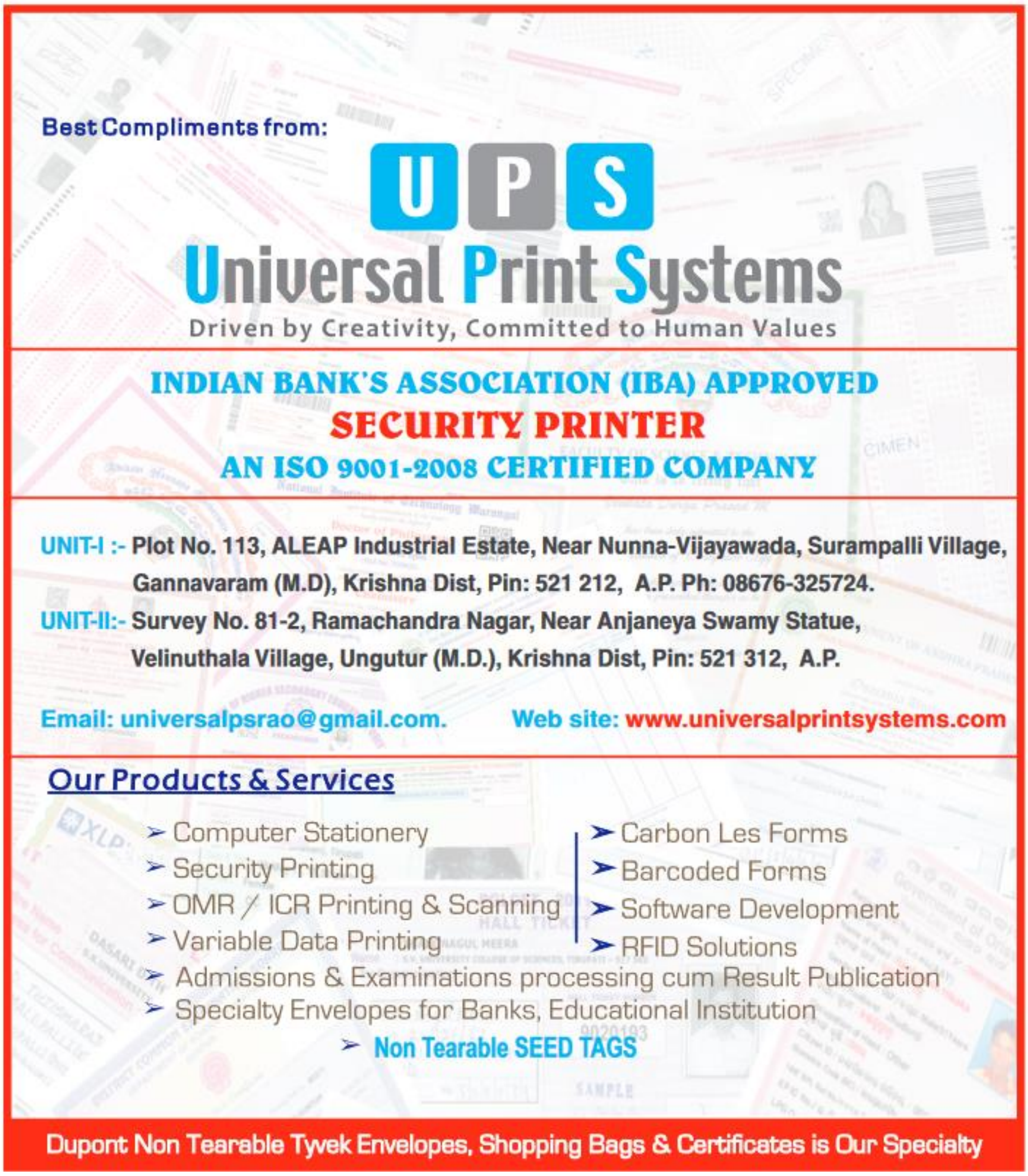

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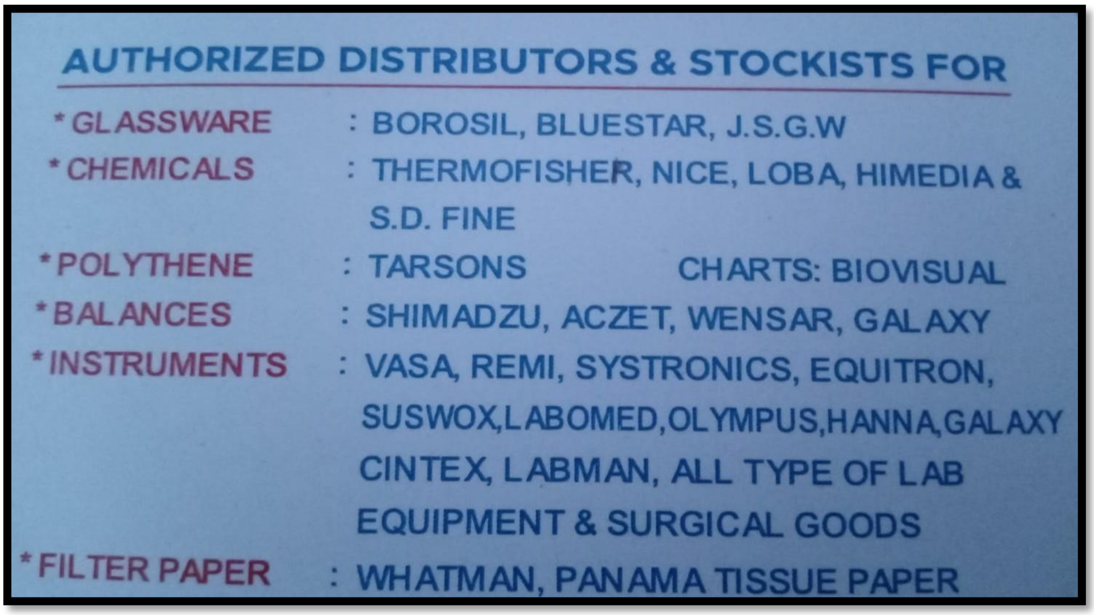

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ABOUT THE CONFERENCE

The International Conference on Sustainable Solutions in Engineering and Technology (SSET-2024) is scheduled on August 29th & 30th, 2024 at Basaveshwar Engineering College, Bagalkote, Karnataka, India. The conference focuses on engineering and technological solutions for sustainable development to bring together professionals, researchers, policy makers and stake holders from various fields to discuss and address pressing global challenges. This conference serves as a platform for sharing knowledge, exchanging ideas, and fostering collaborations to develop innovative and practical solutions to promote sustainability across different sectors.

The aim of the conference is to identify sustainable engineering practices and to explore their implementation on a broader scale, considering economic, social, and environmental impacts. This international conference on sustainable solutions in engineering and technology promotes the transfer of sustainable technologies, methodologies, and practices from research institutions to industries fostering innovation and driving the adoption of sustainable solutions.

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