



Shri Vile Parle Kelavani Mandal's
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Permanently Affiliated to the University of Mumbai)
NAAC Accredited with "A" Grade (CGPA : 3.18)



DJS STR-I-KE

2023-2024

EDITORS

Prof. Amit A. Deshmukh

Dr. Anuja A. Odhekar

Prof. Yukti Bandi

Prof. Pavan Borra

Prof. Abhilasha Raghtate

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**DJSCE IETE-ISF OF
DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION**

About D. J. Sanghvi College of Engineering



Shri Vile Parle Kelavani Mandal “SVKM” to the society at large grew out of a humble seed planted during India’s freedom movement namely by Shrimati Gokalibai Punamchand Pitamber High school – to nurture socially relevant education. Today SVKM has grown into a mega education nucleus with distinguished achievements. SVKM’s Dwarkadas J. Sanghvi College of Engineering (DJSCE), was established in the year 1994. In the span of more than 25 years, DJSCE has come a long way and has made its impact felt not only in the country, but also abroad. The college runs several undergraduate programs, such as Electronics and Telecommunication Engineering, Information Technology, Computer Engineering, Mechanical Engineering, Chemical Engineering and Electronics Engineering. These undergraduate programs are accredited by the National Board of Accreditation. The Institute is NAAC accredited with an ‘A’ grade (CGPA: 3.18) and recently started programs, such as Computer Science and Engineering (Data Science), Artificial Intelligence and Machine Learning, Artificial Intelligence and Data Science, Computer Science and Engineering (IoT and Cyber Security with Block Chain Technology). DJSCE is an autonomous institution permanently affiliated to the University of Mumbai. Along with the undergraduate program, DJSCE also runs post-graduate and Ph.D. programs in Electronics and Telecommunication, Computer and Mechanical Engineering departments, affiliated to the University of Mumbai. Our students have performed exceedingly well in national and globally competent multinational companies and, also in the universities in India and abroad as they pursue their higher education. Today, DJSCE has grown into a premier institute of technical education and has a stimulating educational environment with distinguished faculties and state-of-the-art facilities.

Declaration

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Engineering, DJSCE**

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From the Editorial Desk

Electronics and Telecommunication Engineering has always played a major role in the advancement of the latest in the technology arena. As technology progresses rapidly, it has become essential for engineers and technologists to keep up with the changes in their respective areas of expertise. The IETE- Student Forum (IETE-SF) was formed in the year 2005 under the Department of Electronics and Telecommunication of Dwarkadas J. Sanghvi College of Engineering, to not only facilitate the flow of ideas and information but also to encourage the advancement in the field of Electronics and Telecommunication Engineering. To keep up with new technologies, IETE-SF conducts technical workshops and seminars to encourage them to work on their technical skills. This forum paves a way for students to gain knowledge apart from their academic curriculum. In addition to conducting workshops and seminars, IETE-SF runs the book-bank facility where students can avail a wide range of technical books. Three years ago, a new initiative was taken by the student forum to run a component-bank facility, which enables students to avail themselves of various electronic components, which can be used for building technical projects. ‘DJS Strike’, a project mentorship program, which encourages students from the second, third, and fourth years to team up together to build a product/product prototype is continued this year as well by the IETE-SF. Over the last fifteen years, the EXTC Department has organized various technical events like STTP on Microwave and Antenna, Image Processing, and Wireless Networks. The department also organized. National conferences like NCCT-2011 in the year 2011, International Conferences like ICCT-2013 and ICCT-2015 in the year 2013 and 2015 respectively. Since 2017, the department has been organizing the International Conference on Wireless Communication (ICWiCOM 2017, ICWiCOM 2018, ICWiCOM 2019, and ICWiCOM 2021) where the conference addresses only narrow topics in the domain of Wireless Communication. Proceedings of the conferences are available on the Springer Digital Library. In October 2025, department is planning International conference on Wireless Communication (ICWiCOM 2025), proceedings of the same will be published on the Springer Digital Library.

For the last six years, IETE-SF has been organizing ‘DJS Strike’, a project competition. This competition aims to provide a platform for students to showcase their technical skills as well as technical paper writing skills. After a vigorous review process, the research papers of the best projects are published in the ‘DJS Strike’ Journal, which has a recognized ISBN Number. Due to the overwhelming response received for DJS Strike, IETE- SF has been motivated to organize ‘DJS Strike 2023-24’. The best technical projects in coherence with the field of Electronics and Telecommunication built by undergraduate students will be displayed during the competition.

We hereby appreciate the efforts taken by all the faculty members of the department of EXTC and the IETE-SF student committee members for organizing ‘DJS Strike 2023-24’.

Congratulations to all the participants of DJS Strike 2023-24!

Best wishes!

Prof. Amit A. Deshmukh
Professor & Head, EXTC, DJSCE

About DJS STRIKE

DJS STRIKE is a novel initiative of the Electronics and Telecommunication Engineering Department organized by the student's committee of IETE-SF. It is collaborative learning where students from various departments are working together, sharing their knowledge to develop a product/product prototype. Product development is an essential and integral part of the competition. This concept has been introduced as Innovative Product Development in the curriculum for second (audit course) and third year (credit course) students from Academic year 2019. DJS Antariksh is a key outcome of the DJS Strike Mentorship Programme. It is the official rover challenge team of DJSCE, and it is pioneered by the students of the Department of EXTC and aims to build next-generation Martian Rover. Students are encouraged to continue the development of the project to an industry level product by allowing them to continue it as the final year project as well as a project for the subsequent year of the competition, to ensure sufficient time for students to work upon it and develop it into an industry level product. DJS strike starts with floating projects in various domains, followed by forming groups of Second and Third-year students mentored by a final-year student and guided by a faculty member. Certain groups also have sought the guidance of the esteemed alumni; this has provided them a perspective of the current industry level demand for products. Each group gives three project topic preferences, exploring topics across a range of subject boundaries motivates students to pursue further knowledge in different subject areas that are part of the curriculum, thus motivating curriculum-based learning with practical exposure. One topic is allotted after discussion with faculty coordinators. After finalizing the topic, each group goes through various stages of the review process at regular intervals displaying their progress, and are evaluated based on different criterias. Each review consists of 25 marks. This review is executed over a span of eight to nine months. The structure of the review and guidance given by reviewers helps in the timely submission and systematic approach in completing the project in all aspects. The first review which is a documentation review primarily focuses on the ability of the student to apply basic knowledge, analyze the problem, and propose a model tool to execute the project. In the second and third reviews which are progressive reviews, each group is required to complete about 30% and 80% of the project respectively and write the first draft of the technical paper based on the work done. Students are guided on how to write a technical paper. In the fourth review which is a final review, each group is required to demonstrate the full product and submit the final draft of a technical paper. Each technical paper undergoes plagiarism check by Turnitin software and based on the report, the paper with minimum plagiarism is accepted for publication in DJS strike magazine with ISBN number.

DJS Strike is a yearlong academic activity where students share and apply their knowledge of engineering fundamentals and an engineering specialization to achieve success in product development. Strike provides an opportunity to further enhance the project in the subsequent academic year, which enables the prototype to turn into a product. Each student learns how to function effectively as a team member as well as a team leader. This project-based learning holds great weightage in any resume and can help boost the career of the student. It reflects their practical knowledge and enhances the prospect of the student not only to get a job or admission for higher studies but also benefits them while securing better internships of their choice having worked on projects of that caliber. It allows more in-depth exploration of topics, issues, and problems within and across subject areas and disciplines. It helps students to nurture themselves as an engineer, giving them a chance of finding the solution to a similar problem that they might carry out in their future profession. The projects made a great impact in the form of Industrial as well as from a social perspective.

Prof. Yukti Bandi, Prof. Pavan Borra, Prof. Abhilasha Raghtate
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IoT Based Heart Rate monitoring system

¹Manan Mistry, ¹Kris Shah, ¹Pratham Suthar, ²Tanaji Biradar

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Associate Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹manan050703@gmail.com, ¹shahkris2003@gmail.com, ¹prathams1301@gmail.com, ²tanaji.biradar@djsce.ac.in

Abstract—The adoption of IoT technology has transformed the development of heartbeat sensors, offering significant societal advantages. These innovative sensors can accurately detect a person's heart rate, aiding in the monitoring and potential prevention of heart attacks. Equipped with Wi-Fi and Bluetooth capabilities, they seamlessly integrate with smart devices for efficient data monitoring. When the heart rate exceeds a predefined threshold, the sensor promptly alerts the individual, enabling timely intervention. This paper highlights the importance of early detection in mitigating the severity of heart attacks and emphasizes the role of IoT in healthcare innovation. By leveraging sensors and microcontrollers, wearable devices can effectively monitor heartbeats and transmit alerts to medical professionals and family members via the Internet, demonstrating the practical application of IoT in improving cardiac care.

Keywords— IoT Technology, heart rate monitoring, ESP32 microcontroller, pulse rate sensor, medical alerts, Healthcare innovation, Heart attack prevention

I. INTRODUCTION

Monitoring the heart rate is an essential aspect of maintaining optimal health for athletes and patients alike. It serves as a crucial indicator of heart condition, making it a priority to keep track of. While there are multiple methods of measuring heart rate, the most precise and accurate one is through Electrocardiography. However, for convenience, using a Heartbeat Sensor is a more accessible option. These sensors come in various forms and sizes, providing an instantaneous and effortless way to monitor heart rate. They can be found in Wrist Watches, Smartwatches, Smartphones, chest straps, and other devices. Heart rate is typically measured in beats per minute (bpm), indicating the number of heart contractions and expansions in a minute. With advancements in technology, the integration of cutting-edge tools into healthcare and personal wellness has transformed the monitoring experience. In recent years, the integration of cutting-edge technology into healthcare and personal wellness has revolutionized how we monitor and manage our health. One such advancement is the utilization of ESP32, a powerful microcontroller, for heart rate detection. This innovative approach combines the versatility of ESP32 with the precision of heart rate monitoring to create wearable devices that offer real-time insights into cardiovascular health.

II. LITERATURE SURVEY

1. IoT in Healthcare: IoT helps monitor patients remotely with the help of smart wristwatches and smartphones allowing real-time data collection for timely healthcare interventions.

Pulse Rate Sensors: Sensors like PPG are used to measure heart rate non-invasively by detecting blood volume changes in tissues.

2. ESP32 Microcontroller: ESP32 is a versatile microcontroller with Wi-Fi and Bluetooth capabilities, suitable for wireless communication in remote monitoring systems which helps in real-time collection of the data through smart devices.

3. Wireless Communication: Different protocols like Wi-Fi and Bluetooth are explored for efficient transmission of health data in real-time and for emergency SOS situations.

5. GUI Development: Creating user-friendly interfaces is crucial for presenting health data to users, ensuring effective visualization and interaction where everyone can access it and get the data in time.

III. THEORY WORKING PRINCIPLE:

The IoT-Based Heart Rate Monitoring System operates by utilizing a pulse rate sensor to sense heartbeats non-invasively. The sensor converts blood volume changes into electrical signals, and the resulting digital heart rate data is transmitted wirelessly to an ESP32 microcontroller. The ESP32, equipped with Wi-Fi capabilities, communicates with a Graphical User Interface (GUI) enabling real-time visualization of heart rate data. Users, including healthcare professionals or individuals, can interact with the GUI to monitor, analyze, and set thresholds for heart rate.

Continuous monitoring allows for immediate detection of irregularities, and the system can generate alerts if predefined limits are exceeded and can help in contacting an individual in case of emergency. The integration of this system into the Internet of Things (IoT) ecosystem enables remote access to health data, contributing to effective and timely healthcare management.

BLOCK DIAGRAM:

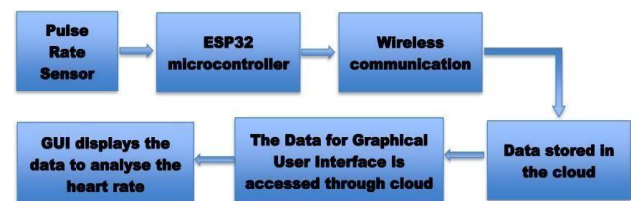


Fig.1 Block Diagram

CIRCUIT DIAGRAM:

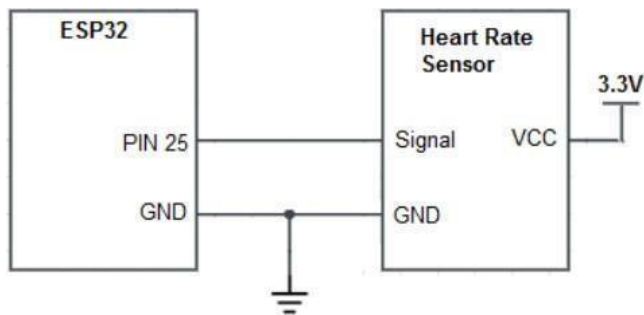


Fig.2 Circuit Diagram

IV. DETAILS OF COMPONENTS

• PULSE RATE SENSOR

The pulse rate sensor, employing photoplethysmography, detects blood volume fluctuations. Integrated with the ESP32 microcontroller, it captures heart rate data by measuring variations in reflected light. This data undergoes processing to calculate heart rate, facilitating real-time monitoring within the project's system. Such integration enhances health tracking and promotes wellness by providing accurate and timely information. The sensor's non-invasive nature, coupled with the microcontroller's computational capabilities, ensures a portable and efficient solution for monitoring cardiovascular health. This system offers users a convenient means to track their heart rates and make informed decisions about their well-being, enhancing overall health management.



Fig.3 Pulse Rate Sensor

• ESP32 MICROCONTROLLER

The ESP32 microcontroller, renowned for its low-power consumption and integrated Wi-Fi/Bluetooth capabilities, serves as the project's central processing unit. It interfaces with the pulse rate sensor to acquire real-time heart rate data, employing signal processing algorithms for noise filtering and heart rate calculation. Its computational prowess enables efficient data processing, ensuring accurate monitoring. Furthermore, the ESP32 facilitates wireless transmission of processed data to a display unit for visualization, enhancing

usability. Overall, the ESP32's versatility and functionality make it a crucial component in the heart rate monitoring system, enabling seamless integration and effective health tracking and wellness promotion.



Fig.4 ESP32 MICROCONTROLLER

• LED

An LED (Light-Emitting Diode) is a semiconductor light source commonly used to visually indicate heartbeat movements in the monitoring system. Integrated into wearable devices or display units, LEDs flash or pulse in sync with detected heartbeats, offering real-time feedback to users.

• Working of the sensor

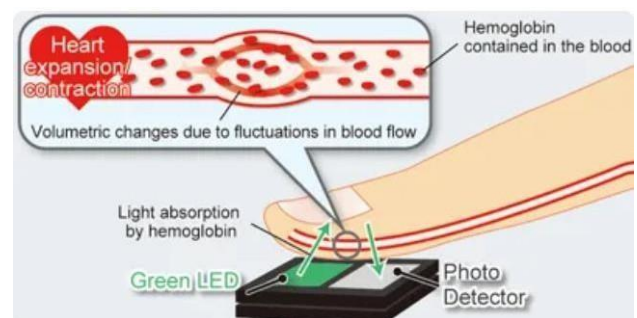


Fig.5 Working of the sensor

A heart rate detector sensor works by picking up subtle shifts in blood flow and pressure within the body. Usually utilizing a method called photoplethysmography (PPG), it measures the fluctuations in blood volume under the skin. This involves emitting light through the skin, which is then absorbed by blood vessels. By analyzing the reflected light, the sensor can detect changes in blood volume corresponding to the heartbeat. The sensor then processes this data to determine the heart rate in beats per minute (BPM). This information is often displayed in real-time on a connected device, offering valuable insights into an individual's cardiovascular health and fitness levels.

SOFTWARE IMPLEMENTATION:

The sensor measures the patient's heart rate, and wireless communication is used to transfer the data to the GUI. The MERN (MongoDB, Express.js, React.js and Node.js) stack is used to create the system's Graphical User Interface (GUI).

The GUI developed using the MERN stack not only visualizes real-time heart rate data but also stores information about the patient for a week. The GUI interface is designed to continuously monitor the patient's heart rate for 20 minutes daily. Using the MongoDB database, patient data such as heart rate readings, timestamps, and relevant metadata are stored securely. Node.js with Express.js handles backend operations, including data storage and retrieval. React.js facilitates a user-friendly frontend interface for seamless interaction. This comprehensive system ensures continuous monitoring, data storage, and visualization, enhancing health tracking capabilities and promoting patient well-being.

OUR WEBSITE INTERFACE

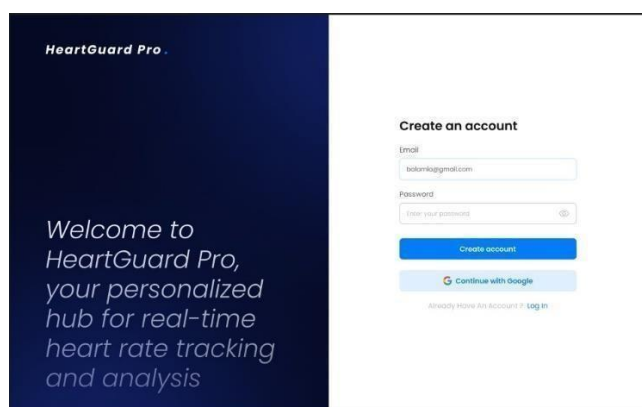


Fig.12 Login page

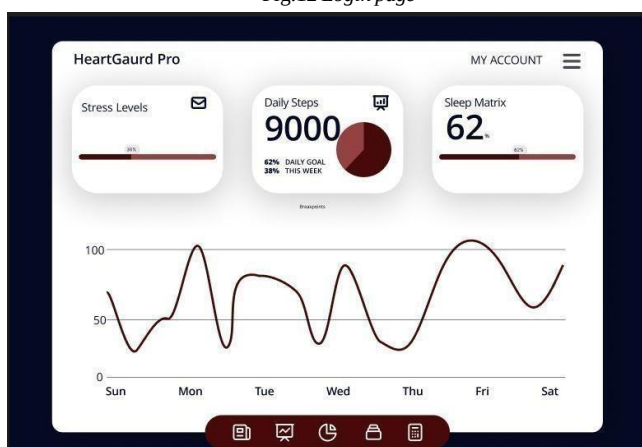


Fig.13 Data visualization of patient's heartbeat

V. RESULTS AND CONCLUSION

The Heart Rate Monitoring System effectively monitored heartbeats in real-time, with the sensor detecting each heartbeat and wirelessly transmitting this data to a user-friendly display with the help of the ESP32. Not only that, but the system also offered the option for users to set their own limits and receive alerts if necessary. This makes it a practical and reliable choice for remote health monitoring, offering a secure and easily accessible means to monitor heart health.

VI. FUTURE SCOPE AND APPLICATION

The possibilities for improvement and expansion within the IoT-Based Heart Rate Monitoring System are endless. Exciting advancements such as incorporating advanced sensors for a more comprehensive health monitoring experience, utilizing machine learning for predictive analysis, and creating a user-friendly mobile application are all within its future scope. Additionally, features such as cloud storage for effective data management, multi-user support, and integration with wearable devices have the potential to greatly enhance the system as well. By integrating AI technology into the cloud for data analysis, the system could detect issues at a faster rate and provide necessary advice and suggestions. Furthermore, it could even monitor the functionality of a pacemaker and detect any potential problems. A compact yet advanced ECG model can easily sync with standard smart devices, revolutionizing its functionality. Incorporating educational elements would further enhance user interaction, while ensuring worldwide accessibility and compliance with regulations are fundamental aspects for its widespread adoption. The possibilities for the system's growth are limitless, with potential to become an all-encompassing, user-friendly solution that adapts effortlessly to changing healthcare demands.

The potential of the IoT-Based Heart Rate Monitoring System extends far beyond its initial applications in healthcare and fitness. Not only does it allow for remote patient monitoring and personal health tracking, but it also has implications for optimizing exercise routines and aiding in the research and development of medicine. Furthermore, the system has proven beneficial in a variety of other areas, such as elderly care, stress management, and clinical research. Its versatility is further highlighted by its integration into corporate wellness programs, health and fitness apps, and emergency response systems. With its ability to monitor and manage heart health in diverse contexts, the system offers a simple yet highly effective means of promoting overall well-being.

Integrating heart rate monitoring data into healthcare systems is crucial for smooth operation. Following interoperability standards like HL7 and FHIR ensures compatibility across different systems. Robust security measures, such as encryption protocols and access controls, protect patient privacy. Seamless synchronization with electronic health records (EHR) enables comprehensive patient care by providing access to historical heart rate data alongside other medical information. Integration also supports the development of clinical decision support tools, assisting healthcare providers in diagnosis and treatment. Scalability and flexibility ensure the system can adapt to evolving healthcare IT infrastructures, enhancing its effectiveness in improving patient outcomes.

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Web Based Agrobot

Shoaib Attar¹, Kodali Chaitra Thejasvi¹, Ujjwal Kumar Thakur¹, Mukund Jha¹, Kanchi Senjalia¹, Raghav Agrawal¹, Sanjay B. Deshmukh²

¹U.G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai 400056

²Assistant Professor, Electronics and Telecommunication Department, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai 400056

Email: ¹shoaibattar3849@gmail.com, ¹kcethejasvi43@gmail.com, ¹ujjwalthakurofficial@gmail.com, ¹jhamukund20@gmail.com, ¹raghav6044@gmail.com, ²sanjay.deshmukh@djsce.ac.in

Abstract - We design and implement novel web-based agrobot system aimed at revolutionizing agriculture through enhanced crop monitoring and management. The agrobot integrates cutting-edge technologies such as Internet of Things (IoT), artificial intelligence (AI), and web-based interfaces to provide real-time data on soil moisture levels, temperature, humidity, and crop health. Utilizing image processing algorithms, the agrobot can identify pests, diseases, and nutrient deficiencies, enabling timely interventions for optimized crop yield. The web-based platform facilitates remote access and control, allowing farmers to monitor and manage their fields from anywhere, using any device with internet connectivity. Furthermore, the system offers data analytics tools for insightful decision-making and predictive analytics for future crop planning. Through this innovative approach, the web-based agrobot offers a cost-effective and sustainable solution for modern agriculture, paving the way towards increased productivity and food security.

Keywords – Agrobot, Web-based, Crop monitoring, IoT, Artificial intelligence

I. INTRODUCTION

In recent years, agriculture has undergone a significant transformation propelled by advancements in technology. The integration of automation, Internet of Things (IoT), and web-based interfaces has revolutionized traditional farming practices, leading to increased efficiency, productivity, and sustainability. This project aims to contribute to this ongoing agricultural revolution by introducing a web-based agrobot system that automates crucial farming tasks such as sowing, plowing, and irrigation based on user inputs provided through a web dashboard.

Traditional farming methods often require extensive manual labor and are susceptible to inefficiencies and inconsistencies. By leveraging automation and web-based technologies, our proposed agrobot system offers a solution to these challenges. Through the integration of automated machinery and IoT sensors, the agrobot can perform tasks such as sowing seeds, plowing fields, and irrigating crops with precision and accuracy.

Central to the functionality of the system is the web dashboard, which serves as the interface for users to input instructions and monitor the progress of farming operations in real-time. Users can access the

dashboard from any internet-enabled device, allowing for remote management and control of the agrobot system from anywhere in the world.

The automated sowing, plowing, and irrigation capabilities of the agrobot system are designed to enhance the efficiency and productivity of farming operations while reducing the need for manual labor and resources. By leveraging user input provided through the web dashboard, the system can adapt to specific farming requirements, optimize resource utilization, and ultimately contribute to sustainable agricultural practices.

Overall, this project represents a step towards the future of farming, where technology-driven solutions play a pivotal role in meeting the growing demands of global food production while minimizing environmental impact and ensuring long-term agricultural sustainability.

II. LITERATURE SURVEY

[1] developed an agrobot project for production cycle of tomato plant in a green house. Which was based on a, vehicle carrying the picking arm (a six degrees of freedom andromorphic arm with a gripper/hand), the head with the two micro cameras [for the color stereoscopic vision system] and the VME rack for the complete control of the system. [6] developed a smart agriculture agrobot with AI sensor-based technology which used ARM processor for sensor data and used cloud based IOT for crop monitoring.

[5] developed a sensor-based robot for sowing seeds which used IR and ultrasonic sensor for proximity and obstacle detection along with moisture and temperature sensor for data monitoring.

[4] developed a leaf disease identification and fertilizer bot using IOT

technology to capture images in real time and incorporated support vector machine (SVM) based classification algorithm for disease and healthy plant detection in real-time

III. METHODOLOGY

Green houses help keep pests out of the field and shield crops from extreme heat or cold. It shields crops from unfavorable environmental conditions all year long so that food production can be sustained.

This technology uses a sensor (soil moisture, temperature, humidity, and light) attached to a portable stick to monitor the crop field and triggers the irrigation system automatically. Wireless transmission is used to transfer real-time sensor data to a Web server database.

The web page aided seed plantation technique is employed by this system. This makes it easier to plant seeds at the desired

spot by only clicking on the location as it appears on the webpage. Additionally, a webcam has been attached for video surveillance, enhancing its security.

IV. HARDWARE EQUIPMENTS:

1) RASPBERRY PI :

A regular keyboard and mouse can be used with the inexpensive Raspberry Pi computer, which is the size of a credit card and connects into a TV or computer monitor. We can program in languages like Scratch and Python with this small device. For our project, we are utilizing the Raspberry Pi 3 b+ model. The Raspberry Pi 3 b+ model lowers the cost and accelerates time to market by enabling the board to be included into final products with a notably decreased amount of wireless LAN compliance testing.



Fig.I. Raspberry Pi

2) Arduino Mega 2560:

The Arduino Mega 2560 is a microcontroller board with the following features: 4 UARTs (hardware serial ports), 16 analog inputs, a 16 MHz crystal oscillator, 16 digital input/output pins (of which 15 can be used as PWM outputs), USB, power jack, ICSP header, and reset button. It can run from a 6 to 20 volt external power. However, the 5V pin may only give five volts, and the board can become unstable, if the supply is less than seven volts. The voltage regulator may overheat and harm the board if more than 12V is used. Thus, a voltage range of 7 to 12 volts is advised.



Fig.II. Arduino Mega 2560

4) DHT 11 Temperature and Humidity Sensor:

The DHT 11 is a very affordable digital sensor that measures humidity and temperature accurately. To precisely measure the ambient conditions, this sensor combines a thermistor with a capacitive humidity sensor. These measures can be seamlessly integrated with a variety of microcontrollers, such as Arduino or Raspberry Pi, by being converted into serial data. The DHT 11 provides an easy-to-use interface for retrieving data thanks to its small size and four pins, one of which is devoted to serial data transfer. With remarkable accuracy of $\pm 5\%$ for relative humidity and ± 2 degrees for temperature, it performs exceptionally well in producing accurate readings of both

temperature and relative humidity in degrees Celsius. As such, it is a great option for a wide range of applications.

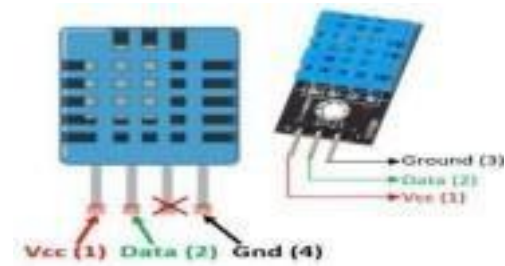


Fig.III. DHT11

5) Soil Moisture Sensor:

A soil moisture sensor, such as the YL-69 sensor module we utilized in our project, functions by gauging the water content within a material, typically soil, on a volumetric basis. This sensor uses a useful technique that involves two probes to put current into the soil. It then measures the resistance in the soil to determine the moisture content. Increased water content causes the soil to become more electrically conductive, which lowers resistance levels and ultimately points to a higher moisture content. On the other hand, drier soil has less conductivity, which raises resistance values and indicates a lower moisture content. This sensor efficiently provides informative data about soil moisture levels by measuring the electrical conductivity of the soil. This helps to accurately understand the environmental conditions that are important for a variety of applications, including environmental monitoring projects and agriculture.

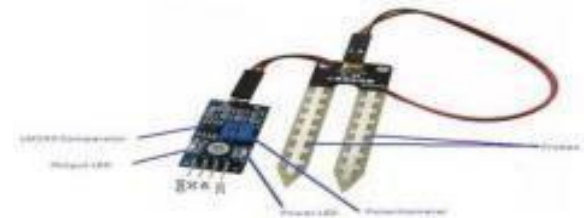


Fig.IV. Soil Moisture Sensor

3) V Wheels:

A V-groove wheel is a particular kind of caster that usually has a flat or rounded exterior diameter with a V-shaped groove. This particular gadget is made to help roll big items and equipment on iron tracks as they are moved from one location to another. V groove wheels can be rolled on level terrain just as conventional wheels.



Fig.V. V-Wheels

6) Servo Motor:

Servo motor is an electrical device which can push or rotate an object with great precision. If motor is used is DC powered then it is called DC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in small and light weight packages. The servo motor model we used for this project is S8218. It works on PWM (Pulse Width Modulation) principle, means its angle of rotation is controlled by the duration of applied pulse to its Control PIN. Servo motor is made up of DC motor which is controlled by a variable resistor (potentiometer) and some gears. High speed force of DC motor is converted into torque by Gears. Potentiometer is connected to the output shaft of the Servo, to calculate the angle and stop the DC motor on required angle.



Fig.VI. Servo Motor

7) Stepper Motor:

Stepper motors are among the various electrical items for which the National Electrical Manufacturers Association establishes standards. Hard drives, linear actuators, and CNC machines are prominent applications for NEMA17 stepper motors. The motor is rated for 12 volts and has six lead wires. Lower voltage can be used to run it, but the torque will decrease. With a step angle of 1.8 degrees, these motors can span 1.8 degrees with 200 steps every revolution, meaning they have a high degree of control. Due to their 12V operation, these motors have a high torque output. Thus, this motor is the best option for you if you're searching for a small, simple-to-use stepper motor with a lot of torque.



Fig.VII. Stepper Motor

8) Motor Driver:

The ST Company stands out for its production of the L298N Motor Driver Module, a high voltage Dual H-Bridge perfect for accommodating

common TTL voltage values. This versatile driver is specifically designed to power inductive loads such as DC motors and stepper motors, offering the essential functions of speed control, forward and reverse capabilities. Noteworthy is its impressive capacity to handle a continuous current of up to 2A in each channel and voltages up to 46V, making it a reliable choice for various motor control applications. Moreover, the L298N allows for the simultaneous and independent control of two DC motors, granting users precise manipulation over speed and direction through its twin H-Bridge setup. The above-depicted controller board features connections marked +12V and +5V. The motor power is connected to the +12V pin. The voltage range that this pin accepts is +7VDC to +35VDC. This feature-rich motor driver empowers users with the flexibility and efficiency needed to drive multiple motors with ease, enhancing the overall performance and control capabilities of various electromechanical systems.



Fig.VIII.Motor Driver

9) Webcam:

A webcam, a device renowned for its ability to capture live images and videos, serves as a crucial tool for our project by facilitating real-time monitoring of the cultivation area through live video feed transmission. Comprising essential elements such as a lens for optical focus, an image sensor for capturing visual data, and support circuitry for operational functions, webcams offer versatile functionality. Additionally, they often feature one or more microphones, enabling clear audio communication to complement video streams. These integrated components collectively enhance the quality and interactivity of video sessions, making webcams indispensable for various applications, including video chatting with multiple participants and professional streaming setups. The seamless integration of hardware and software allows webcams to leverage computer networks, such as the Internet, to transmit data efficiently, making them an invaluable asset in our endeavor to monitor operations effectively.



Fig. IX. Webcam

V. WORKING

• Starting The Bot

The process begins with starting the web-based agrobot.

• Initial Coordinates

The agrobot is set to a starting position with X, Y, and Z coordinates. These coordinates determine the agrobot's initial location within the field.

• Input X, Y, Z for Agrobot

The X, Y, and Z values are input for the agrobot. these values are entered manually through the web dashboard.



Fig.X. Block Diagram

Taking Values of Temperature, Humidity and Moisture. The next step involves taking sensor readings for temperature, humidity, and moisture. This data is collected from sensors onboard the agrobot. And this data is displayed on web dashboard.

• Live Streaming via Web-Cam

A live stream is established via webcam, which provides real-time visual feedback of the field from the agrobot's perspective. which is shown on the feed of web dashboard.

• Field Control

Field control involves controlling the operations of sowing, plowing and irrigation of the field using the web dashboard.

i) Plowing of the field: when inputs for plowing operation are triggered then plowing tool moves through the field to plow the entire field and then returns to initial position after plowing is completed.

ii) Sowing Operation: On user input of sowing, the bot moves to a check for the seeder coordinates. If the X, Y, and Z coordinates align with the programmed seeder coordinates, then the following occurs:

a. Take Correct Amount of Seeds: A designated amount of seeds are retrieved, possibly from a hopper or dispenser.

b. Release Seeds: The seeds are released onto the ground at the current coordinates (X, Y, Z).

c. Move Seeder to Initial Position:

The seeder returns to its initial position.

iii) Irrigation Operation: On requirement of watering achieved through irrigation operation as follows:

a. Take Water: The agrobot takes in water, possibly by activating a pump or valve connected to a water source.

b. Release Water: The agrobot dispenses the water onto the ground at the current coordinates (X, Y, Z) specified earlier.

c. Move to Initial Position: The agrobot returns to its initial position.

• Disease Detection

Input for disease detection in plants prompts the webcam to capture images from the field in real time and through machine learning model the output is displayed on web dashboard.

• Field Data Monitoring

VI. IMPLEMENTATION

Setup:

1) Development

Arduino Sketch: Program Arduino Mega to control motors, collect sensor data (like soil moisture, temperature, etc.), and communicate with ESP32 over serial communication.

ESP32 Firmware: Develop firmware to receive sensor data from Arduino Mega and send it to the web dashboard via Wi-Fi. Control the webcam to capture images.

Web Dashboard: Develop a web application to display sensor data, control the agrobot functions, and show live webcam feed.

ML Model Integration: Integrate a pre-trained Convolutional Neural Network (CNN) model for plant disease classification. You can use libraries like TensorFlow or PyTorch for this.

Webcam Integration: Write code to capture images from the webcam and display them on the web dashboard.

2) Integration:

Establish communication protocols between Arduino Mega, ESP32, and Raspberry Pi. Use Serial communication between Arduino Mega and ESP32, and Wi-Fi communication between ESP32 and Raspberry Pi.

Ensure proper synchronization and error handling in data transmission.

Integrate the ML model into the Raspberry Pi software to process the images captured by the webcam and classify plants as healthy or diseased.

3) Testing and Debugging:

Test each component individually to ensure they work as expected.

Integrate components together and test the entire system.

Debug any issues encountered during testing.

4) Deployment:

Deploy the system in the field and ensure it operates reliably under real-world conditions.

Provide necessary maintenance and support for the deployed system.

Software Aspect:

Raspberry Pi & Python: The Raspberry Pi runs the ML model built with Python using

TensorFlow or PyTorch. OpenCV assists with image pre-processing before feeding them into the CNN model.

FastAPI: A lightweight and efficient framework for creating an API endpoint that receives images from the web dashboard and returns disease prediction results from the ML model.

ReactJS & Firebase: ReactJS allows building user-friendly web dashboard to display sensor data, captured images, and disease prediction results. Firebase facilitates user authentication, stores sensor data in the realtime database, and potentially stores captured images for later analysis.

Docker: Docker containers package the ML model and its dependencies, ensuring consistent execution across different environments during deployment.

Model Training: Train the CNN model on a dataset of healthy and diseased plant images beforehand. This dataset can be sourced online or created specifically for your target crops.

Webcam Streaming: Explore libraries like OpenCV or specialized streaming solutions for capturing and displaying a live video feed from the webcam on the dashboard (optional). **Security:** Implement user authentication and authorization mechanisms on the web dashboard using Firebase or custom solutions.

Backend Frameworks: Flask or Django can be used instead of FastAPI for building the backend API.

Cloud Storage: Consider cloud storage solution Google Cloud Storage for storing captured images.

Data Processing and Transmission:

Raspberry Pi: This minicomputer acts as the data collection hub. It gathers sensor data (directly or via an Arduino/ESP32) and webcam images. **Data Filtering and Preprocessing:** Implement software routines on the Raspberry Pi to filter out noise or outliers from sensor readings. Preprocess captured images from the webcam for the ML model (e.g., resizing, normalization).

FastAPI: The FastAPI backend API can receive preprocessed images from the ReactJS frontend for disease prediction using the ML model.

Data Visualization and User Interface:

Firebase: Utilize Firebase's Realtime Database to store sensor data from the Raspberry Pi in real time. This allows for immediate updates on the web dashboard.

ReactJS Dashboard: The ReactJS web dashboard displays the following:

a. Sensor Data: Present live and historical sensor readings (temperature, humidity, soil moisture, etc.) using gauges, charts, or tables.

b. Webcam Feed (Optional): Integrate a live video stream from the webcam for visual monitoring of the field.

c. Disease Prediction: Display the results from the ML model on captured images, indicating the probability of plant disease.

d. Alerts and Notifications: Set up a system to trigger alerts or notifications based on sensor readings exceeding predefined thresholds (e.g., critical soil moisture levels).

VII. APPLICATIONS

Agriculture is a labor-and time-intensive industry in today's society. Using traditional agricultural methods, farmers are experiencing enormous losses in terms of productivity as well as financial losses. We created an Agro-bot that is web-based by employing automation. There are numerous uses for a web-based agrobot, or agricultural robot, that is managed and observed via a web interface in a variety of agricultural fields.

Field Monitoring and Management: Using the web interface, farmers can keep an eye on their fields from a distance. They can access real-time data gathered by the agrobot's sensors on crop health, temperature, humidity, and soil moisture. This makes it possible to implement timely interventions like fertilization, irrigation, and pest control.

Precision farming: Agrobots with GPS and image sensors can collect comprehensive data on crop health, weed dispersion, and soil conditions. Through the online interface, this data can be processed and analyzed to optimize planting patterns, apply pesticides and fertilizers more effectively, and cut down on resource waste.

Autonomous Crop Cultivation: Using pre established settings and directives obtained via a web interface, web-based agrobots are capable of planting, cultivating, and harvesting crops on their own. This boosts productivity and decreases the need for physical labor, particularly in large-scale farming operations.

Greenhouse Management: Agrobots can monitor and regulate temperature, humidity, and light levels in greenhouse settings to provide crops the best growing circumstances possible. Farmers can change settings through the online interface and get warnings or notifications when conditions deviate from optimal ones.

Weed Detection and Removal: When agrobots are fitted with cameras and image processing algorithms, they are able to recognize weeds amid crops and eliminate them on their own with the use of chemicals or mechanical tools. Farmers can keep an eye on weed management efforts and take appropriate action as needed thanks to the web interface.

Crop scouting and surveillance: Agrobots are able to patrol greenhouses and fields, looking for pests, diseases, or other problems that could be impacting the health of the crops. Through the online interface, farmers may monitor real-time video feeds and sensor data, enabling targeted interventions and early detection to reduce crop losses.

Data Analysis and Decision Support: The web based platform has the ability to compile and examine information gathered from several agrobots in various fields or places. Farmers may make well informed decisions to maximize agricultural yields and resource utilization by using machine learning algorithms, which can offer insights and recommendations.

VIII. FUTURE SCOPE

After the completion of our project, it is worth noting that there are several enhancements that could be implemented to further enhance its capabilities and functionality. These improvements, which are outlined below, encompass various aspects of the project:

- 1) One potential enhancement involves leveraging **A I t e c h n o l o g y** to accurately identify and classify different types of seeds based on distinct characteristics, aiding in efficient seed analysis.
- 2) Another notable improvement is the potential integration of a camera system with a servo motor, enabling enhanced surveillance capabilities that can **p a n** and tilt in multiple directions, providing comprehensive monitoring and security features.
- 3) Additionally, considering user convenience and accessibility, a bespoke Android application could be designed and implemented to allow seamless interaction with the project, enabling users to remotely control and monitor its operations with ease.
- 4) Furthermore, enhancing the project's battery capacity could significantly improve its operational efficiency and overall performance, ensuring prolonged usage duration and reliability.
- 5) Lastly, refining the device's programming to accommodate and execute a broader range of functions and tasks could elevate its versatility and utility in various applications, enhancing its overall functionality and appeal. refining our approach, we managed to seamlessly integrate the agrobot into our system, enhancing its capabilities and functionalities. The comprehensive knowledge gained from this experience has not only elevated our project but also inspired us to explore new innovations and advancements in the field.

IX. RESULT ANALYSIS

After meticulously following the detailed methodology outlined earlier and successfully integrating the various components, the efficient agrobot smoothly retrieved the seed located at the predetermined spot. Following that, the seed

was carefully planted with precise adherence to the specific instructions provided by the user through a dedicated webpage interface, while the advanced irrigation system automatically adjusted its settings based on real-time data collected by the sensor, ensuring optimal conditions for the growth of the seedling.

X. CONCLUSION

After the successful completion of the project, we familiarized ourselves with the intricate details of the software and hardware components involved. This deeper understanding has sparked a renewed sense of drive and enthusiasm to further enhance our project and achieve significant milestones.

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IoT in Healthcare

Niharika Thakur¹, Jeetmanya Joshi¹, Dharak Shah¹, C.K. Beral²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹thakurniharki038@gmail.com, ¹jeetjooshi@gmail.com, ¹dharakshah1207@gmail.com

Abstract— The healthcare field has had a technology revolution through the advent of Internet of Things technology. Our IoT health monitoring system is a novel platform that relies on the robust ThingSpeak platform, providing a complete solution for continuous remote monitoring of patients' vital signs. These sensors are located all over the patient's body in order to detect and process ECG, oxygen saturation, pulse rate, and temperature now these are also said to be tracked after major hospitalization (Raza & Qamar 2014). These data sources forward their information via live wireless links towards an inclusive IoT gateway from where it is compiled and encrypted before sending as secure information into ThingSpeak cloud. With this data available in real-time, care teams can make good decisions based on it and intervene earlier enough to help such person. This means that our system's main focus area is scalability and interoperability which suits well with modern health infrastructure as well as extending monitoring outside the typical clinical settings. It allows healthcare givers to monitor patients who are not admitted in hospitals especially those who remain in their homes as well as other distant locations. This will see patient-monitoring tools reach more people thus patients will remain healthy The algorithms that our system is built around are very strong and this ensures the accuracy of data while also maintaining consistency in the process by using proactive anomaly detectors which in turn bring any abnormality to the attention of the caregivers.

Keywords— Health monitoring, Vital signs, ECG (Electrocardiogram), Oxygen saturation (SpO2), Pulse rate, Temperature monitoring, ThingSpeak platform, Remote monitoring, Real-time data.

I. INTRODUCTION

The increasing use of the Internet of Things (IoT) technology in healthcare systems reflects a trend towards patient monitoring and personalized medicine. This partnership between IoT and healthcare has brought about improvements in the tracking of vital signs, with critical advantages in terms of early warning, timeliness and better recovery prospects for patients. Our research aims to fill this gap by developing an outcome-driven health monitoring system that tracks physiological metrics such as ECG SpO2 HR BT. By using ThingSpeak platform features, our solution provides a cost-effective way to monitor and assess patients' health conditions in real-time.

The increasing number of long term illnesses, in conjunction with an aging society emphasizes the importance of monitoring technologies that empower individuals to manage their health from the comfort of their homes. Traditional medical practices often rely on visits to healthcare facilities, which may fail to detect any changes in patients health between appointments. In contrast enabled health monitoring systems promote surveillance that empowers individuals to proactively address their well being on their own terms. Our study expands upon the existing research on IoT based health

monitoring systems focusing on challenges such, as data accuracy, reliability and interoperability. We utilize state of the art sensors to monitor signs, supported by advanced signal processing algorithms for accurate and reliable data analysis. The ThingSpeak platform serves as the backbone of our system, providing a robust cloud-based infrastructure for data storage, visualization, and analysis. Furthermore, our system incorporates functionalities for anomaly detection and alert generation, enabling timely notifications to caregivers and healthcare providers in the event of abnormal vital signs or emergencies.

II. LITERATURE SURVEY

The fusion of Internet of Things (IoT) technology, with healthcare has attracted interest recently with many research studies delving into the uses and advantages of IoT driven health monitoring systems. An in-depth examination of the literature uncovers several notable trends and progressions in this area.

Remote Patient Monitoring is becoming increasingly recognized for its importance, in managing illnesses and improving patient outcomes. Studies by Marschollek et al. (2015) and Zanaboni & Wootton (2016) have shown the effectiveness of driven monitoring systems in detecting health issues and reducing healthcare costs by lowering hospital readmissions.

Wearable sensors are components of IoT based health monitoring setups allowing for monitoring of vital signs and physiological parameters. Research by Bonato (2010) and Gao et al. (2014) delves into types of sensors like electrocardiogram (ECG) patches, pulse oximeters and temperature sensors showcasing their potential for seamless integration, into daily life.

Data. Signal Processing: Utilizing signal processing techniques is crucial, this is used in deriving the insights from the data produced by IoT health monitoring systems. Research conducted by Chen and colleagues in 2017 as Nemati and team in 2018 delves into the application of advanced data analysis approaches like machine learning and deep learning for real time examination of physiological data to promptly identify irregular patterns that may indicate health issues.

Cloud Based Platforms: Embracing a dive in cloud computing platforms such as ThingSpeak where it includes server aspects, provides cost efficient solutions for storing, processing and interpreting healthcare data. Studies carried out by Wang et al. In 2017. Chen et al. In 2020 explore the utilization of cloud based platforms for monitoring of patients underscoring their role in enabling seamless communication among wearable devices, mobile apps and healthcare providers.

Interoperability and Standards: For, Achieving interoperability poses a challenge in driven health monitoring systems due to the diversity of devices and protocols complicating the integration and exchange of data. Research conducted by Stoitsis et al. In 2018 along with Kouroubali et al. In 2019 stresses the significance of interoperability standards like HL7 FHIR and IEEE P11073 to ensure communication, between devices and healthcare systems.

III. PROPOSED DESIGN

Speech In our project, about healthcare monitoring we are in the process of developing a comprehensive system that can monitor continuously patients' vital signs such as electrocardiogram (ECG) pulse rate, oxygen saturation (SpO2) and temperature. We are determined to develop an efficient means of real time monitoring and analysis for patients health conditions by utilizing Arduino UNO as the microcontroller and ESP32 for WiFi connectivity.

Arduino UNO will function as the microcontroller while ESP32 will be used for WiFi communication together with sensor modules for ECG (AD8232), pulse rate, SpO2(MPX30101), and DS18B20 temperature. Moreover, we plan on integrating LCD display to visualize vital signs especially temperature.

For this system development, we shall apply Arduino IDE coupled with embedded C programming language. To facilitate interfacing and data collection, we shall leverage sensor libraries meant specifically for AD8232, MAX30102, DS18B20 sensors and LCD devices. The use of HTTP or MQTT protocols is essential when it comes to transmission of data and this case we have chosen to incorporate ESP32 WiFi chip.

Our system will entail these major steps; gathering patient's vitals using sensor modules; processing and filtering them out removing all manner of interferences or flawed data thus confirming its correctness in sign measurements. The refined sensor data will be sent wirelessly to the ThingSpeak platform using the ESP32 WiFi chip. Through the ThingSpeak platform healthcare providers can view real time visualizations of the patients signs allowing them to remotely monitor and evaluate the patients health condition.

In conclusion, our IoT healthcare monitoring system adequately meets the need for scalable and affordable methods for continued patient monitoring and remote health care solutions. The system aided by the Arduino UNO, ESP32, and sensor modules help capture real-time patient vitals and thus can be used by healthcare providers and other stakeholders to proactively manage the outcome. Given the

growing advancement in technology, our method is versatile and has the capacity to transform the mode of health care delivery and the approach to disease to complete major healthcare scenario.

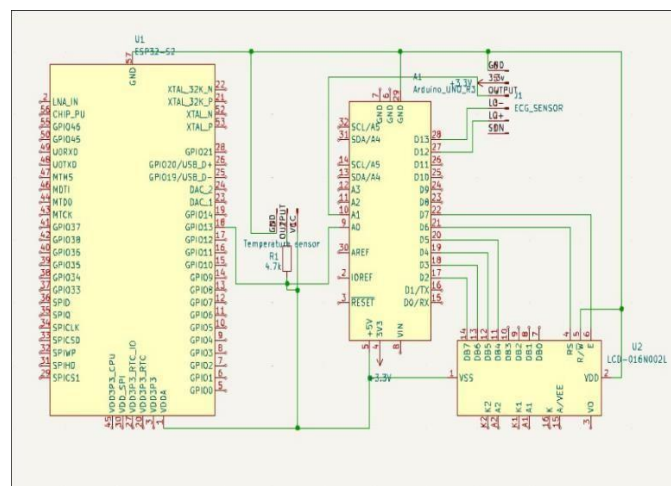


Fig.1 Circuit for IOT Healthcare System

IV. IMPLEMENTATION

The evolution of Internet of Things technology has brought a revolutionary change to the healthcare sector, allowing doctors as well as a patient to monitor patients' vital signs remotely and over an extended period. This paper discusses the design and implementation of an IOT-based healthcare monitoring system designed to monitor electrocardiogram, pulse rate, saturation of peripheral oxygen, and temperature, which represented ECG, PR, SpO2, and Temp respectively. It demonstrates that the use of Arduino UNO as the microcontroller and IoT ESP32 as the Wi-Fi chip for transferring data is a cost-effective way of providing real-time monitoring and analyzing patients' health conditions.

The hardware setup consists of the Arduino UNO serving as the microcontroller, for data acquisition and processing. Connecting the system to the platform ThingSpeak, is the ESP32 Wi-Fi chip. Among the sensors utilized are the AD8232 ECG sensor monitoring heart activity through electrocardiogram signals the MAX30105 Sensor for pulse rate and oxygen saturation and the DS18B20 temperature sensor for tracking body temperature. Data collected from these sensors is displayed on an LCD screen. The system's firmware is developed using Arduino IDE with embedded C programming language.

For Wi-Fi communication ESP32 is configured to connect to a network and transmit sensor data to ThingSpeak using HTTP or MQTT protocols in time. The patients ECG signals, pulse rate, SpO2 levels and temperature readings are sent to ThingSpeak server promptly.

Operating procedures involve data acquisition where sensor modules capture signs like ECG signals, pulse rate, SpO2 levels and temperature readings from patients. Signal processing follows to refine sensor data by eliminating noise and artifacts, for measurement of signs.

Data Transmission Process: The processed sensor data is transmitted to the ThingSpeak IOT platform from the ESP32

WiFi chip wirelessly. The patient vital signs are visualized in real-time in the ThingSpeak dashboard, and the patient's state is made accessible to the healthcare provider for analysis.

V. RESULTS AND CONCLUSION

Experimental Demonstration:

In our IoT healthcare monitoring project, we conducted an experimental demonstration involving the integration of temperature and ECG sensors to monitor vital signs in real-time. The project aimed to provide continuous monitoring of patients' health status and visualize the data using graphs on the ThingSpeak platform, as well as display it on an LCD pattern for easy accessibility.

The experimental setup included Arduino UNO as the central microcontroller, ESP32 as the WiFi chip for data transfer, and sensor modules for temperature (DS18B20) and ECG (AD8232). Additionally, an LCD display was incorporated to visualize the data in real-time.

The temperature sensor monitored the patient's body temperature, while the ECG sensor captured electrocardiogram signals to monitor cardiac activity. The acquired sensor data was transmitted wirelessly to the ThingSpeak IoT platform via the ESP32 WiFi chip.

On the ThingSpeak platform, the temperature and ECG data were visualized using graphs, providing healthcare providers with insights into the patient's health status. Simultaneously, the data was displayed on the LCD pattern for immediate access and interpretation.

The experimental demonstration showcased the effectiveness of our IoT healthcare monitoring system in providing real-time monitoring and visualization of vital signs. By leveraging Arduino UNO, ESP32, and sensor modules, our system offers a reliable and efficient solution for continuous patient monitoring and remote healthcare delivery.



Fig.2 Temperature Data on Arduino UNO IDE Serial Monitor and Thingspeak Graph

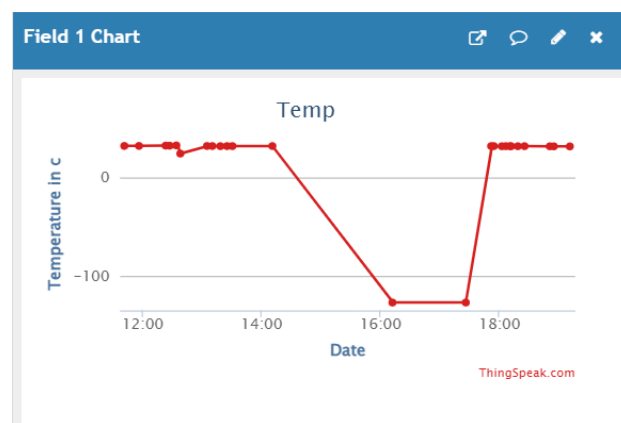


Fig.3 ECG Graph



Fig.3 LCD Output for Temperature

VI. Social Impact & Future

Over The prospects of the implementation of IoT-based health monitoring systems have much potential in solving multiple social issues in healthcare delivery and enhancing public health outcomes. Specifically, it seems that by using IoT technology to facilitate the remote monitoring of vital signs and physiological parameters, such systems can help individuals, communities, and healthcare systems in various ways. More specifically, such systems would facilitate the reduced geographical proximity barriers to access to healthcare services. In other words, the residents of remote and underserved areas can commute hundreds of miles in case of a medical emergency or need for specialized medical services.

Patient empowerment and engagement; These systems allow patients to access and receive assistance without having to physically go to healthcare facilities. They provide a way to keep track of signs and communicate with healthcare providers remotely. IoT solutions encourage participation and empowerment by continuously monitoring their well being and offering personalized health advice. This helps patients gain an understanding of their health status and encourages them to take actions. Consequently recent studies have strongly supported the idea that this approach can lead to adherence, to treatment recommendations and positively influence patients health outcomes.

Preventing Health Issues Early. Based systems allow for monitoring and analysis of physiological data, within a persons body in real time. This helps in identifying any patterns in vital signs and taking necessary actions. As a result the chances of diseases progressing and complications arising are minimized. Additionally the use of IoT supported systems can lead to cost savings by reducing expenses related to hospital admissions, emergency room visits, rehabilitation and long term disease management. By improving detection of health deterioration and being proactive in managing conditions these systems contribute to lessening the financial strain on healthcare systems and enhancing cost effectiveness in healthcare delivery. Aspects that are increasingly crucial, in todays healthcare landscape.

Future Trends and Directions: Overall, the development of IoT-based health monitoring systems is likely to take several more steps in the future because of technological, health, and societal developments. Several trends and directions might shape these systems in the future or influence their adoption: Integration with Wearable Devices and Implantable Sensors. First, IoT health monitoring systems in the future are likely to become integrated with portable wearable devices and implantable sensors that will be used to continuously measure vital signs and other physiological parameters. Because of their reduced size, maximized convenience and comfort, and superior accuracy, these devices will be seamlessly integrated with patients' lifestyles.

Data Analytics and Artificial Intelligence (AI) Advancements: The continued developments in data analytics, machine learning and AI will improve the capabilities of IoT health monitoring systems for real-time analysis, prediction, and decision support. These technologies will result into better understandings of healthy conditions, personalized treatment options and methods for disease prevention.

Collaborative Healthcare Ecosystems: Collaboration healthcare ecosystems are going to be the hallmark of future IoT health monitoring where patients, caregivers, healthcare providers, researchers and technology developers come together to co-create innovative solutions. In order to respond effectively to individual end users' needs and desires, they should engage in cooperative partnerships as well as use transdisciplinary approaches that will lead them towards co-designing, implementing and evaluating of internet-of-things enabled health monitoring systems.

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Automated Irrigation System

Mohit Patel¹, Bhavya Sheth¹, Ira Doshi¹, Rahul Taware²

¹ U.G. Student, Department of Electronics and Telecommunication, D. J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Department of Electronics and Telecommunication, D. J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹mohitpatel.mp606@gmail.com, ¹bhavyasheth4@gmail.com, ¹iradoshi2003@gmail.com, ²rahul.taware@djsce.ac.in

Abstract—In the vast expanse of agricultural landscapes, where the heartbeat of nature pulses through every furrowed field, lies the essence of sustenance and livelihood. Amidst this tapestry of growth, the delicate balance of moisture levels can be the difference between abundance and adversity for field crops. All too often, the rhythm of growth is disrupted by the unpredictable whims of nature – too much water, and crops suffocate; too little, and they wither away. But with our system, such uncertainties become relics of the past. Through a symphony of sensors and algorithms, we empower farmers to nurture their crops with precision and foresight. At the heart of our endeavor lies a profound understanding of the dynamic interplay between soil, water, and plant life. With meticulous precision, our system harnesses the power of advanced sensors, sophisticated algorithms, and real-time data analytics to monitor and manage soil moisture levels with unparalleled accuracy. At its core, our technology embodies the spirit of stewardship, offering farmers a reliable ally in the quest for optimal crop health. Through real-time monitoring and data analysis, we provide insights that transcend the limitations of human perception, enabling proactive decision-making and resource optimization.

Keywords— ESP32, plant moisture sensor, rover, water pump, farming, Arduino IDE.

I. INTRODUCTION

Agriculture plays a very important role in our country's economy, contributing significantly to our national income. Therefore, it's crucial to enhance the agricultural sector by improving technology and system efficiency to increase crop yield. In simpler terms, boosting the advancement of agriculture benefits our nation's growth and the overall well-being of its people. Meeting the challenge of improving crop yield, crop quality, and the crop yield quantity while reducing the need for manual monitoring is essential for this industry.

This is possible by adapting IoT, or the Internet of Things – a concept where objects can share data over a network without human involvement. By attaching sensors to selected objects, IoT enables real-time monitoring, leading to crop growth in a greater extent. Smart agriculture employs various technologies, including IoT devices, to increase agricultural productivity and improve crop management. By exchanging data wirelessly, IoT bridges the gap between the physical and virtual worlds. It enhances precision agriculture by boosting yields, productivity, and crop quality. It also facilitates real-time, cost-effective monitoring of large farms via drones, using sensors to track factors like temperature, humidity, and soil moisture as well as empowers farmers to optimize production and maintain food supply sustainably. Implementing precision agriculture within smart farming can enhance food security by improving crop quality and yield.

This is particularly crucial post-COVID-19, considering movement restrictions. Monitoring physical parameters like temperature, humidity, and soil moisture is essential for successful agriculture. These factors significantly influence crop growth. Precision agriculture involves adjusting crop inputs based on current environmental conditions. It relies on sensors to collect data such as soil temperature and humidity, allowing for informed decisions and reduced water consumption. Real-time monitoring systems help farmers irrigate crops promptly, based on their needs.

This project aims to design an algorithm for real-time soil moisture monitoring to optimize soil moisture levels and encourage user involvement. Such techniques can increase agricultural yield and reduce water consumption. Intelligent systems like this offer practical solutions to agricultural challenges. In this study, a smart agriculture system for real-time soil moisture monitoring is explored. Soil moisture sensor, which measure soil humidity and water content, are used to send data to a microcontroller. Farmers can set predetermined moisture content ranges based on their crops needs, adjusting water distribution across fields accordingly because the quantity of water required for each crop is different. Real-time data display allows users to mark field sections based on moisture content, matching needs with available resources.

So, for our project we have two ESP32 microcontrollers playing distinct roles: one governs the rover, which carries the moisture sensor, while the other serves as a central unit housing a DC water pump. The rover, outfitted with the moisture sensor, traverses the field, constantly assessing soil moisture levels. Upon detecting low moisture, it promptly communicates this data to the central system. Upon receiving the signal, the central system, equipped with the water pump, springs into action, delivering water to the parched area, thereby maintaining an ideal moisture balance for the crops.

II. OBJECTIVE

Some of the important objectives of our project encompass a comprehensive approach to revolutionizing agricultural practices through technological innovation:

Real-time Soil Moisture Monitoring: The primary aim is to develop an algorithm that facilitates continuous monitoring of soil moisture levels in real time, leveraging state-of-the-art moisture sensors.

Optimization of Soil Moisture Levels: Employ advanced techniques to optimize soil moisture levels, ensuring they align precisely with the specific requirements of various

crops, thereby fostering optimal conditions for robust plant growth and heightened productivity.

Encouraging User Involvement: Design a user-friendly system interface that enables active engagement, providing farmers with real-time data display and empowering them to set customized moisture content thresholds tailored to their crop preferences and needs.

Increased Agricultural Yield: The overarching goal is to enhance agricultural yield by meticulously maintaining optimal soil moisture levels, thereby fostering an environment conducive to accelerated crop growth and amplified productivity.

Reduced Water Consumption: Implement intelligent irrigation strategies driven by real-time soil moisture data, with the dual objectives of minimizing water consumption while ensuring crops receive adequate moisture for sustained growth and development.

Practical Solutions to Agricultural Challenges: Develop an intelligent system equipped to address prevailing agricultural challenges such as inefficient water usage and suboptimal crop management, harnessing cutting-edge technologies like IoT and real-time monitoring to devise effective solutions.

Efficient Resource Allocation: Enable farmers to make informed decisions regarding water distribution across fields by providing real-time moisture data, facilitating efficient resource allocation and bolstering overall crop management practices.

Rover and Central System Integration: Ensure seamless integration and communication between the rover, equipped with moisture sensors, and the central system housing the water pump, thus facilitating swift and efficient irrigation actions in response to detected moisture deficiencies.

Scalability and Adaptability: Design the system to be highly adaptable and scalable, capable of accommodating diverse agricultural settings and crop types, thereby maximizing its utility and applicability across various farming scenarios.

Validation and Testing: Conduct rigorous validation and testing procedures in real-world agricultural environments to assess the system's efficacy, reliability, and impact on crop yield and water usage efficiency, thereby ensuring its suitability for widespread adoption and implementation.

III. PROPOSED DESIGN

The proposed project design is poised to revolutionize agricultural practices by leveraging cutting-edge technology. At its core is a meticulously crafted rover, controlled with an ESP32 microcontroller at its helm. This rover, outfitted with a servo motor further connected to a moisture sensor, autonomously traverses the expanse of agricultural fields, monitoring soil moisture levels further leading to a better growth and life for the plants. Commanded through the sophisticated Blynk application, it seamlessly transmits real-time data to the central ESP32 module for comprehensive analysis and visualization.

Complementing this agile rover is a centralized system, also powered by the ESP32 microcontroller, smartly engineered to orchestrate field-wide irrigation operations. Upon

discerning that soil moisture levels have dipped below the stipulated threshold voltage, this central system orchestrates the timely activation of water supplies, ensuring optimal hydration for crops.

Furthermore, to avert potential collisions and navigate with precision, the rover is equipped with a camera stand. Beyond moisture management, this innovative solution incorporates an LM35 temperature sensor to precisely gauge ambient temperatures. This data is harnessed to dynamically adjust moisture requirements, ensuring that plant needs are intelligently met amidst fluctuating environmental conditions.

Through this comprehensive approach, the project not only optimizes agricultural efficiency but also fosters scalability for large-scale operations, heralding a new era of sustainable farming practices.

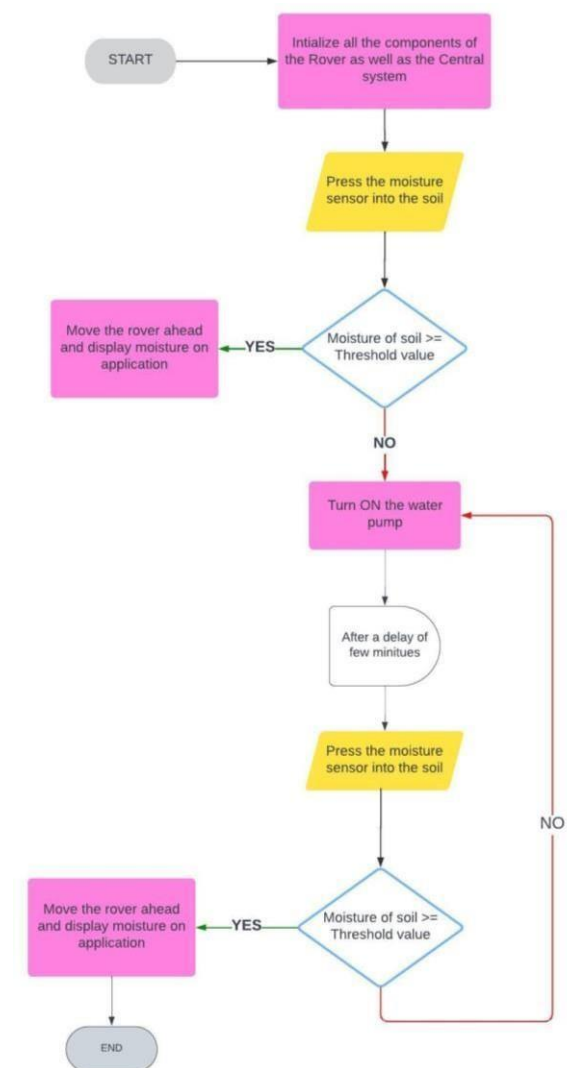


Fig.1 Flowchart of the complete system's operation

IV.IMPLEMENTATION

To begin with the implementation of the project we firstly designed the circuit diagrams of our system which have been shown in Fig 2. and Fig 3.

Fig 2. Shows the circuit diagram of our Remote-controlled rover which has been implemented using ESP32 WROOM DEV Module. The ESP32 is a microcontroller which has several General-Purpose Input Output pins. We used these pins to perform various tasks of the rover. Firstly, we connected the L298N motor driver to the microcontroller which was further connected to the L shaped BO motors for the free movement of the rover around the fields.

Then we have connected a servo motor which has inclination of up to 180°. On this servo motor we have attached a resistive soil moisture sensor. The resistive moisture sensor has two probes which are exposed to the soil. It sends an electric current from one probe to another which measures the resistance of the soil between them. When the water content of the soil is high, it has a higher electrical conductivity. Hence, a lower resistance reading is obtained which indicates high soil moisture. When the water content in the soil is low, it has poorer electrical conductivity. Hence, a higher resistance reading is obtained, which indicates low soil moisture. Hence, when the servo motor is inclined the moisture sensor gets pressed into the soil in order to check the moisture levels of the soil and further it gets shared with the microcontroller as well as with the application of rover, as soon as the reflected moisture is observed to be low the central system comes into action.

The LM35 temperature sensor is used to detect the surrounding temperature of the plant. The LM35 IC provides an output which is linearly proportional to the temperature changes of the surroundings. If the output of the monitoring is high the threshold of the required moisture will be increased hence preventing the plants from drying out in summers. The temperature is reflected in the application for better accessibility.

The rover is also equipped with a camera stand which is used to attach our mobile phone and use the IP webcam while moving around the fields. This will help one to observe the fields easily and help in better visualization. It will also help in avoiding collisions as well as accidents. It can also be used for security purposes during night time.

In order to supply voltage to the complete system we have used 3 lithium-ion batteries of 3.7 volt each i.e. approximately 12 volts. The complete battery package is connected to a battery management system for avoiding excess supply and short circuits in the system. The battery package is rechargeable hence reducing the maintenance cost of the project.

Also, in the rover application there is a crop selection menu which will enable the user to set different moisture levels for a variety of the crops hence leading to fostering pf a number of crops at the same time at the same place.

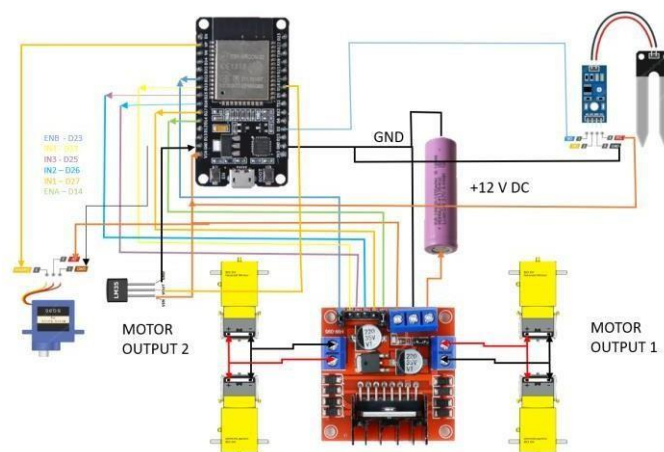


Fig.2 Circuit diagram of the Rover for Soil moisture sensing

Once the low moisture is observed on the application of the rover, we turn on the DC water pump. Once the central system is turned on, we observe that the water supply to the plants begins and as soon as the moisture of the soil reaches to the required threshold, we can switch off the water supply as per our requirement.

The circuit diagram of the central system is shown in Fig 3. Here another ESP32 microcontroller is used which is connected to the DC water pump through the L293D motor driver.

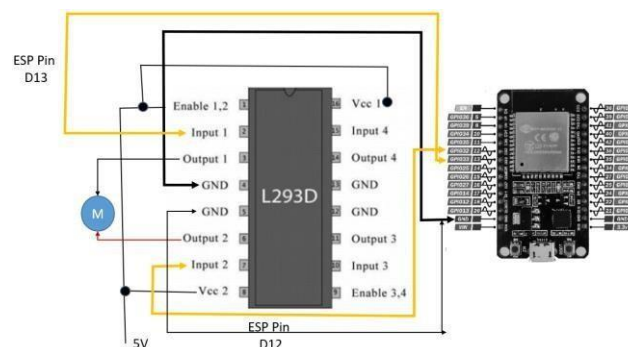


Fig 3. Circuit Diagram of the Central system

The central system is also connected to 2 lithium-ion batteries of 3.7 volts each in order to operate all the components of the system. These batteries are also rechargeable.

V. RESULTS AND CONCLUSION

As per the proposed design we implemented our project and successfully completed the project. As the rover is moved around the fields there is a camera stand attached to the front side of the rover where a mobile phone can be attached and through IP webcam one can observe the surroundings of the rover hence, avoiding it from running into obstacles or collision further preventing accidents. Now, the moisture sensor is pressed into the soil using the slider in the rover application due to which we are able to detect the moisture of the plant and it also gets reflected on the application. As we

observe that the moisture of the soil is less than the requirement, we turn on the water pump at the central system and soon the moisture level of the soil gets stable. Along with the moisture the temperature is also measured for monitoring purposes hence, if the temperature of the surroundings gets too high, the threshold levels of the moisture can be set accordingly in order to prevent drying out of the plants. Also a crop selection feature is added to the project which increases the scalability of the project.



Fig 3. Rover for Moisture Sensing



Fig 4. Central system for water supply.

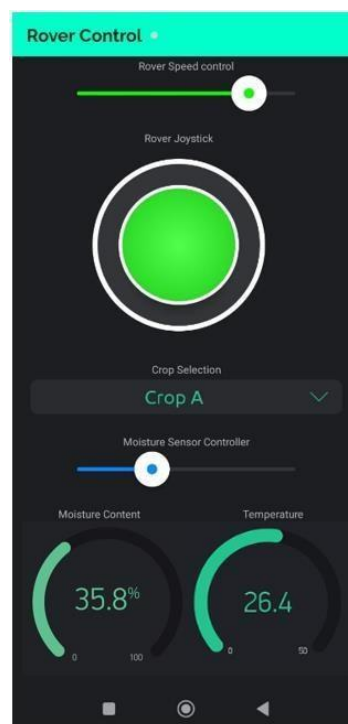


Fig 5. Blynk Application

VI. SOCIAL IMPACT

The proposed agricultural project offers a promising solution to enhance farming practices through innovative technology. Central to the project is a rover designed to autonomously traverse agricultural fields, monitoring soil moisture levels and transmitting data for analysis. This data-driven approach enables farmers to make informed decisions about irrigation and crop management, ultimately improving productivity and sustainability. By leveraging advanced technology, the project aims to address key challenges faced by farmers, such as water management and environmental impact. In doing so, it has the potential to foster resilience in agricultural communities and contribute to global efforts towards food security and environmental sustainability. Through seamless communication via the application, the rover transmits data for comprehensive analysis and visualization, empowering farmers to optimize irrigation strategies and enhance crop health.

The social impact of this project is multifaceted and far-reaching. Firstly, by significantly improving agricultural efficiency and productivity, it has the potential to bolster food security and alleviate poverty, particularly in rural communities where agriculture serves as the primary livelihood. The project's focus on sustainable practices not only ensures the long-term viability of farming operations but also reduces environmental degradation, preserving natural resources for future generations. Moreover, by embracing technology and innovation, the project creates opportunities for skill development and capacity-building among farmers, empowering them to adapt to evolving agricultural landscapes and market demands.

Furthermore, the project's emphasis on data-driven decision-making fosters transparency and accountability within the agricultural sector, potentially reducing inequalities and improving access to markets for smallholder farmers. Additionally, by mitigating the adverse effects of climate change through efficient water management and adaptive farming practices, the project contributes to global efforts towards environmental sustainability and climate resilience.

In essence, the proposed agricultural project represents not only a technological breakthrough but also a catalyst for social change. By harnessing the power of innovation to address pressing agricultural challenges, it paves the way for a more equitable, resilient, and sustainable future for farming communities worldwide. Through its holistic approach to enhancing agricultural practices, the project embodies the transformative potential of technology in shaping a more prosperous and inclusive society.

ACKNOWLEDGEMENT

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Student Management System

Rohan Shah¹, Ritika Mali¹, Ayushi Kansara¹, Vaishnavi Pawar¹, Shriya Nayak¹, Suman Swain¹, Soham Nagvekar¹, Disha Shah¹, Poonam Kadam²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

Email: ¹rohanshah6982@gmail.com, ¹ritikamali19@gmail.com, ¹ayushik0903@gmail.com ¹vaishpawar2003@gmail.com, ¹shriyanayak44@gmail.com, ¹shumansswain@gmail.com, ¹sohamnagvekar2293@gmail.com, ¹dishajshah31@gmail.com, ²poonam.kadam@djsce.ac.in

Abstract— Whenever we talk about making a team with friends or a faculty, we make mouth to mouth commitments rather than solid statements. Our project changes the way a student forms a team for projects or for committees. We standardize the way of storing such information and saving the hassle for an administrator to enter such data manually. To improve this process, we are implementing Recommendation Systems with collaborative filtering so that a student with a particularly required skillset is recommended at the top. In the project we are using firebase as a backend which is a “NO SQL” database for complex nesting of documents. The recommendation system part is done using TensorFlow and keras. We have used the concepts of Database management systems and web development along with Machine learning to create a product which is fast and scalable. For web development we are using NextJs 14 this is based on React which is a JavaScript framework that was made by Facebook. The document structure in firebase is such that it consists of 3 collections that are master data, test data, Jointeamreq data and team data. We are planning to add chat options which will require one more collection. Our whole app is secured using Google’s O Auth API using Authjs which is very trusted.

Keywords— Database Management Systems, Content based Filtering, Recommendation Systems, React, Firebase, TensorFlow, Cosine Similarity, TFID Vectorization, Machine learning

I. INTRODUCTION

In today's fast-paced and interconnected world, the need for efficient collaboration and teamwork is more critical than ever across various domains, from education to professional projects. However, the manual process of forming teams with the right mix of skills, expertise, and shared interests can be time-consuming and challenging. To address this need, innovative approaches leveraging machine learning techniques have emerged, offering a data-driven and systematic way to match individuals based on their capabilities and preferences. This research delves into the application of TF-IDF vectorization and cosine similarity algorithms in team formation, aiming to streamline collaboration, promote diversity, and enhance project outcomes. Furthermore, the integration of a user-friendly frontend, Firebase for real-time database connectivity, easy logins using Google authentication, and deployment on Vercel's platform adds a layer of accessibility, convenience, and scalability to the system, making it a comprehensive solution for modern collaborative work environments. By harnessing the power of machine learning and seamless frontend-backend integration, this research contributes to a

more efficient, inclusive, and innovative approach to collaborative work, ultimately driving success and productivity in diverse sectors and industries. Top of Form
Bottom of Form

II. LITERATURE SURVEY

Content-Based Filtering[1] is a type of recommendation system that suggests items to users based on the features of both users and items, aiming to find a good match. To achieve this, it requires having features of each user and features of each item in the system. These features are used to construct feature vectors for users and items, which are then used to compute vectors (v_{j_u} and v_{i_m}) representing user preferences and item features. Features such as age, gender, country, past behaviours, and ratings are commonly used to describe users, while features like year, genre, critic reviews, and ratings are used to describe items. Content-Based Filtering uses these feature vectors to decide which items and users might be a good match for each other. It can handle cases where users have rated some items by taking the dot product between user and item vectors to predict user ratings. On the other hand, Collaborative Filtering recommends items based on the ratings of users who have given similar ratings as the target user[2]. Unlike Content-Based Filtering, Collaborative Filtering does not require explicit features of users or items. Instead, it finds similarities between users based on their ratings and uses this information to recommend new items. Similarity metrics such as cosine similarity or Pearson correlation coefficient are often used to determine the similarity between users. Collaborative Filtering is effective at handling cases where users have rated some items, making it a versatile approach for recommendation systems. Both approaches have their strengths and can be used in different scenarios. Content-based filtering focuses on the features of users and items, while collaborative filtering relies on user ratings and similarities. The approach involves using neural networks to compute feature vectors for users and movies. These vectors are then used to predict user ratings for movies.[3]

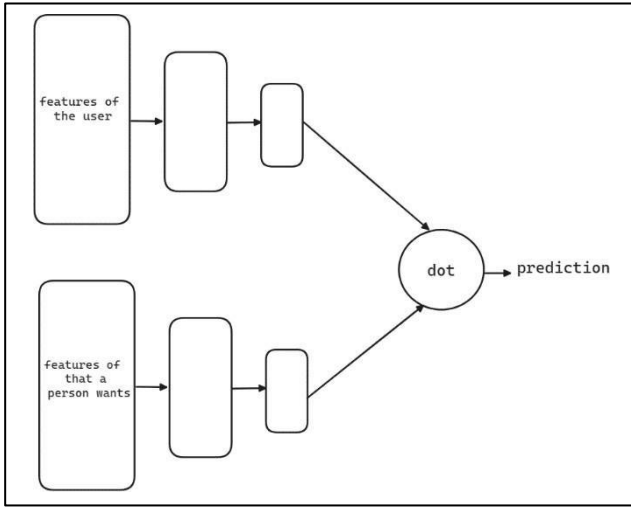
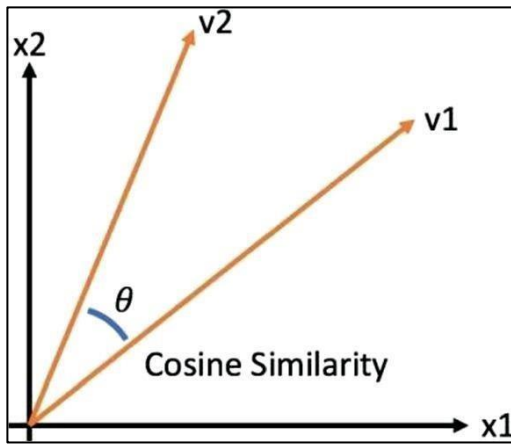


Fig 1. Neural Network Architecture

Cosine Similarity [4]: If some users want some skill sets which are present in vectors and a person has a similar set of skills, this distance or similarity can be calculated by finding the cosine similarity between them. The less the value of theta the more we can recommend that person to the user



$$\cos\theta = \frac{v_2 \cdot v_1}{||v_1|| ||v_2||}$$

Fig 2. Cosine Similarity Visualization

TF-IDF vectorization: A fundamental technique in natural language processing (NLP) and information retrieval. TF-IDF stands for Term Frequency-Inverse Document Frequency, and it involves converting text documents into numerical vectors. This process begins with tokenization, where documents are broken down into individual words or tokens, followed by calculating the TF for each term in each document (TF = number of times a term appears in a document divided by the total number of terms in the document). Additionally, IDF is computed to measure the importance of a term across the entire corpus (IDF = logarithm of the ratio of the total number of documents to the number of documents containing the term).4/25/2024 10:45:00 PM Multiplying TF by IDF yields the TF-IDF score, which reflects the significance of a term in a document relative to its occurrence across the corpus. TF-IDF vectorization plays a pivotal role in various NLP tasks such as text classification, clustering, and recommendation

systems, enabling efficient and meaningful analysis of textual data.

Backend: Firebase is a NoSQL database that has gained significant popularity in recent years due to its ease of use, real-time capabilities, and seamless integration with other Google Cloud services. As a NoSQL database, Firebase offers a schema-less data model, which means that data can be stored without a predefined structure, allowing for flexible and dynamic data storage. This is in contrast to traditional relational databases that require a predefined schema.

Firebase provides several key concepts and features that are essential to understanding its database management system (DBMS). One of the core concepts is the document-oriented data model, where data is organized into collections and documents. A collection is a group of documents, like tables in a relational database, while a document is a JSON-like object that contains key-value pairs of data. This structure enables developers to store and retrieve data in a hierarchical manner, making it easy to manage and query data.

Another important concept in Firebase is real-time data synchronization. Firebase uses WebSocket technology to establish a persistent connection between the client and the server, allowing data to be synchronized in real time. This means that any changes made to the database are immediately reflected across all connected clients, providing a seamless and interactive user experience.

Firebase also offers powerful querying capabilities through its Firestore database. Developers can perform complex queries using Firebase's query operators, such as filtering, sorting, and pagination, to retrieve specific data from the database. This makes it easy to build dynamic and responsive applications that can adapt to user interactions and data changes.

Additionally, Firebase provides authentication, storage, hosting, and other cloud services, making it a comprehensive platform for developing and deploying web and mobile applications. Its integration with other Google services, such as Google Analytics and Google Cloud Functions, further enhances its capabilities and scalability.

In summary, Firebase is a NoSQL database with a document-oriented data model, real-time synchronization, powerful querying capabilities, and seamless integration with other Google Cloud services. It simplifies database management and enables developers to build modern, interactive, and scalable applications.

III. PROPOSED DESIGN

In our proposed student management system, we aim to automate the process of teaming up similar students with shared interests for collaborative projects while providing students with the flexibility to accept or reject team requests. The system begins with students creating detailed profiles that include information about their interests, skills, academic background, and project preferences. Using this information, we employ an advanced interest matching algorithm that leverages techniques such as collaborative filtering or clustering to identify groups of students who exhibit common interests and complementary skills.

Within the system, students can browse and explore a variety of projects posted by their peers or faculty members. Each project is accompanied by a comprehensive description, requirements, deadlines, and team size specifications.

Students also have the option to create new project proposals, specifying the skills and expertise needed for successful completion. When the interest matching algorithm identifies a potential team match, students are notified and provided with detailed information about the project and their prospective team members.

Crucially, our system includes a mechanism for students to review team proposals and either accept or reject team requests based on their preferences and availability. This opt-in approach ensures that students have control over their project engagements and can align themselves with teams that best fit their interests and goals. Additionally, the system integrates robust communication and collaboration tools such as messaging, discussion forums, and video conferencing to facilitate seamless team interaction and project management. To maintain accountability and foster a positive team dynamic, the system incorporates feedback and evaluation features that allow students to provide input on team members and overall project experiences. Supervisors or instructors can also monitor team progress and offer guidance or feedback as needed. Importantly, the system includes an opt-out mechanism that allows students to leave teams or opt out of team formations without adverse consequences on their academic standing or project participation.

Privacy and security are paramount in our design, with stringent measures in place to protect student data and ensure secure collaboration within teams. The system is designed for scalability and performance, capable of handling a large volume of users, projects, and team formations efficiently. Overall, our proposed student management system streamlines the process of forming collaborative teams, enhances student engagement and collaboration, and empowers students to actively participate in projects aligned with their interests and aspirations.

IV. IMPLEMENTATION

Student Management Portal [5]-

The student management portal built with Firebase Firestore is designed to streamline the process of team management and collaboration among students. The portal incorporates Firebase Authentication using Auth JS to allow users to securely log in and access their account. Upon logging in, users can input essential data such as their SAP ID, gender, and membership details.

Auth JS abstracts away the complexity of OAuth 2.0 and provides a simple and secure way to implement Google Sign-In and other authentication methods in web applications. It handles the authentication flow, token management, and user information retrieval, allowing developers to focus on building features and functionality without worrying about low-level authentication protocols.

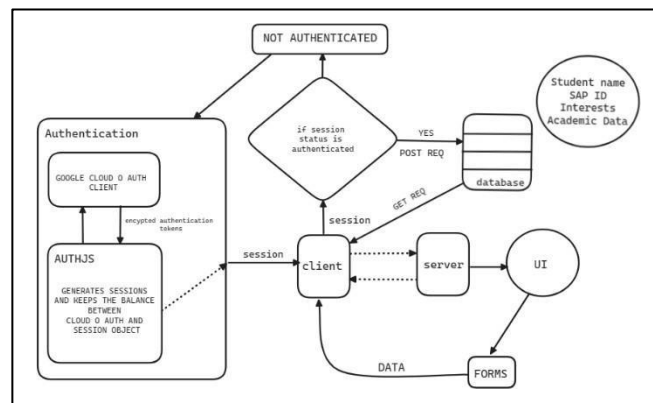


Fig 3. Architecture of the App

One of the core functionalities of the portal is the ability to send and manage join team requests. Users can initiate join team requests by providing the necessary information, such as the team they wish to join and any additional details. This request is then stored in the JoinTeamRequest Database within Firestore.

When a join team request is received, the recipient user can either accept or reject the request. If the user chooses to accept the request, a new document is created in the Teams database, specifying which document IDs are associated with the team. This allows for efficient team management and organization within the portal.

On the other hand, if the user decides to reject the request, the data related to that specific join request is promptly deleted from the JoinTeamRequest Database, ensuring that the portal remains clean and up to date.

Overall, the student management portal leverages Firebase Firestore for data storage and management, Firebase Authentication for user authentication, and custom databases such as JoinTeamRequest and Teams for handling team-related requests and data. This streamlined approach enhances collaboration, communication, and organization among students using the portal.

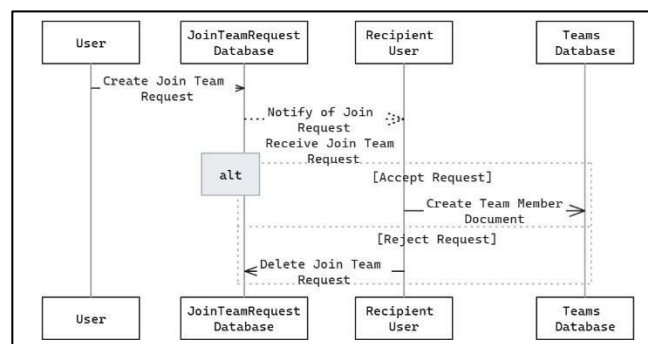


Fig 4. Architecture of Database

Recommendation System:

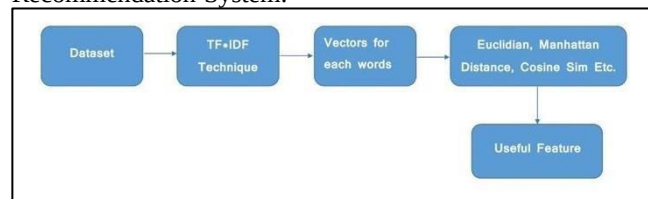


Fig V. Recommendation System Model

TF-IDF vectorization is a technique used to convert textual data, such as the skills of students in this case, into numerical vectors. The purpose of TF-IDF vectorization is to represent the importance of each term (skill) within a document (student's skill list) relative to all documents (all students' skill lists) in the dataset. This technique considers both the frequency of a term within a document (Term Frequency, TF) and its importance across all documents (Inverse Document Frequency, IDF). Terms that are frequent in a specific document but less frequent across all documents are assigned higher weights, indicating their uniqueness or significance for that document. In the code provided, TF-IDF vectorization is used to transform the skills of each student into TF-IDF vectors. These TF-IDF vectors capture the distinguishing features of each student's skills, allowing for more accurate comparisons and recommendations based on skill similarity.

Cosine similarity, on the other hand, is a metric used to measure the similarity between two vectors. In this context, cosine similarity is used to compare the TF-IDF vectors representing the skills of different students, or the skills required for a project. The cosine similarity calculates the cosine of the angle between two vectors, providing a measure of their directional similarity irrespective of their magnitudes. A higher cosine similarity score indicates that the vectors are more aligned in terms of their direction, implying greater similarity. In the code, the cosine similarity matrix is computed using the TF-IDF vectors of student skills. This matrix quantifies the similarity between the skills of different students. When recommending a student for a project, the cosine similarity is calculated between the TF-IDF vector representing the project's skill requirements and the TF-IDF vectors of all students. The student with the highest cosine similarity score is considered the best match for the project, as their skills align most closely with the project's requirements.

In summary, TF-IDF vectorization converts textual data into numerical representations that capture the importance of terms within a specific context. Cosine similarity measures the similarity between these numerical representations, allowing for effective comparisons and recommendations based on skill compatibility. Together, TF-IDF vectorization and cosine similarity form the backbone of content-based recommendation systems, enabling personalized and accurate recommendations by analysing the similarity of skills between students and projects.

V. RESULTS AND CONCLUSION

```
from sklearn.metrics.pairwise import cosine_similarity
from sklearn.feature_extraction.text import TfidfVectorizer
# Convert the skills column into a list of strings
skill_strings = df['Skills'].apply(lambda x: ' '.join(x)).tolist()

# Create a TfidfVectorizer object
vectorizer = TfidfVectorizer()

# Transform the skill strings into TF-IDF vectors
tfidf_matrix = vectorizer.fit_transform(skill_strings)

print(tfidf_matrix)

# Compute the cosine similarity matrix
cosine_sim = cosine_similarity(tfidf_matrix)

# Print the cosine similarity matrix
print(cosine_sim)
```

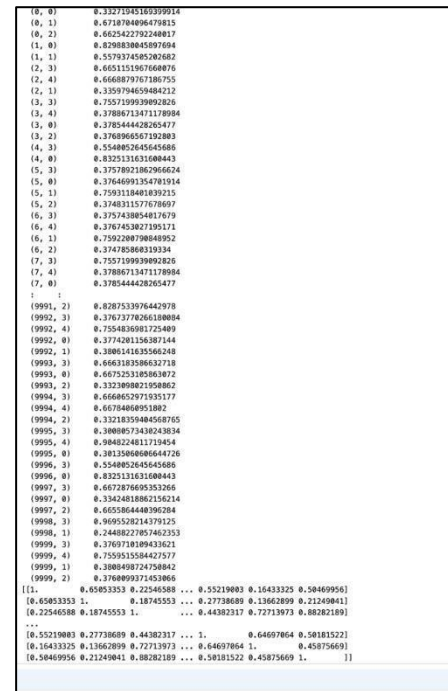


Fig 6. TFIDF vectorization and cosine similarity matrix for skills of 10,000 students

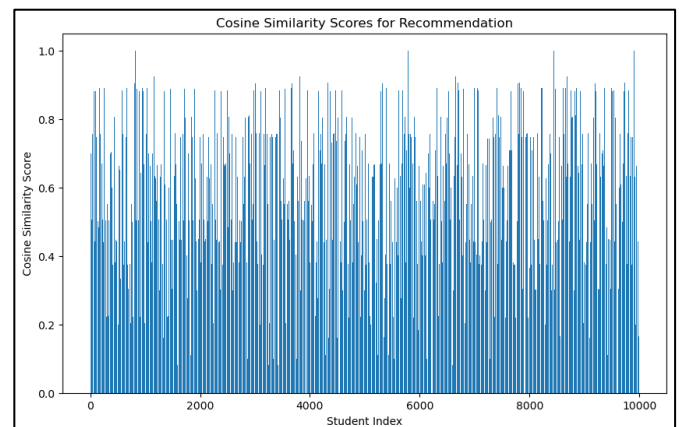


Fig 7. Distribution of Cosine similarities throughout the dataset

```
def recommender(skill_list):
    # Convert the skill_list into a string
    skill_string = ' '.join(skill_list)

    # Transform the skill string into a TF-IDF vector
    skill_vector = vectorizer.transform([skill_string])

    # Compute the cosine similarity scores between the skill vector and all student vectors
    scores = cosine_similarity(skill_vector, tfidf_matrix)

    # Find the index of the student with the highest cosine similarity score
    best_student_index = np.argmax(scores)

    # Get the best student from the dataframe
    best_student = df.iloc[best_student_index]

    return best_student
recommender(["Java", "elex"])
```

[8] ✓ 0.0s

Name	Renee Tank
SAP ID	84682278
Branch	AIIM
Skills	[elex, Java, elex, Java, elex]
Gender	Male
Name: 216, dtype: object	

Fig 8. Recommender Implementation

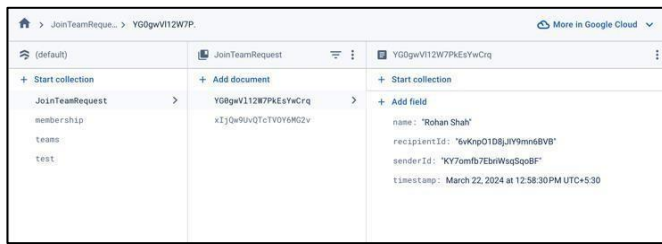


Fig 9. Database Collections

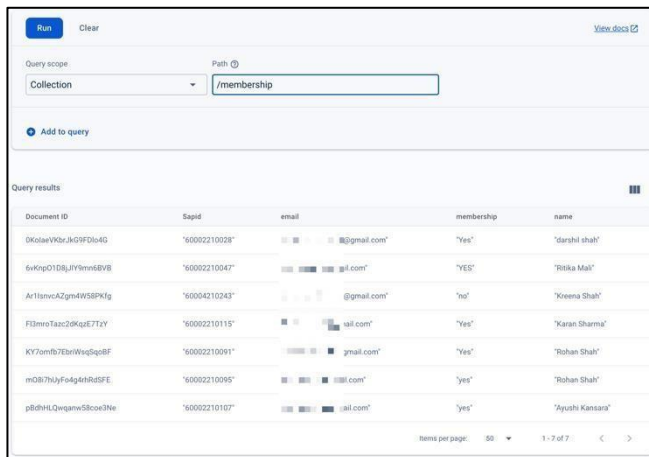


Fig 10. Main database

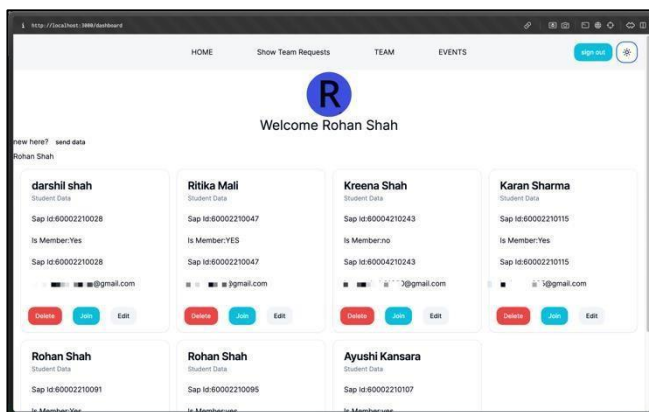


Fig 11. User Interface of the app

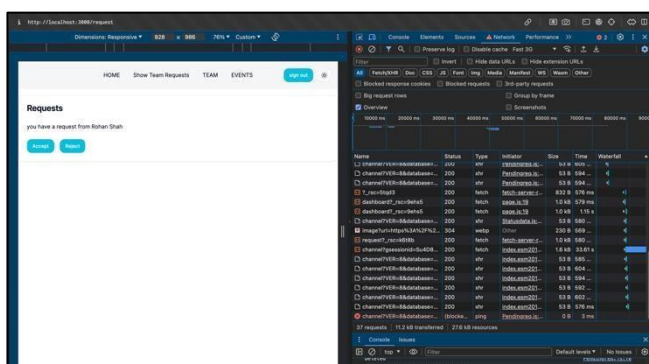


Fig 12. Request for Team Join

Conclusion:

The discussions surrounding the development of a machine learning-based recommendation system for team formation, leveraging TF-IDF vectorization, cosine similarity algorithms, and seamless integration with frontend technologies like Firebase for database connectivity and Google authentication for easy logins, culminate in a vision for streamlined collaboration and enhanced project outcomes. This project not only addresses the challenges of manual team formation but also promotes diversity, inclusivity, and innovation by matching individuals based on their skills and interests. By harnessing the power of machine learning and modern web technologies, the system offers a scalable, efficient, and user-friendly solution for team formation in education, professional networking, and project management. The potential impact of this research extends to various domains and industries, driving success, productivity, and positive collaboration experiences in the digital age.

VI. SOCIAL IMPACT & FUTURE

The social impact of the project lies in its potential to revolutionize team formation and collaboration dynamics among students. By utilizing machine learning algorithms to match students based on their skills and interests, the project fosters a more inclusive and efficient environment for collaborative work. It reduces the time and effort traditionally spent on manually forming teams, ensuring that students with complementary skills and shared interests are brought together for projects. This not only enhances the quality of project outcomes but also promotes diversity, creativity, and effective teamwork among students from diverse backgrounds and disciplines.

Looking towards the future, this project holds immense promise in education and beyond. In the academic realm, it can be integrated into learning management systems to facilitate project-based learning, where students are grouped dynamically based on their capabilities and interests. Moreover, similar recommendation systems can be adapted to various industries and domains, such as professional networking platforms, where individuals are matched for collaborative projects or job opportunities based on their skills and expertise. As technology continues to advance and machine learning becomes more sophisticated, the potential applications and impact of such recommendation systems are bound to expand, shaping the future of collaborative work and innovation across different sectors.

ACKNOWLEDGMENT

This project and technical paper were greatly supported by Professor Poonam Kadam. Her expert coaching and comprehensive assistance with the approach to solving problems with simple ideas and suggestions of new features kept us motivated throughout the project, and this paper would not have been possible without his contributions. We are grateful to our colleagues who contributed their knowledge and experience to the research and assisted us throughout the process.

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Automated Waste Segregation

Riddhesh Mistry¹, Sanika Raul¹, Shreya Jagani¹, Aarti Ambekar²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹riddheshmistry360@gmail.com, ¹sanikaraul970@gmail.com, ¹shreyajagani84@gmail.com, ²aarti.ambekar@djsce.ac.in

Abstract— Waste is currently a major cause of worry all over the world. Due to population increase, municipal solid trash is quickly increasing in developing countries such as India. The content of garbage changes depending on a variety of criteria such as living standard, climate, socioeconomic status, and so on. As a result, we suggest a system in which we separate waste and prepare manure from Dry & Wet Waste. This project describes a garbage categorization system that combines Python, CNN, and Keras to determine if garbage is wet or dry via a camera. The model learns from labeled images and improves accuracy through transfer learning. The system also contains a function that allows users to take garbage-related photographs and classify them using the model. The system also includes an Arduino Uno microcontroller and a servo motor that opens the appropriate bin based on the classification output. The level of garbage can also be detected, and the data is stored. This project could be used in waste management systems and smart cities to improve waste sorting and reduce environmental impact. Furthermore, by integrating such a technology into waste management practices and smart city projects, we can improve waste sorting operations while reducing environmental degradation. This newly developed technology presents a possible option for solving waste management's pressing concerns and progressing toward a more sustainable future.

KEYWORDS—Waste segregation, Machine Learning, Trained Model, Tensor flow, python, OpenCV

I. INTRODUCTION

The globe is facing a significant waste management dilemma, with an increasing amount of waste being produced every day.

There is one key issue that must be addressed as the world moves forward. We must deal with garbage! In our daily lives, we witness images of overflowing waste bins with garbage spilling out. Because of the high quantity of insects and mosquitoes that breed on it, a variety of diseases develop. A sensible lifestyle begins with cleanliness, which starts with good waste management. Proper garbage sorting and disposal can help to greatly reduce waste's negative environmental impact. To address this issue, we created a garbage classification system that uses a webcam to determine whether waste is dry or wet. Using machine learning, we're working on creating a system that can separate waste on its own, whether it's in smaller towns or big cities. The field of machine learning is concerned with developing computer programs that improve with participation. garbage segregation is the process of separating garbage into different parts. Separating garbage into dry and wet waste is implied by waste isolation. Glass, metals, and wood products are included in the category of dry waste. Wet waste, which is overly heavy due to its soggy, generally refers to natural

waste that is mostly generated by consuming meals. This paper describes a smart waste management system that classifies and detects various trash types, then allocates each type of waste to a designated compartment. Two commonly used machine learning techniques include support vector machines (SVM) and deep learning with convolutional neural networks (CNN). CNNs have played a crucial role in advancing pattern recognition capabilities. The suggested approach is to create an autonomous waste segregation system. The app uses data provided to a CNN to find and sort garbage. The algorithm then decides if the garbage is dry or wet. As mentioned earlier, the current system employs a microcontroller and sensors for direct waste separation. However, our intention is to first categorize the waste before incorporating larger hardware components. The outcomes are transmitted to the system's hardware elements, comprising an ESP32 and a servo motor responsible for transferring garbage into designated bins. Our approach promises effective garbage distribution into designated compartments as a result of seamless coordination between software algorithms and hardware pieces, representing a significant step toward comprehensive waste management systems.

II. OBJECTIVE

Waste management has become a critical global concern, particularly in rapidly developing countries like India where population growth exacerbates the accumulation of municipal solid waste. The escalating volume of waste underscores the urgent need for efficient waste management systems that can mitigate environmental impact and promote sustainability. Efforts to address waste management challenges have led to the development of various automated waste classification systems. These systems leverage advanced technologies such as machine learning and computer vision to categorize waste into distinct types, facilitating more effective recycling and disposal processes. Create a robust and efficient system that can segregate garbage into various groups without human interaction. This includes properly identifying and classifying waste materials as dry or wet. Train the system to recognize and sort waste using machine learning, specifically Convolutional Neural Networks (CNNs) using visual inputs. The goal is to improve the system's ability to correctly recognize various sorts of waste materials. Implement real-time image analysis capabilities by taking photographs of waste products with a webcam or other comparable device. The system should be able to quickly and accurately process these photos in order to offer fast trash classification feedback. Integrate hardware components such as ESP32 and servo motors into the system to allow for automated garbage segregation depending on classification results. This includes creating mechanisms that open appropriate bins or containers

based on classification results. Optimize waste management procedures by increasing waste, segregation efficiency and accuracy. This includes decreasing the reliance on human sorting procedures and minimizing errors in trash classification. Conduct a feasibility study to determine whether the suggested system is viable and successful in real-world waste management circumstances. Consider considerations including system dependability, scalability, and adaptability to different waste compositions and settings. Investigate ways to link the proposed system with existing waste management infrastructure to supplement and improve present waste sorting methods. This could include working with municipal waste management bodies or private waste collection companies. Assess the proposed system's environmental impact, including its ability to decrease waste pollution, conserve natural resources, and alleviate ecological harm. This entails making a thorough assessment of the system's environmental impact and contribution to sustainability. Identify topics for future study and development to enhance the proposed system. This could include broadening the classification categories to encompass more sorts of garbage, combining with other smart city systems, or investigating novel technology applications in waste management. Finally, promoting information sharing and capacity-building activities might encourage local communities to actively participate in waste management efforts. By raising awareness and educating about sustainable waste practices, the suggested system can catalyze beneficial behavioural changes and contribute to long-term environmental conservation goals.

III. PROPOSED DESIGN

The proposed design detailed in the technical paper is a comprehensive garbage classification system targeted at dealing with the expanding waste management difficulties, particularly in developing nations such as India. The system uses machine learning, primarily Convolutional Neural Networks (CNNs), to autonomously detect and classify garbage as dry or wet using picture analysis from a camera. The system takes photos from a webcam and processes them with TensorFlow, a popular open-source toolkit for machine learning tasks. The system uses TensorFlow to identify relevant labels and classifications from large datasets, allowing garbage to be classified as dry or wet. The system's primary feature is the use of Convolutional Neural Networks (CNNs) for garbage classification. CNN models are trained on annotated picture datasets, which enables the system to reliably recognize and categorize waste products in real time.

The proposed design includes hardware components including the ESP32 and servo motor. These components make it easier to physically separate waste by automatically opening the appropriate bin depending on the CNN model's classification output. The system has capabilities that identify garbage levels and store relevant information for study. This data can be used to track garbage formation patterns and improve waste management methods. The proposed architecture supports smart city objectives by interacting with existing trash management systems. By improving garbage sorting operations and lowering environmental effect, the technology helps to create more sustainable and efficient urban environments. Overall, the proposed system represents

a significant step towards addressing the pressing challenges of waste management in developing nations, offering a scalable solution with far-reaching implications for urban sustainability.

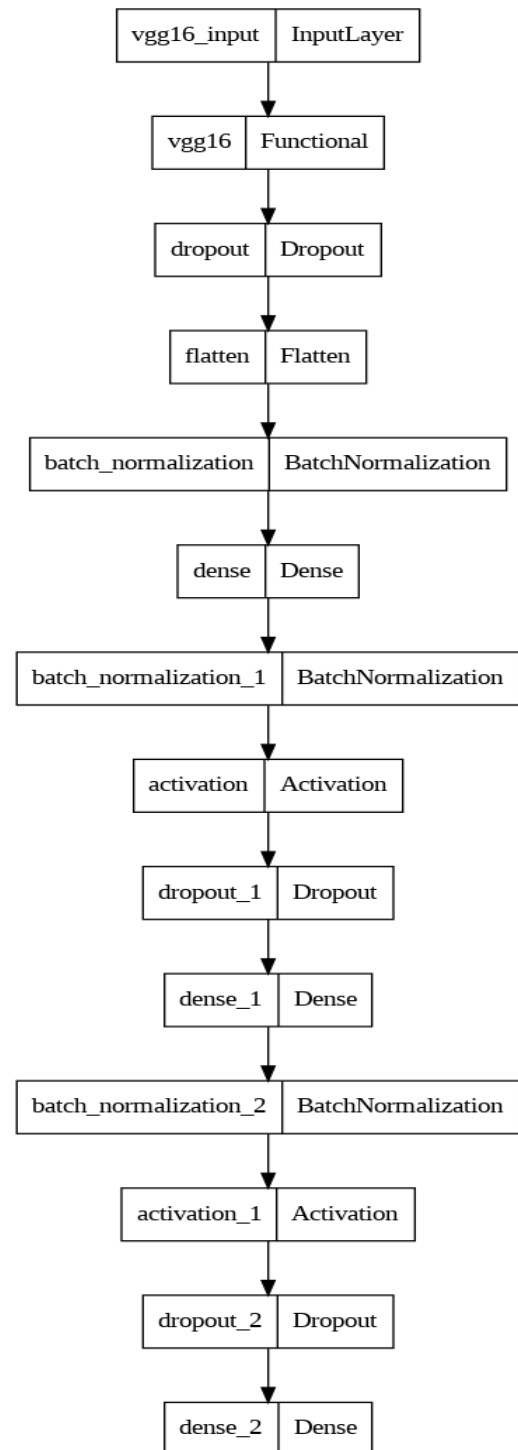


Fig.1 Layout

IV. IMPLEMENTATION

Initially, we must train the images, or data, after gathering a sufficient number of samples from the data set. It is critical to train and test the dataset before generating results. Steps: Place the thing in front of the camera.

Capture and transfer the image to the system. The system will use TensorFlow to process the image. Furthermore, object detection is performed using CNN and Keras. It detects waste and converts it into an array of pixel values. Pixel multiplication will occur, and this process will repeat across the image. Using this technique, the system generates the convolutional layer. The results of the entire procedure are communicated to the hardware part, which is instructed to send the necessary dustbin. Convolutional neural networks, often known as deep, feed-forward ANNs, are designed to process and recognize images in addition to other visual data analytics. CNNs perform well in image processing and artificial intelligence (AI) applications because they are specifically designed to handle pixel inputs.

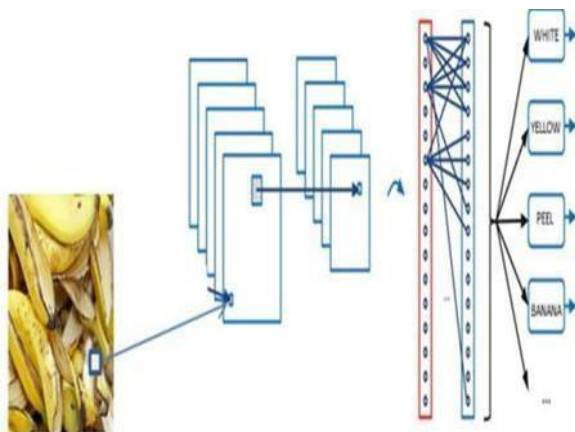


Fig.2 Neural Network

Natural methods where the visual cortex-activated convolutional systems of the organism drive the availability design between neurons. CNN uses three layers to function.

A. Layer 1: Convolutional Layer.

Accepts an input image or feature map. Filters/Kernels are composed of learnable parameters that slide across the input image to execute convolution processes. These filters capture various patterns such as edges, textures, and forms. Filter weights are multiplied by the relevant pixel values in the input picture to perform the convolution operation. After combining the data, regions of interest are highlighted on activation maps. The result of the convolution procedure contains high-level representations of the input image's characteristics. The activation function is typically used after the convolution operation to create nonlinearity, helping the network to learn complicated correlations in data.

2. Maximum Pooling Layer:

Uses a sliding window to lower the spatial dimensions of feature maps, hence down sampling them. Typically, max-pooling selects the highest value within each frame. Determines the size of the window used for pooling operations, which influences the degree of down sampling. Define the amount by which the pooling window advances across the feature map. Larger stride values result in more aggressive down sampling. Max-pooling reduces computing

complexity, prevents overfitting, and improves the receptive field.

3: Fully-connected Layer:

Receives flattened output from previous levels, usually after pooling. Each neuron in the completely linked layer communicates with every neuron in the previous layer. These linkages are characterized by learnable weights and biases. Calculates the weighted total of inputs to determine which features are important to specific classes. Frequently employs activation functions such as ReLU (Rectified Linear Unit) to induce nonlinearity and enable the network to learn complex decision boundaries. Training involves using optimization techniques like gradient descent and backpropagation to change the weights and biases in the fully-connected layer.

Image Processing:

Image processing involves processing incoming images, such as photographs or video clips, as part of a signal processing system [2][3]. The outcome of image processing can alternatively be a picture or a group of properties or attributes related to an image.[3]. The fundamental purpose of image preprocessing is to improve visual information by deleting redundant photographs and adding important ones for future processing [4]. Preprocessing improves image details by removing distortions and enhancing particular characteristics of the original image.

Tensor Flow

Google's TensorFlow is a popular open-source framework for numerical calculations and large-scale machine learning applications. Its functions include data processing, model training, prediction, and refinement of future outcomes. TensorFlow is well recognized for combining techniques for machine learning and deep learning models. It has gained in popularity and is commonly utilized in a wide range of real-world deep learning applications, including text-based apps, voice search, and image identification. One famous application is TensorFlow's Object Detection API, which excels at identifying and locating things in photos. Its flexibility and open-source nature have made it a significant player in AI and machine learning.[3]

V. RESULTS AND CONCLUSION

The created automatic waste segregation model produces promising results, with an accuracy rate of around 87% on test data. The model uses Convolutional Neural Networks (CNN) and image recognition algorithms to properly categorize waste items as dry or wet, accurately identifying objects such as cardboard, plastic, glass, and metal. Using the TensorFlow and Keras frameworks improves the model's efficiency and reliability in trash classification jobs. The integration of machine learning techniques enables real-time image processing, allowing the model to extract specific patterns and attributes while maintaining position, rotation, and scale invariance. Future developments could concentrate on increasing model accuracy by adding datasets and investigating other machine learning techniques. Expanding the classification categories to include hazardous or electronic trash would improve the system's utility. Integration with

smart city technologies, such as waste collection systems and mobile waste classification and monitoring applications, could help to improve waste management practices and community participation. Finally, the automated waste segregation model offers a promising solution to waste management difficulties, with the goal of contributing to a clean environment. Continued research and development in this area has the potential to boost sustainable waste management methods and environmental conservation. Furthermore, the successful deployment of the automatic waste segregation concept demonstrates the transformative effects of technology in tackling serious environmental concerns.

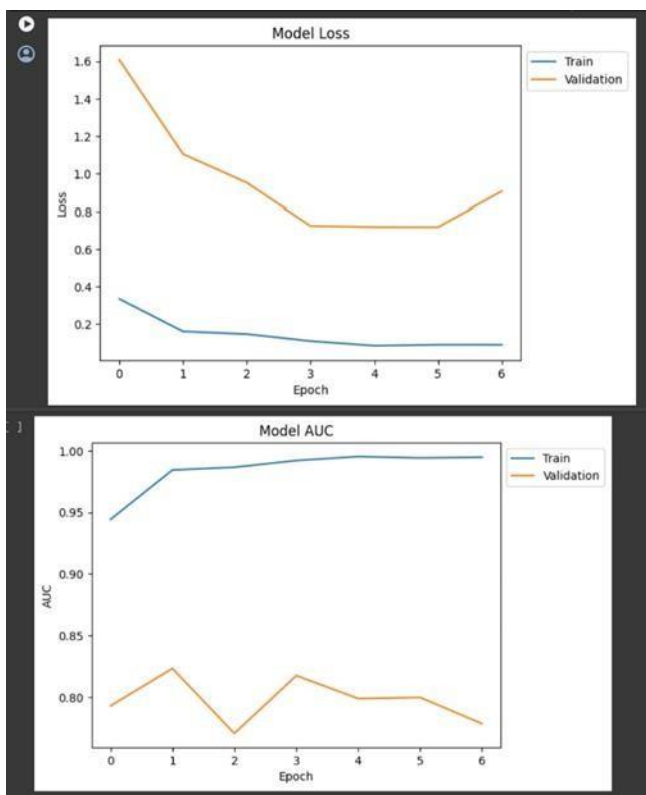


Fig.3 Model Loss and AUC graph

The Experimental demonstration is as follows:

The experimental presentation shows the model's capacity to accurately classify waste materials into dry and wet categories via a camera interface. After gathering photos of garbage products, the model uses TensorFlow and Keras for image recognition. The categorization results are then displayed, illustrating the model's capacity to recognize different sorts of waste items. The demonstration focuses on the actual use of the proposed model in waste management systems, emphasizing its ability to expedite waste segregation operations and increase environmental sustainability.

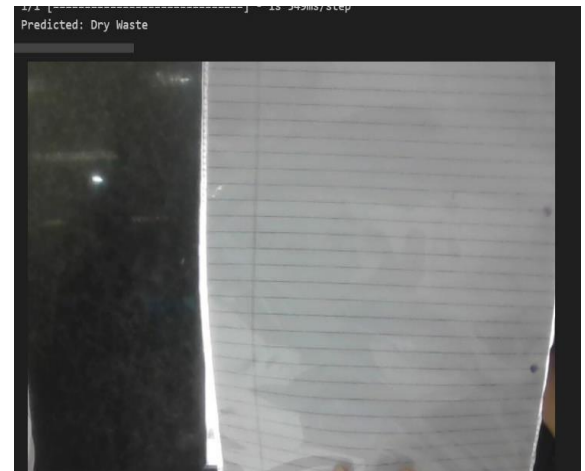


Fig.4 Dry Garbage

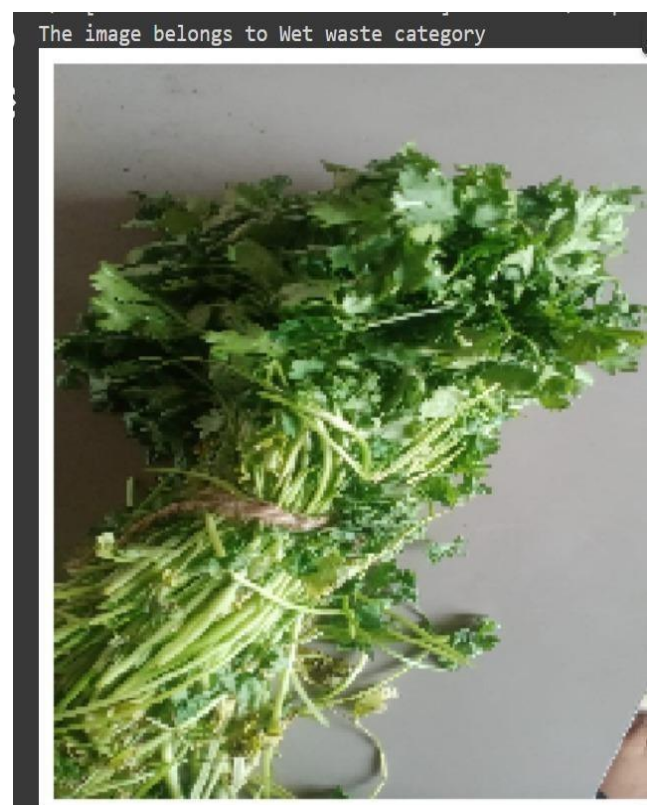


Fig.5 Wet Garbage

VI. SOCIAL IMPACT

The proposed approach helps to reduce the environmental impact of garbage accumulation by efficiently categorizing it as dry or wet waste. Proper waste management procedures help to reduce pollution, conserve natural resources, and alleviate ecological harm, resulting in a healthier and more sustainable environment for current and future generations. Effective waste management is strongly linked to public health outcomes. By automating waste segregation operations and lowering the danger of contamination and disease transmission associated with incorrect trash disposal, the proposed system protects public health and well-being. Minimizing garbage in public places also helps to minimize the proliferation of pests and vectors that can spread diseases, resulting in a healthier and more secure living environment.

The use of smart waste management technologies, such as mobile applications for garbage classification and tracking, encourages community involvement and participation in waste management activities. The suggested approach fosters environmental consciousness and responsible citizenship by empowering individuals to actively participate in waste segregation and disposal activities, encouraging communities to work together to create a cleaner, more sustainable future.

Efficient waste management strategies assist both the environment and public health while also generating economic value. The suggested system lowers operational costs for garbage collection, transportation, and disposal by improving waste segregation processes and maximizing resource use using technologies such as CNN and machine learning algorithms. Furthermore, by fostering recycling and resource recovery, the system generates cash and provides jobs in the waste management industry. The proposed waste segregation approach, when combined with other smart city solutions such as garbage collection and transportation systems, helps to progress smart city initiatives that aim to improve urban liveability, sustainability, and efficiency. By leveraging innovative technologies and data-driven methodologies, the system assists cities in optimizing waste management operations, reducing environmental footprints, and improving inhabitants' overall quality of life. Furthermore, the economic benefits of effective waste management cannot be disregarded. By streamlining trash segregation processes and lowering operational expenses, the system not only saves governments money but also generates economic opportunities through recycling and resource recovery activities. This can result in employment creation and economic development in the waste management industry, which benefits local economies and communities. Overall, the social impact of the suggested waste segregation system goes beyond environmental and public health benefits to include community empowerment, economic growth, and the progress of smart city programs.

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Automated Robot for Cleaning Purposes

Sreekrishna Nair¹, Soham Shetty¹, Shrey Sheth¹, Sanjay B. Deshmukh²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai 400056

E-mail: ¹sreekrishna11nair@gmail.com, ¹soham5102003shetty@gmail.com, ¹shreysheth63@gmail.com, ²sanjay.deshmukh@djsce.ac.in

Abstract— All our lives we have seen how a human moves object from place to place within a certain time frame. From moving three hundred kilograms of molten steel to moving groceries in a local market, the process of segregation is a sight not so uncommon for the human eye. Despite us performing this task for centuries we have not managed to perfect it and make what we call for as human error. In industries where utmost caution may be required this could lead to physical or/and financial harm. To prevent this from taking place we have developed a mechanical arm which can read the colour and sort as per that data. This empowers them to act as intelligent sorters, efficiently categorizing objects into designated bins or assembly lines. Imagine a robot effortlessly separating red, green, and blue components on a conveyor belt, a task previously requiring human attention. We have used a very good colour sensor by the name of TCS3200 and high performance servo motors in MG995r which could easily take load upto ten kilograms and the whole process of sorting can be done without any error in a matter of a few seconds.

Keywords— *Industrial Rover - Material Transport Robot Warehouse Automation - Autonomous Navigation - Human-Robot Collaboration - Production Efficiency – Smart Sensor Detection - Battery Management - Robot Vision Localization and Mapping - Real-time Monitoring*

I. INTRODUCTION

Imagine a factory floor not of sterile greys and harsh industrial lights, but one where robots move with a newfound vibrancy. This isn't science fiction; it's the exciting reality of the evolution of pick and place robots. Once relegated to repetitive tasks, these tireless workers are now incorporating color, adding a whole new dimension to their capabilities. This isn't just about aesthetics; it's about unlocking a new level of intelligence and automation. Efficiency is a skill mankind has been striving to achieve for ages and it takes years for a person to achieve that skill and perfect it, and yet we shall never see a one-hundred percent accurate human based function. The pick-and-place arm however took us a little less than a year to make and despite its nascent creation has shown a clean strike, one hundred percent efficiency. Despite the clear results achieved it still has a lot of room for growth and the sky is the limit for this Arm. Although it can only sort as per colour now, it could later on also sort as per the weight and shape of the object. We could also improve the colour scale to incorporate more flavourful colours such

as orange, yellow and pink. However we may experience some time delay but can still expect at least twenty-seven percent more accuracy than a human based sorting. By increasing the parameters of this instrument we are not compromising in the accuracy but in the duration it takes to complete one cycle and return. For example if we were to add three more colours to our current scale it could show us a delay of thirty to forty milli-seconds. This may seem as a miniscule for one item however in a factory with lakhs of items to be placed it could lose more than ten hours of every day work. We wanted a product that could provide us with both high speed and high level accuracy. However to improve our speed and still be able to sort more colours would need us to implement another one of such arms with an inbuilt/or coded RGB values of the new colours, or may require us to use a higher level of signal processor and a more complex colour sensor both of which techniques could prove to be really expensive. So we opt for an economical, accurate and a fast measure.

II. LITERATURE SURVEY

Pick and place robots have long been a mainstay of industrial automation, excelling in repetitive tasks like sorting and assembly. However, recent advancements in color recognition technology are pushing the boundaries of what these robots can achieve. This literature survey explores how researchers are leveraging color to enhance the capabilities of pick and place robots. So far we have only talked about the colours within the visible spectrum but now when we think of it, we could also apply it to objects which emit infrared radiations and could sort it based on the intensity.

This technological advancement could increase the economical state of a company, a state maybe even a nation. Since these arms don't need any breaks or any rest, they can easily perform eighteen to twenty hours if within the right environment. Not to mention that every year the automation industry loses more than 900 billion dollars due to human based errors. We would not only see a decrease in losses but a significant rise in the profits.

This would also work well in industries where humans cannot be in the vicinity for a prolonged duration and could be affected by materials that need to be sorted. The future of color recognition in pick and place robots is promising. Research continues to improve the robustness and accuracy

of color detection algorithms, while advancements in sensor technology offer new possibilities.

It can be integrated with deep learning which can help in color identification in complex scenarios.

III. PROPOSED DESIGN

The arm is placed on a thick plywood board with four specific markings. One for the arm and other three for the coloured objects (Red, Green and Blue). We then place a power supply on it and the circuit that is built on the breadboard. This circuit comprises of the colour sensor, the ultrasonic sensor and the buck converters. the arduino gets connected to all the aforementioned parts and to the arm's servo motors which are placed together in a bracket. Multiple brackets are connected and one servo motor goes on top of the gripper. Most of the tools used for making the wooden board anyway, like drilling to make hole for bolting the chassis to the wooden board. Other than that is for electrical component connection to each other by soldering some jumper cables.

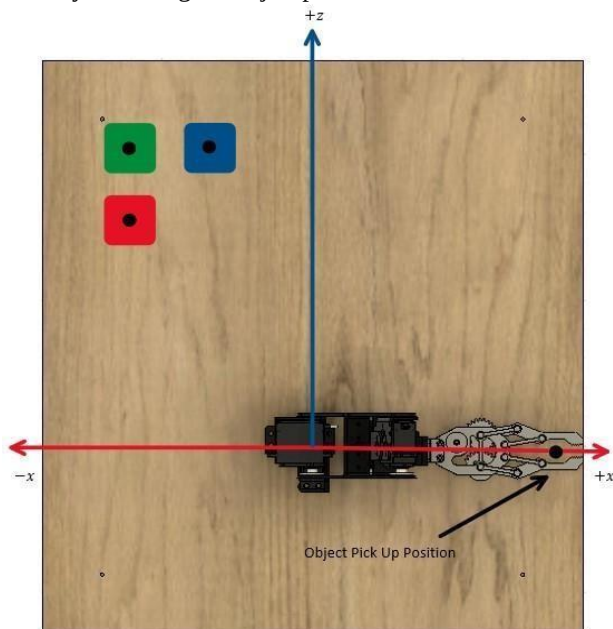


Fig.1 Model Diagram of the Robotic Arm

IV. IMPLEMENTATION

We're aiming to create a system that can pick up objects, sort them based on color, and then place them in designated locations. To achieve this goal effectively, we need to address two crucial aspects:

We need to determine the origin point for the objects the robot will be sorting. Where will they be entering the system? Understanding this will influence the design of the initial pick-up area and the robot's approach strategy.

Just as important as picking up the objects is knowing where they should go after being sorted by color. This requires establishing designated drop-off zones for each color category. These designated zones should be positioned strategically to ensure smooth operation and efficient sorting.

To transform our robot arm into a color-sorting marvel, we need to equip it with the "eyes" to distinguish between objects. These "eyes" come in the form of sensors strategically placed at the gripping point of the robot arm. The role of the HC-SR04 ultrasonic sensor is that it acts as a vigilant guardian, emitting and receiving ultrasonic waves to detect the presence of an object within its range. Essentially, it tells the robot arm, "There's something here ready to be picked up!"

Once the HC-SR04 confirms the presence of an object, the TCS230 color sensor steps in to play its vital role. This sensor acts like a detective, analyzing the object's color and providing this crucial information to the robot's control system. Armed with this knowledge, the robot can then make informed decisions about where to place the object based on its pre-programmed color sorting criteria. control the robot arm by simply changing its X, Y, and Z coordinates – that's the beauty of using a Cartesian coordinate system. However, the real world of servo motors controlled by Arduino libraries like "Servo" speaks a different language – degrees of rotation. Here's where the magic happens. To bridge this gap, we need mathematical formulas that translate the desired end effector position (given in X, Y, and Z values) into the specific degree values each servo joint needs to rotate. This conversion process allows us to program the robot's movements using intuitive Cartesian coordinates while seamlessly instructing the servo motors in their native language of degrees.

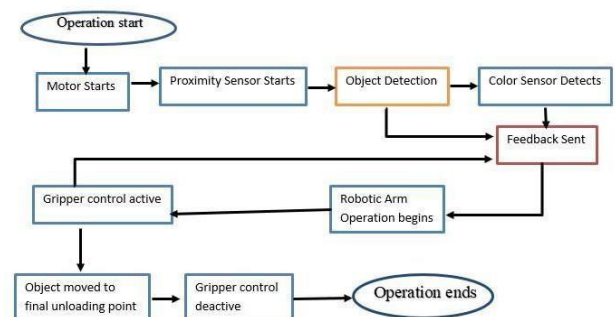


Fig.2 Flowchart of the proposed Robotic Arm

In robotics, we can use a technique called forward kinematics to calculate the position of a robot's end effector (the tip) given the specific rotational angles of each joint. This is essentially like knowing the lengths and angles of a chain, and then predicting where the end will be. However, for robot control, forward kinematics isn't ideal.

What we truly need is the opposite: inverse kinematics. This method allows us to determine the joint angles required to move the end effector to a desired position in

space. This is crucial because robot control systems send commands (messages) to the actuators (servo motors) specifying the rotational angles they need to achieve. By calculating these angles through inverse kinematics, we can translate desired end-effector positions into specific instructions for the robot's joints, effectively telling it how to reach its target.

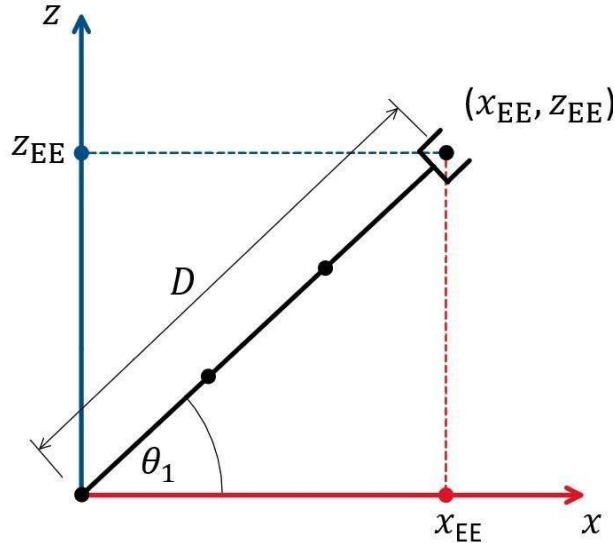


Fig.3 Inverse Kinematics

In this project, the inverse kinematic equation will use a geometric method to determine the joint angles of the robot arm to reach desired end effector position. For reducing the complexity, we reduce the problem from 3D to 2D point of view. Now, let us assume that we look at the robot arm from above, which represents the plane (x, z). To make the gripper (end effector) reach desired coordinate position the first joint should rotate at variable declared as "Theta 1", beside the first joint rotation, the arm need to span to make end effector reach desired coordinate position. Let's symbolize variable how far the arm needs to be spanned as "D".(As shown in fig.3)

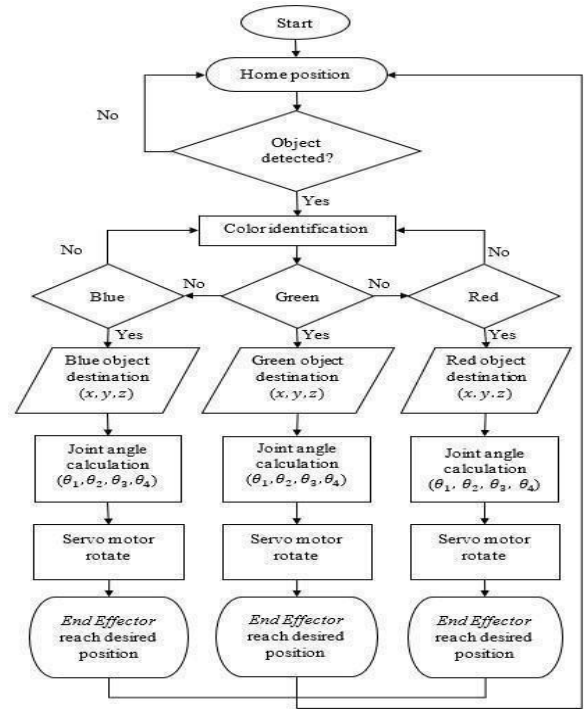


Fig.4 System Diagram

V. RESULTS AND CONCLUSION

From this project we learn about the requirements and the theory behind the creation of an industry level pick and place robot. The incorporation of color recognition and camera systems has unlocked a new level of automation, enabling these robots to excel at sorting, handling, and assembling with unprecedented precision and adaptability. It also tells us about the clear vision that this device has in the future of automation. This technological revolution promises to streamline manufacturing processes, boost efficiency, and reduce errors. As we move forward, continued advancements in color recognition algorithms, sensor technology, and deep learning will further enhance the capabilities of pick and place robots. We obtained satisfying results in terms of speed, accuracy and control.

VI. SOCIAL IMPACT & FUTURE

This device has been misguided as an instrument that will decrease the jobs due to decline in human labour but what we don't see is that to create one such device you need atleast three pairs of hands and three brains to work with each other. Also it will revolutionize the automation industry by increasing supply and making most out of the demand needed in any sector or industry. This will further incorporate and enhance the integration of software into hardware and fullfil various needs as per the requirement. The future is bright for the pick and place robot since it can not only sort as per the

weight but also as per various other parameters such as luminence, weight, temperature. It can also be paired with deep learning and can further be accustomed to various environments which can alter the RGB scale and be made lighter using high power more expensive relays along with motors. Basically as we invest more time, resources and effort in it we are only going to improve the facilities for this project device. Imagine robots seamlessly sorting a kaleidoscope of products on a conveyor belt, or precisely assembling components with intricate color-coded markings. This future is not a distant dream; it's on the horizon, driven by the transformative power of color in pick and place automation. As we move forward, the possibilities are truly limitless, and the vibrant world of colorized pick and place robots promises to paint a brighter future for industrial production, one precise and efficient operation at a time.

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This project and technical paper were greatly supported by Professor Sanjay B. Deshmukh. His expert coaching and comprehensive assistance were invaluable to us at every level of this project, and this paper would not have been possible without his contributions. We are grateful to our juniors as much as we are to our seniors who contributed their knowledge and experience to the research and assisted us throughout the process. We would also like to thank each others as we overcame various problems and encountered each with one another's help and support and could never have the thought of trying to do all the work single-handedly. We motivated each other and would like to thank our readers and guides who take this project as a reference for future developments in the domain.

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Biomimetic Robotic Hand

Dhruv Panchal¹, Darshan Markar¹, Shreedhar Barot¹, Venkata A P Chavali²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056
E-mail: ¹dhruvpanchal248@gmail.com, ¹darshanmarkar28@gmail.com, ¹barotshreedhar66@gmail.com, ²venkata.chavali@djsce.ac.in

Abstract—The development of biomimetic robotic hands has gained significant interest in recent years due to their potential to mimic human hand functionalities. The interest in research and development of the humanoid hand has been steadily growing in recent years. This paper signifies how two motors control a robotic hand that offers solutions to public problems, how they can enhance the quality of life for individuals, and the engineering principles underlying their construction. Furthermore, this paper explores diverse applications of biomimetic robotic hands across domains such as prosthetics, industrial automation, and healthcare assistance, highlighting their potential to revolutionize human-robot interaction and task execution. In healthcare, biomimetic robotic hands offer assistance to individuals with disabilities or mobility impairments. These hands can be integrated into assistive devices, such as robotic prostheses, to help users perform activities of daily living independently. By providing users with naturalistic movement, biomimetic hands enhance their quality of life. The aim is to investigate how well the robotic hand could imitate the movements of a hand gesture through a potentiometer and camera feed to grip objects through wireless communication.

Keywords— humanoid hand, biomimetic, wireless communication

I. INTRODUCTION

The main aim of this project is to build a wireless robotic hand that can perform all the possible gestures and lift objects with high holding torque using two motors. In a world where technological advancements are often associated with high costs, this project has made a significant step towards making a positive impact on the lives of individuals with physical disabilities. The development of a low-cost robotic hand capable of executing a wide range of gestures provides hope for those who cannot afford traditional prosthetic solutions. This project not only addresses financial constraints but also aims to provide a solution that promotes independence. The precise manipulation of finger movements in a robotic hand is attained by employing two methods: camera feed and potentiometer. This microcontroller handles the communication between the potentiometer and motors. Potentiometers, calibrated to detect varying degrees of finger flexion, relay this data to the microcontroller, enabling them to interpret and translate these movement into specific commands. Another microcontroller is connected to National Electrical Manufacturers Association (NEMA motor) and the servo motor provides precise instructions for finely tuning the angle and position of each finger to make the desired gestures accurately. The harmonized interplay of potentiometers, microcontrollers, and motors facilitates the replication of human-like hand gestures within the robotic hand.

II. OBJECTIVE

In everyday life, people need to use their hands most of the time to perform any task, although it's difficult for people with physical disabilities. Thus, the main objective is to create an economical robotic hand capable of performing a wide range of motions for people who can use it easily. This innovation aims to offer a practical solution for people, providing them with an accessible and affordable tool to assist with daily activities. By using cost effective materials and simplified mechanics, the robotic hand provides an efficient alternative without compromising on functionality. Moreover, the project prioritizes user friendly and simplicity of operation, allowing users to perform tasks with ease.

III. LITERATURE SURVEY

The data on hand gestures has been collected by two methods - potentiometer and a camera feed. For the camera feed, a trained model of the hand was used through the MediaPipe framework [3]. The Mediapipe framework is designed to implement a machine learning model that builds pipelines to perform inference over the sensor data [3]. Regression is used to predict the coordinates of landmarks directly. This helps in creating a detailed model of the hand landmarks [3]. The system consists of three main components: a palm detector model, which processes the captured image and returns an oriented box of the hand. The hand landmark model, which operates on the bounded box image and provides 3D hand key points along with a gesture recognizer. It will classify these 3D hand key points and configure them into a discrete set of gestures [3]. The library in Mediapipe contains 543 key points, including 33 body poses, 468 facial points, and 21 landmarks per hand, for human body pose detection [5]. The other method is using a potentiometer and applying the working principle of a flex sensor [6]. The flex sensor functions as analog resistors, operating as variable voltage dividers. Encased within these sensors are carbon resistive elements layered on thin, flexible substrates. When the fingers bend, the sensor generates a resistance proportionate to the amount of bend in the finger [6].

IV. PROPOSED DESIGN

The proposed low-cost robotic hand design presents a promising solution for enhancing efficiency and reducing costs in various industrial applications. To mimic the motion of the human hand, a camera feed and potentiometer are used to provide hand gesture data to the robotic hand. The robotic hand is controlled using a gearbox, which enables it to perform 18 different gestures, including abduction and adduction motion, with high torque and precision. Using abduction and adduction motions, the hand will be able to grasp items of any shape and size.

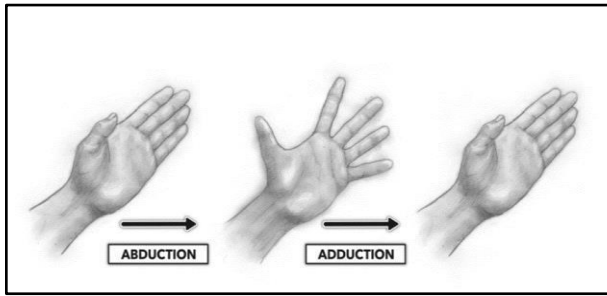


Fig.1 Abduction and Adduction

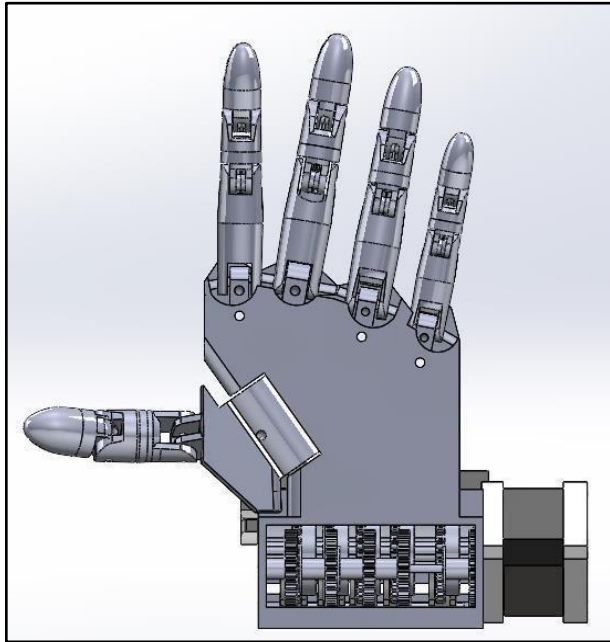


Fig.2 Robotic Hand

V. IMPLEMENTATION

The two main components in this project are Arduino UNO and Raspberry Pi Pico. Arduino UNO collects data from the potentiometer, which measures the amount of deflection or bending of the human finger. As the finger bends, the resistance of the potentiometer increases, which is calibrated to the angular value of the finger. Another method implemented is through Machine Learning (ML), where camera feed captures the hand data. The Mediapipe framework analyzes data by detecting and assigning landmarks to the hand. The angle of the finger is calculated using the distances between these landmarks. To reduce latency during wireless communication, the angular data for all fingers (described by five digits) is transferred to an Arduino Uno using the Pyserial library.

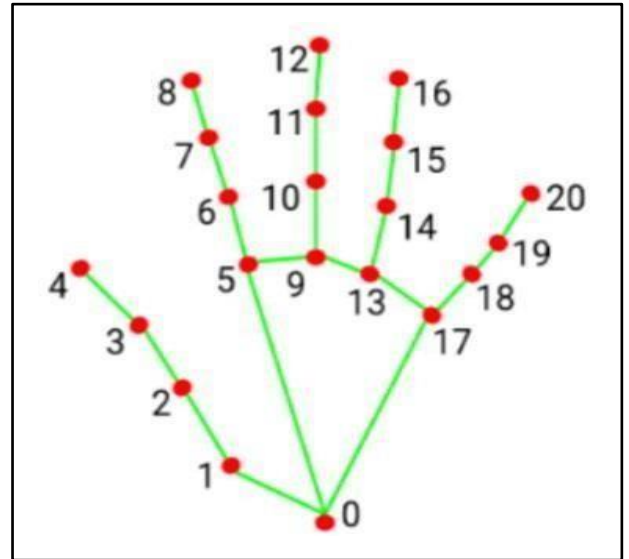


Fig.3 Hand landmark in MediaPipe

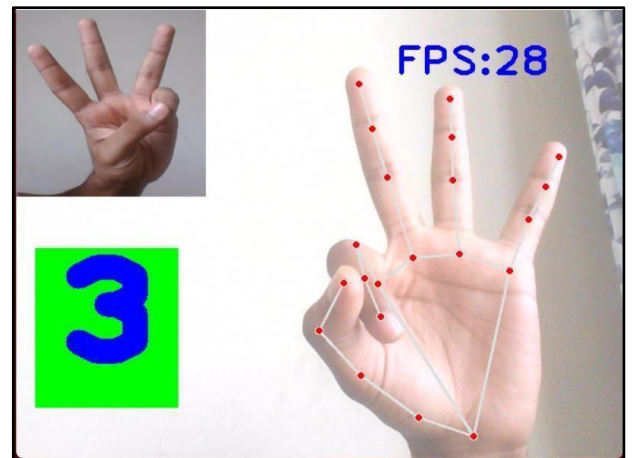


Fig.4 ML Implementation

In a robotic hand, three types of gears are used: internal gear, external spur gear, and control gear, which are responsible for controlling the fingers of the robotic hand. There are five internal gears, and around each gear there are some positions where teeth are excluded, which are responsible for 18 different possible combinations, which give access to the NEMA motor to control different combinations of finger movements. The Raspberry Pi Pico has all locations stored of teeth arrangements formed by internal gears, based on the received data, the internal gears are rotated at specific angle through NEMA motor. There are five Control gears, each gear controls the motion of a finger using threads. There are five External spur gears for Internal gear, the gear exhibits two motions: rotational and linear motion.

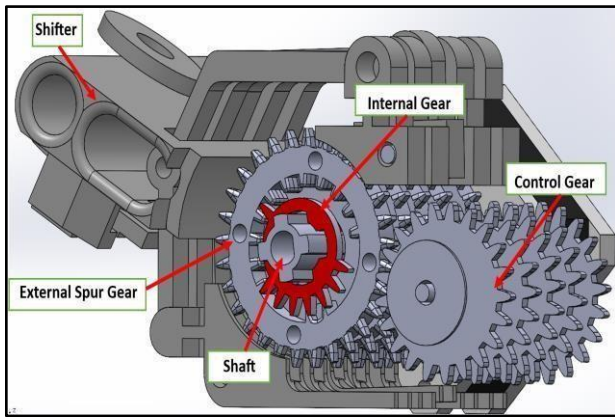


Fig.5 Gear box

Rotational motion is controlled by NEMA motor and linear motion is across the shaft controlled by servo motor. Based on External spur gear's linear motion there are three cases Fig.7 :

In first case, external spur gear is not connected with internal gear due to which NEMA can only control the rotation of the internal gears and set the teeth arrangement to control particular fingers as per the data received to Raspberry Pi Pico.

In second case, once the arrangement of internal gears is set, using shifter the servo motor shifts the external gear towards internal gear. In external spur gear a 'Bit Holder' is attached which gets locked with the tooth of the internal gear due to which the external spur gear gets connected with internal gear and control gear, it will stop the gear to move further. This enables NEMA motor to control the finger motion as per the arrangement of internal gear.

In third case, while the servo motor shifts the external spur gear towards internal gear, if in specific teeth arrangement tooth of an internal gear is missing, then it won't get locked with bit holder and the gear shifts further and the internal gear gets completely inside the external spur gear. This disconnects the contact between the control gear and external spur gear which disables NEMA motor to control finger.

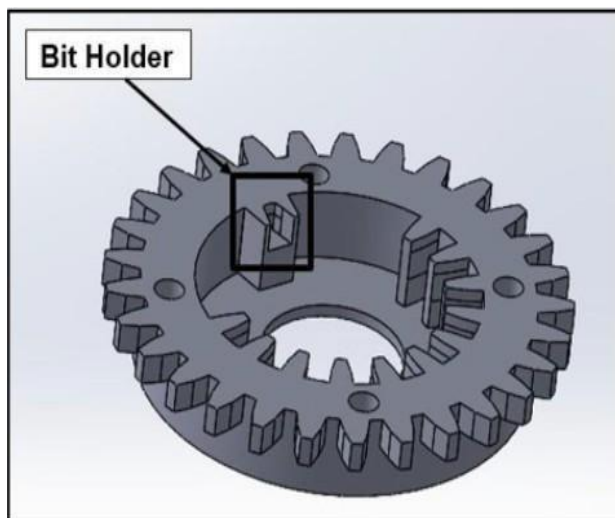


Fig.6 External spur gear

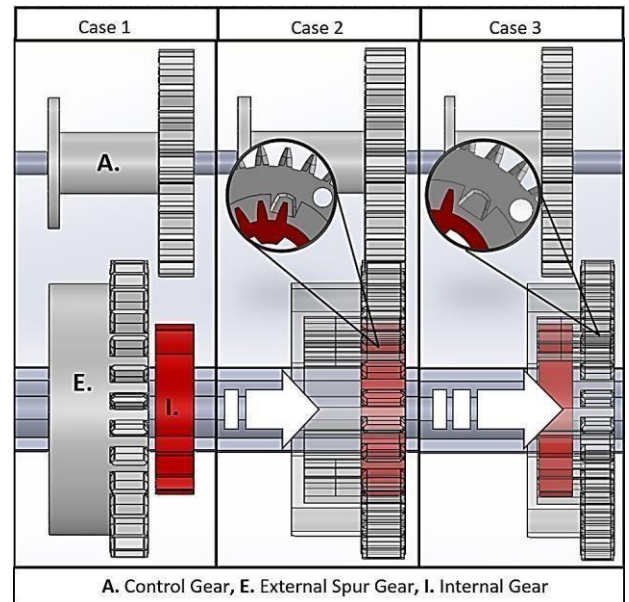


Fig.7 Working of external spur gear

While controlling motion of fingers using NEMA motor, the fingers can get over rotated. To avoid over rotation a potentiometer is connected to the shaft of the NEMA motor which ensures the rotation of fingers between the defined range of angle.

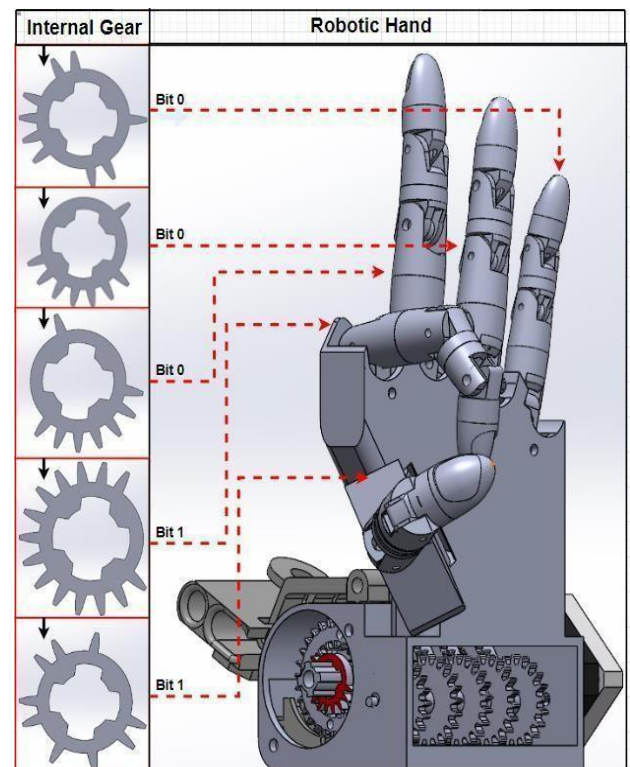


Fig.8 Internal Gear teeth arrangement controls

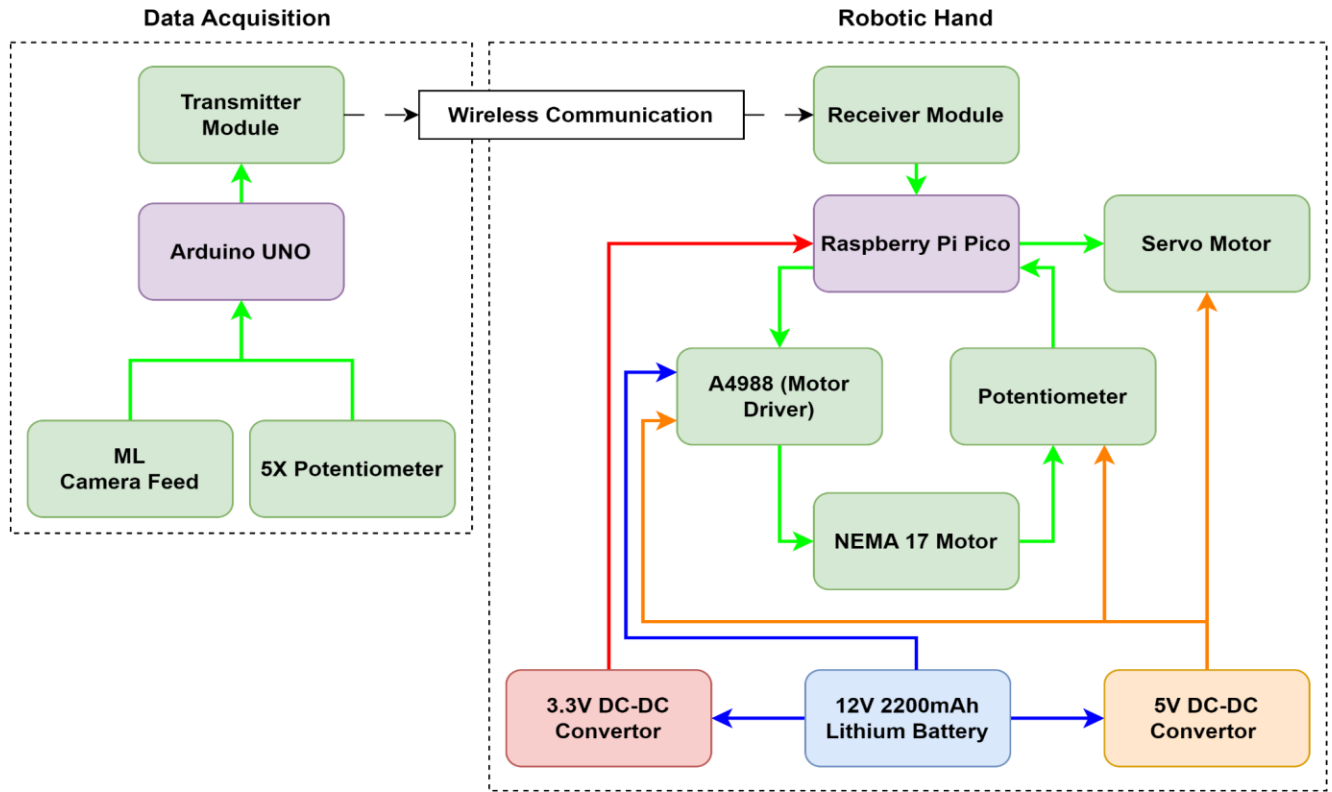


Fig.9 Block diagram

Calculation: Parameters of all Gears in Gear Box

Parameters	Values
Total teeth on external spur gear (T_E)	29
Total teeth on control gear (T_C)	21
Total possible teeth on internal gear	18
Average speed of NEMA 17 (W_{Avg})	300 RPM
Torque of NEMA 17 motor (r)	4.2Kg/cm
Diameter of Thread winding cone	8mm
Diameter of Control Gear	30mm
Diameter of Internal Gear	22mm
Diameter of External spur gear	40mm
Diameter ratio of Control Gear to thread Winding Gear (D_W)	3.75:1

- Total Speed of Control Gear (S_C)

$$S_C = \frac{T_E}{T_C} \times W_{Avg} = \frac{29}{21} \times 300 = 414.28 \text{ RPM} \quad (1)$$

- Total Torque of Control Gear (τ_C)

$$\tau_C = \frac{T_E}{T_C} \times \tau = \frac{29}{21} \times 4.2 = 5.8 \text{ Kg/cm} \quad (2)$$

- Total Holding Torque (τ_H)

$$\tau_H = \frac{T_E}{T_C} \times D_W = \frac{29}{21} \times 3.75 = 5.17 \text{ Kg/cm} \quad (3)$$

- With a consistent pitch diameter of 1.5mm across all gears, they seamlessly engage without any risk of slipping, ensuring smooth operation.

V. RESULTS AND CONCLUSION

The project's successful implementation not only broadens accessibility for individuals facing financial barriers to traditional prosthetics but also enriches the ongoing conversation surrounding economical and inclusive advancements in the realm of robotics. The project focuses on how the robotic hand can be made more technologically useful and mimic human hands more efficiently. All the finger movements and gestures are achieved with the help of one Stepper motor. The advantage of this robotic hand is that it is cost-efficient, one motor is used to control all five fingers, whereas usually one motor is required for each finger movement.

VI. SOCIAL IMPACT & FUTURE

The Biomimetic robotic hand has numerous applications in various fields. In manufacturing and industry, it is extremely useful for automating assembly lines, handling materials, and improving packing tasks. Additionally, these hands play a crucial role in prosthetics, offering them a more natural and functional alternative. In the medical field, they contribute to precise methods by allowing delicate and controlled movements. Moreover, the use of robotic hands extends to space exploration for tasks like repairs, maintenance, and their integration into prosthetic limbs holds the promise of providing features with a more natural and functional range of motion. In medical applications, robotic hands are used to assist surgeons in complex surgeries. In disaster scenarios, these hands aid in search and rescue operations, navigating hazardous environments with agility. Remote handling of robotic hands is employed for tasks in high-risk environments, ensuring safety for human operators. In research and development, robotic hands serve as essential tools for experimentation and testing, contributing to advancements in control and overall robotic system design. The continual evolution of technology promises further innovative applications for robotic hands across a spectrum of domains.

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Smart Cane for Blind People

Kashish Patni¹, Sanya Tyagi¹, Atharva Dhuri¹, Nainika Hadkar¹, Archana Chaudhary²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Electronics and Telecommunication Department, D. J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹patnikashish3008@gmail.com, ¹sanya.ty2610@gmail.com, ¹dhuriatharva48@gmail.com,

¹nphadkar0404@gmail.com, ²archana.chaudhary@djsce.ac.in

Abstract—Our whole life, we have found the sense of seeing normal. But to the people who are visually challenged, see that as a very special gift to a person. Walking with the help of this sense become easier and come naturally to us. But the inability to see can cause serious problems to the people who were visually impaired or become blind due to some incident. Walking and travelling being independent is very common. It is not wanting to travel anymore but needing to travel with the race happening around the world for success and every small thing. Be it going out for work, a walk around the park, or going to school and college; all this has become very difficult for these people to do on a daily basis. Not being able to see makes it difficult to walk around even at their homes where they live, but eventually get accustomed to the surroundings they are in on daily basis. the most difficult to navigate around is the surroundings they visit sometimes. The development and implementation of a Smart Cane is to empower the visually challenged community by addressing the challenges they face in daily navigation. Through the integration of three ultrasonic sensors strategically positioned on the cane, the system can detect and classify obstacles, and provide real-time information and environmental awareness for users. By conducting a thorough review of existing literature on obstacle detection systems and mobility aids for the blind, the project identifies challenges and opportunities for innovation. The theoretical framework outlines the working principle of the Smart Cane, detailing its sensor integration and data processing mechanisms. Results from the project demonstrate significant progress in sensor integration, vibration module implementation, and mechanical design. This research contributes to the advancement of assistive technologies for the visually impaired, and promoting greater autonomy to them in daily life.

Keywords— *Smart Cane, Visually Impaired, Ultrasonic Sensors, Vibrator Motor Module, Arduino, Servo Motor, Internet of Things (IoT).*

I. INTRODUCTION

Visual Impairment has been a concern for researchers for many decades now and the sense of seeing is used to navigate on a daily basis. According to a study conducted between 2015 and 2019, the rate of blindness among individuals aged 50 years and older in India was 1.99%, while the prevalence of visual impairment stood at 26.88%. Vision loss significantly impacts one's quality of life, independence, and ability to move around, leading to increased risks of falls and

injuries. This condition affects their mental well-being, social interactions with friends and family, and results in disparities in employment, income, and educational opportunities. A recent study estimates that the potential loss of productivity due to vision impairment in India is INR 646 billion (\$ 29.4 billion). The main purpose of this technology is to assist individuals with navigating around different places by using real time information from sensors and detect obstacles. It is similar to what a human eye can do i.e. detect and process height of obstacles and help the human to navigate around different places independently. Still there are problems raised in navigating as it is not an autonomous dedicated stick. It cannot categorise the obstacle into chairs, tables, furniture, trees, potholes, puddles, etc. Navigating outdoor environments poses significant challenges for blind and visually impaired individuals, limiting their freedom and independence. Their mobility does not allow them to interact with people and indulge in social activities. This has great effects on their mindset. A large percentage of visually impaired individuals, currently remain unemployed because wide variety of jobs aren't designed for them. For people who are alone with no family or relatives, it becomes difficult for them to be independently navigating or find a job that they can work on being blind. But as everyone knows, there are not many jobs for such people. In recent years, extensive research efforts have focused on designing dependable systems that effectively detect obstacles and alert visually impaired individuals to potential hazards. Many blind people are seen with dogs who are trained for helping the individual navigate around places. But again, many premises do not allow pets inside so at times like these, it gets very difficult. The Smart Cane project is motivated by a sincere commitment to improving their lives. Recognizing the struggles faced, particularly in crowded spaces and varying terrains, led to the conceptualization of a technological solution. The goal is to create a comprehensive tool that not only addresses immediate concerns related to obstacle detection but also enhances navigation and safety.

II. OBJECTIVE

Traveling daily around Mumbai, majorly in local trains; the team has encountered various blind or visually challenged people who find it difficult to find their way around till their designated handicapped coach, especially when they are traveling alone without anyone's help. Talking to them led the team to know a few problems that they encounter the most while

traveling alone. The Smart Cane is a technology that allows a machine to categorize obstacle heights and can be very useful. The user needs to tap the traditional white cane on obstacles in front of them to detect its height. This in turn leads to wastage of time because of doing the same process for every obstacle they encounter while travelling which is quite a lot. Another problem that they encounter is that they must take special training to learn to use the traditional white stick. Till they do not have the training, they cannot navigate around with the traditional stick as well. These are the problems we aim to tackle with our smart cane. The smart cane will get real time information as feedback mechanism for the users. This information is about the height of obstacles detected. We thrive to make the Smart Cane affordable for users from low- income backgrounds. With the smart cane, we plan to make their life comparatively easier and create an impact for the betterment of the society and its people.

III. PROPOSED DESIGN

The sonar effect by the ultrasound waves was used for detecting distance of the obstacle from the user. This sonar effect was implemented by using ultrasonic distance sensors. [2] [3] Obstacle detection within a particular range of distance from the user is important for interpreting its height. The obstacles are classified into three categories depending on their heights. These are foot level, stairs level, and more than knee level. It is discovered that describing more height categories is useless; because no visually challenged person tries to jump or cross through the obstacle with height greater than knee level from front. They just step aside and go past that. This will solve the problem of detecting the obstacle from far away and height will also be detected from that distance reducing the time wasted in tapping around the traditional white cane.

The cane after detecting the obstacle interprets its height. This height is categorized as per one of the height categories. The height category of the obstacle is fed back into the system and as per information received; the vibration intensities of the vibration module will be controlled. The vibration module will be mounted on the top of the stick to get immediate feedback on obstacle height and can accordingly act upon it. [2] The cane will be designed in such a manner that the user can detect obstacles at different heights along with the approximate height of the obstacle. The approximate obstacle height will be known to user by different vibration intensities as per the heights categories defined through a vibration motor module. The intensity or the amount of training usually needed to use the traditional white cane will reduce too much in case of smart cane. The sensor used for categorizing foot level obstacles will be placed on a servo motor which will rotate the sensor from left to right. This sensor will now be able to detect obstacles approaching the user from sideways. This is done for the foot level sensor because every obstacle approaching the user vehicle be detected on the foot level whatever their height maybe.

This feature will help them in crossing roads or travelling in general. We aim to make the user navigate with confidence like that as sighted individual.

IV. IMPLEMENTATION

Circuit Diagram

a) Arduino UNO

This is the microcontroller used for receiving data from different components. It further processes that data to interpret height of the obstacle, its distance from user and vibrating duration. It is also responsible for controlling the rotating motor movements to keep a track on obstacles approaching from sideways. [4]



Figure 1. Arduino UNO (Microcontroller)

b) Ultrasonic Sensor

Three ultrasonic sensors are being used in the circuit to detect the distance of the obstacle from the user. They work on the principle of SONAR effect. These sensors also help in determining obstacle height category. These sensors provide distance data to the microcontroller. [2] [3]



Figure 2. Ultrasonic Sensor (Distance Sensor)

c) Servo Motor

The ultrasonic sensor which categorizes foot level height obstacles is mounted on the servo motor. This motor rotates the sensor sideways for detecting obstacles approaching from sideways. It is very compact in size with minimal torque.



Figure 3. TowerPro SG90 (Servo Motor)

d) Vibration Motor Module

The vibration motor module is used for letting the user know the height category of obstacle with the help of different vibration durations. It has a motor which vibrates for different time duration which is controlled by the microcontroller. [2]



Figure 4. Grove Vibration Motor (Vibration Motor Module)

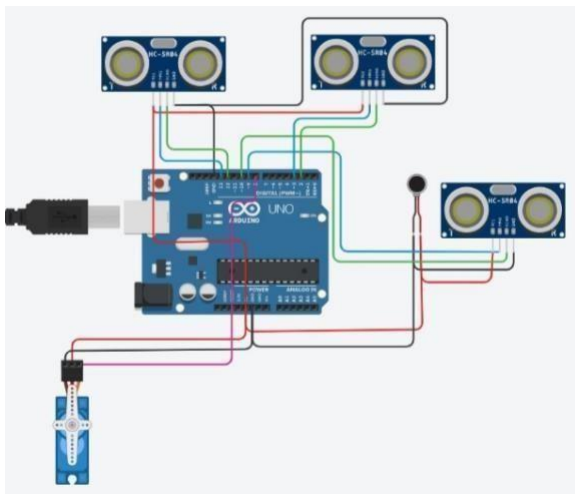


Figure 5. Circuit Diagram of Smart Cane Implementation

Working Principle

The smart cane has three major parts; fixed cane, electronics box, and adjustable cane.

a) Fixed Cane

The fixed cane is mounted on the top of the electronics box. As the name suggests, it is fixed and cannot be adjusted as per user's convenience. 1st prototype has only one stick like the traditional white cane with wheel handle but no electronics separate box. The problem with that prototype was it was complex to determine angle of convenience for users and hence determining height of the obstacle was becoming a problem. As shown in figure, the user still would have to depend on his or her hands to determine the height of the obstacle in front of them. [3] This angular convenience for user was becoming the major problem faced by us to determine the obstacle's height. Final prototype has the fixed stick along with adjustable one. On fixed stick are two ultrasonic sensors mounted for stairs level and more than knee level obstacle detection. [2][3]

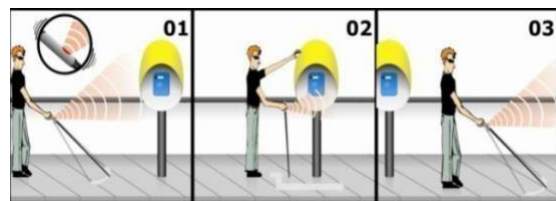


Figure 6. Height Detection Problem Faced [3]

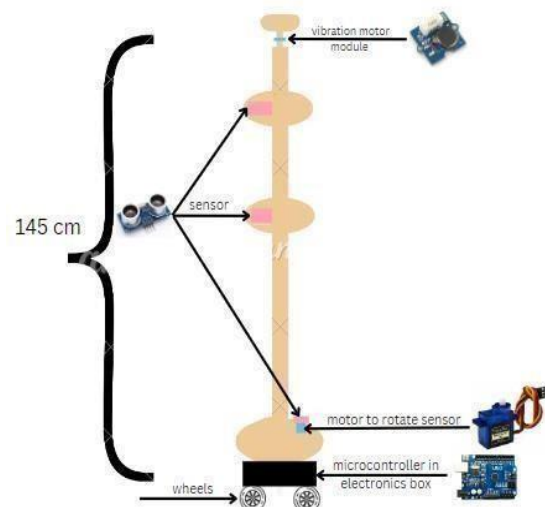


Figure 7. 1st Prototype

b) Electronics Box

The fixed cane is mounted on electronics box. The servo motor is mounted on electronics box which has the foot level sensor mounted on it. The box has the wheels mounted below it. [1] When we as completely abled person while travelling in bus or car can feel the potholes and speed breakers due to smooth motion from wheels then these visually challenged individuals have their heightened senses. Due to wheels being mounted on stick they can slide the stick on the ground smoothly instead of tapping the stick on the ground.[1] Due to this

smooth movement like in cars and their heightened senses, the user can feel the potholes or bumpers before in advance when the stick slides above them. The stick being in front of them helps the user to know it well in advance and hence protect them from falling. Another problem is tackled. The box houses the microcontroller and the battery. [3][4]



Figure 8. Fixed Stick and Electronics Box Implementation on Final Prototype

c) Adjustable Cane

It is mounted on the back of the electronics box using 3D printed parts. The user can set it to any angle as per their convenience. Because of this feature, the height detecting feature was successfully implemented. The final prototype is shown in figure. This will have the handle mounted on it along with vibration module mounted on it. [1] The vibration durations are controlled by the microcontroller from electronics box. [1][4] This module is mounted near the handle so the user can feel maximum vibration intensity like the output of module. [3][1] The maximum duration will be for more than knee level heightened obstacle and minimum being for foot level height obstacle.

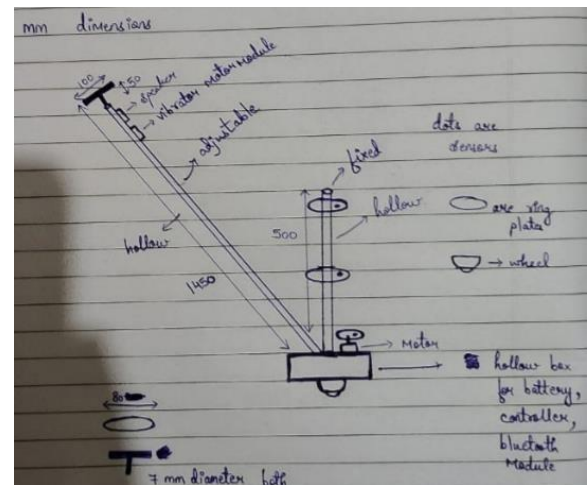


Figure 9. Final Prototype of Smart Cane

V. RESULTS AND CONCLUSION

The Smart Cane's working principle revolves around the integration of three ultrasonic sensors strategically positioned on the cane's joints. These sensors, situated near the top, middle, and bottom sections, collectively contribute to the accurate detection and classification of obstacles. The cane's core functionality lies in its ability to interpret signals from these ultrasonic sensors, ultimately providing real-time information about the height and presence of obstacles in the user's path. [1][2]

The process begins with the ultrasonic sensors emitting high-frequency sound waves into the surroundings. [2][3] These waves encounter obstacles in the cane's proximity, causing them to reflect to the sensors. The sensors, functioning as receivers, precisely measure the time taken for the sound waves to return. By leveraging this time-of-flight data, the Smart Cane calculates the distance between itself and the obstacles.

The height determination is a pivotal aspect of the Smart Cane's functionality. When an obstacle is detected, the cane intelligently utilizes signals from multiple sensors to gauge the obstacle's height accurately. For instance, if an obstacle is detected by both the bottom and middle sensors, the cane relies on the middle sensor's signal to determine the height. This dynamic approach ensures adaptability to obstacles of varying heights, offering enhanced environmental awareness to the user.

The Smart Cane represents a promising solution for empowering visually impaired individuals to navigate their surroundings with increased confidence and independence. The project underscores the potential of assistive technology in fostering inclusivity and improving the quality of life for individuals with visual impairments.



Figure 10. Final Smart Cane Structure

VI. FUTURE SCOPE

While significant strides have been made, certain components and functionalities can be incorporated in future for betterment in the Smart Cane project as follows:

1. Bluetooth Module Integration

The incorporation of a Bluetooth sound module for audio cues. [2] Once this is done, the module will establish a connection with the user's mobile device, allowing for real-time auditory feedback regarding the detected obstacles and GPS navigation.

2. Implementation of Machine Learning Models

Obstacle detection and obstacle categorization models can be incorporated. Obstacles like chairs, tables, trees, human, etc. would be detected and let the user know about these obstacles. This will further enhance autonomy in navigation.

Each task contributes to the functionality of the Smart Cane, ultimately providing visually impaired individuals with a reliable and effective tool for enhanced mobility and safety.

VII. SOCIAL IMPACT

The Smart Cane's development entails integrating advanced features to enhance functionality and user experience. The Smart Cane will help the user in navigating crowded urban spaces with height of obstacle awareness. Navigating in complex interiors like malls and public buildings will not be scary anymore. People will be able to safely explore parks and nature trails with advanced obstacle detection. Their confidence will increase and they will independently use public transportation frequently

with real-time obstacle detection feedback. Mobility will also improve within classrooms and offices for enhanced accessibility. The difficulties these people face in daily life at normal chores will become easier and less stressful. They will become independent and will have their much-awaited freedom and confidence.

ACKNOWLEDGMENT

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Fuzzy Logic and Object Detection based Active Suspension

¹Sayan Bera, ¹Harsh Doshi, ¹Ishika Jain, ²Vishaka Kelkar

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

²Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹285sayanbera@gmail.com, ¹doshih07@gmail.com, ¹ishikamriad03@gmail.com, ²vishakha.kelkar@djsce.ac.in

Abstract— The primary objective is to enhance the performance related to ride quality and comfort. To achieve this goal traditional fixed spring and damper systems are undergoing modifications to incorporate semi active and active systems [1]. This project focuses on assessing the effectiveness of an active suspension system through the development of a car model. The proposed approach involves implementing a fuzzy control system combined with the inputs from object detection YOLO_v8 algorithm to minimize chassis displacement. At the heart of this setup, Raspberry Pi 5 acts as the system's control center, orchestrating the vehicle's response to detected potholes. It meticulously processes the data received from the sensors combining it with the output from pothole detection algorithm and swiftly determines how to adapt the suspension settings with respect to membership functions and rules defined in REAL TIME. The critical components of this mechanism are Raspberry Pi 5, 6 axis gyroscope and accelerometer sensor (MPU6050). Inputs from the sensor along with video input from the camera are fed to the Raspberry Pi 5 where they are used as inputs to the fuzzy logic model, processed and an output is given with respect to membership functions and rules defined.

Keywords— *pothole detection, YOLO_v8, computer vision, Tensorflow, OpenCV, RaspberryPi, Accelerometer, Fuzzy Logic, Neural Networks, Hidden Layers.*

I. INTRODUCTION

The need for suspension in a vehicle stems from the inherent desire to enhance ride comfort, stability, and overall safety. Traditional suspension systems, comprised of springs and dampers, serve to isolate the vehicle's occupants from road irregularities, absorbing shocks and vibrations generated by uneven surfaces, potholes, and other obstacles encountered during driving. This cushioning effect not only prevents discomfort for passengers but also aids in preserving the structural integrity of the vehicle by reducing the transmission of harsh forces to the chassis. On the other hand, the need for active suspension arises from the pursuit of even greater refinement, performance, and adaptability in vehicle dynamics [2]. Active suspension systems employ advanced sensors, actuators, and control algorithms to continuously monitor and adjust various parameters such as ride height, damping characteristics, and even individual wheel forces in real-time. By actively counteracting body roll, pitch, and dive movements, active suspension enhances both ride comfort and handling precision, offering a more refined driving experience across diverse road conditions. Moreover, active suspension can dynamically adjust its behaviour to suit different driving scenarios, optimizing comfort during leisurely cruising and enhancing agility during spirited driving. This technological advancement not only elevates the driving experience but also contributes to improved vehicle safety and stability, making it particularly desirable

for high-performance applications and luxury vehicles where uncompromising ride quality is paramount [3]. It becomes difficult to map each value of pothole intensity with a particular output value. Here fuzzy Logic comes handy as it can generate a crisp value for various uncertain values depending on membership function. There are 4 accelerometers and 4 servo actuators; pothole intensity is detected with the help of accelerometer and pothole detection algorithm (using YOLO_v8) inputs are given to the fuzzy logic program and a crisp output is generated for the corresponding inputs.

II. LITERATURE SURVEY

Fuzzy logic-based active suspension systems are a transformative advancement in automotive engineering, geared towards enhancing ride comfort, stability, and handling by dynamically adjusting suspension damping in response to changing road conditions and driving dynamics. Leveraging fuzzy logic, a branch of artificial intelligence and control theory, these systems excel in managing complex, nonlinear, and uncertain information. Unlike traditional control methods, fuzzy logic enables the representation of vague or ambiguous input data and the formulation of control rules based on linguistic variables. This adaptability empowers active suspension systems to make decisions based on imprecise and incomplete information, effectively mimicking human-like responses to varying road conditions and ultimately elevating ride quality and handling to new heights. Seminal studies, such as the pioneering work by Li and Tomizuka in 2000, have underscored the efficacy of fuzzy logic controllers in improving vehicle dynamics. Further advancements, exemplified by the research of Elmarakbi and Sennah in 2011, explore the integration of fuzzy logic with other advanced control strategies, revealing its versatility and potential for synergistic effects. Practical implementation considerations have also been addressed in studies like that by Zhang et al. in 2015, with a focus on real-time fuzzy logic controllers to mitigate challenges such as sensor noise and system latency. This pragmatic approach ensures that the theoretical advantages of fuzzy logic translate into tangible improvements in vehicle dynamics and ride quality, thereby fostering widespread adoption in the automotive industry. [4]

As automotive technology continues to evolve, the integration of fuzzy logic-based control strategies in active suspension systems holds promise for revolutionizing the driving experience. By enhancing safety, comfort, and overall vehicle performance, these systems are poised to shape the future of transportation. The adaptability, robustness, and real-time capabilities of fuzzy logic control

present a fertile ground for ongoing research and development, driving continuous innovation towards achieving superior vehicle dynamics and ride quality [5]. Thus, fuzzy logic-based active suspension systems stand as a testament to the transformative potential of advanced control technologies in shaping the automotive landscape for years to come [6]. In recent years, YOLO_v8 has emerged as a leading object detection framework, offering remarkable speed and accuracy in identifying objects within images or video frames. Its architecture, built upon previous iterations of the YOLO (You Only Look Once) series, has been fine-tuned to strike a balance between computational efficiency and detection performance. YOLO_v8's architecture typically comprises a backbone network, a neck, and a detection head, enabling it to efficiently process input data and accurately localize objects of interest, such as potholes on roads. This technical paper delves into the specific application of YOLO_v8 for pothole detection, leveraging its capabilities to address the significant safety and infrastructure concerns posed by road damage. The success of any deep learning model, including YOLO_v8, heavily relies on the quality and diversity of the dataset used for training. In the context of pothole detection, creating a robust dataset involves capturing images or videos of roads under various conditions and accurately labelling pothole instances within them.

III. PROPOSED DESIGN

This is a two-part working apparatus at this point; Fuzzy Logic Based Actuators and Object detection using YOLO_v8.

Working principle:

- *Fuzzy Logic Based Actuator*

The active suspension system employs fuzzy logic to dynamically adjust the stiffness of the suspension based on the speed of the car and the intensity of bumps. The system utilizes two input parameters: Speed of Car and Intensity of Bumps. The output is the Stiffness of Suspension. To Implement this project we have used the following components:

ATmega328p Development Board Compatible with Arduino and 6-axis Accelerometer Gyroscope MPU6050 Sensor Module

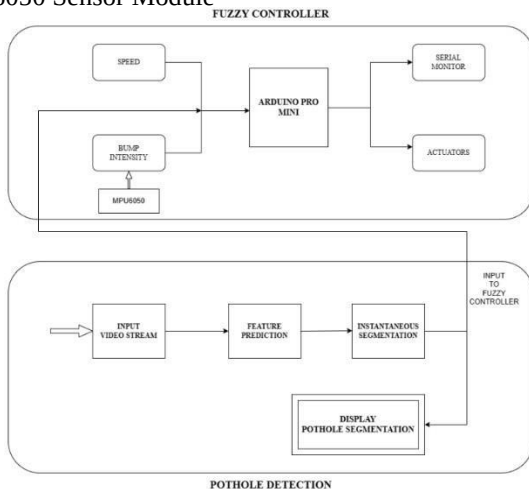


Figure 3.1 Generalized block diagram

As depicted in Figure 3.1, the internal working of the project is initiated by the reception of crucial input signals from the MPU6050 sensor, which is responsible for providing real-time data regarding the intensity of bumps experienced by the vehicle. Additionally, the speed of the car, a pivotal factor in determining the appropriate suspension response, is defined within the code.



Fig.3.2 Fuzzy Logic Model

According to Figure 3.2 we can see the processing of these essential input parameters, namely the speed of the car and the intensity of bumps, constitutes a significant phase in the operation of the fuzzy suspension system. This processing is executed through a set of predefined fuzzy rules, carefully designed to emulate human-like decision-making under varying driving conditions. Each fuzzy rule encapsulates the relationship between the linguistic variables "Speed" and "Intensity of Bumps," translating them into a corresponding suspension stiffness value. [7]



Figure 3.3 Integrating of Arduino with Sensor

Figure 3.3 illustrates the linkage of the sensor with the Arduino microcontroller. Employing the I2C communication protocol, the MPU6050, a 6-axis IMU, combines accelerometer and gyroscope data to monitor real-time device motion and orientation. In summary, the working principle of a fuzzy logic-based active suspension system [7] [8] involves the continuous processing of sensor data through fuzzy logic algorithms, leading to dynamically adjusted suspension settings. This adaptive and real-time

approach allows the system to enhance ride comfort, handling, and overall vehicle performance under varying driving conditions. [8]

• Pothole Detection using YOLO_v8

Pothole Detection using YOLO_v8 represents a sophisticated application of deep learning technology aimed at automating the identification and localization of road defects. YOLO_v8, an evolution of the YOLO (You Only Look Once) series, is chosen for its superior speed and accuracy in object detection tasks, making it particularly well-suited for real-time applications such as road inspection. The process of pothole detection using YOLO_v8 begins with the creation of a comprehensive dataset that encompasses various road conditions, lighting situations, and pothole types. This dataset is crucial for training the YOLO_v8 model effectively, as it allows the model to learn to detect potholes accurately under diverse circumstances. Data augmentation techniques may be employed to artificially increase the size and diversity of the dataset, ensuring that the model generalizes well to unseen scenarios. Once the dataset is prepared, the YOLO_v8 model undergoes training using a deep learning framework such as TensorFlow or PyTorch. During training, the model learns to identify potholes by analysing the features present in the input images or video frames. The training process involves iteratively adjusting the model's parameters to minimize the difference between the predicted bounding boxes and the ground truth annotations provided in the dataset. This optimization process typically requires significant computational resources, often facilitated by GPUs to accelerate training speed. Evaluation of the trained YOLO_v8 model is essential to assess its performance accurately. Common evaluation metrics include precision, recall, and mean average precision (MAP). Precision measures the proportion of correctly detected potholes among all detections made by the model, while recall measures the proportion of actual potholes that are correctly detected. The MAP provides an aggregate measure of the model's performance across different confidence thresholds, considering both precision and recall. In practice, pothole detection using YOLO_v8 can be deployed in various scenarios, including mounted cameras on vehicles, drones, or fixed roadside cameras. Real-time inference capabilities of YOLO_v8 enable prompt identification of potholes as vehicles traverse the road network, facilitating timely maintenance interventions to mitigate road hazards and enhance safety. Despite its effectiveness, challenges such as occlusions, varying road surfaces, and environmental factors like weather conditions can impact the performance of YOLO_v8 based pothole detection systems. Ongoing research efforts focus on addressing these challenges through advanced model architectures, improved data augmentation techniques, and robustness enhancements to ensure reliable performance in real-world conditions. In conclusion, pothole detection using YOLO_v8 represents a cutting-edge application of deep learning technology with the potential to revolutionize road maintenance practices and improve road safety. By automating the detection process, YOLO_v8 enables timely interventions to repair

road defects, ultimately contributing to safer and more efficient transportation infrastructure.

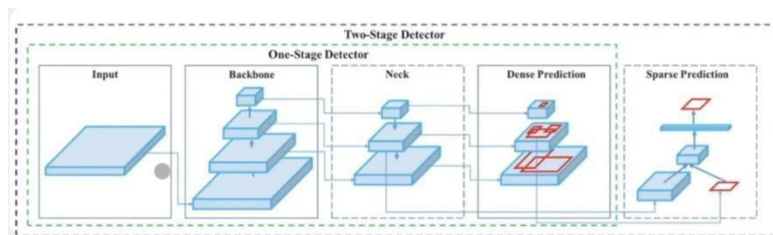


Fig.1 Yolo Architecture

Yolo uses a convolution neural network to predict bounding boxes and class probabilities considering the entire image in a single evaluation in one step and for one unit yolo predicts multiple bounding boxes. the class probabilities for each box and all the bounding boxes across the classes making it the one stage detection model. unlike earlier object detection models which localize objects and images by using regions of the image with high probabilities of contender; yolo considers the full image. About the architecture of yolo, image frames are featured through a backbone which is then combined and mixed in the neck and then they are passed along. YOLO predicts the bounding boxes, the classes of the bounding box and objects of the bounding boxes [9]. Let us understand each of its modules separately.

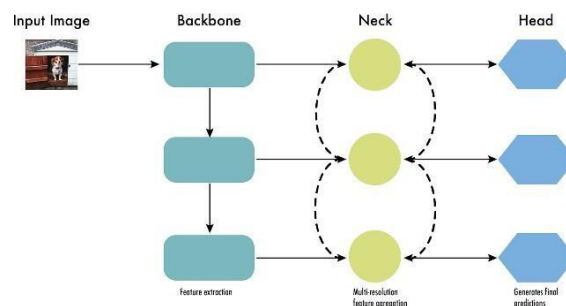


Fig.2 Layers

INPUT LAYER: Firstly, the Input layer is the image input you provide. It can be a two-dimensional array with three channels red, blue, and green; it can also be a video input at each frame of some image input.

BACKBONE: The Backbone is a deep neural network composed mainly of convolutional layers. The main objective of the backbone is to extract the essential features. The selection of backbone is a key step as it will improve the performance of object detection. Often pre-trained neural networks are used to train the backbone. Some of the commonly used pre-trained networks are VGG16, ImageNet, ReutineNet, Resnet50, etc. For YOLO_v8 following pre-trained weights have been used: VoVNET, CSPVoVNET, ELAN, E-LAN. [10]

NECK: Object detector models insert additional layers between backbone and head which are referred to as a copy of the detectors. The essential role of the neck is to collect feature maps from different stages. Usually, a neck is composed of several bottom-up parts and several top-down parts. For enhancement FPN, RFB and PAN are used.

DENSE PREDICTION: Detection happens in the head so the head is also called as dense prediction to set the director to decouple the object localization and classification task for each module. Once the detectors make the prediction for this localization and classification at the same time, this layer is present only in one stage after detectors like YOLO, SSD, RPN into self-detection; they are completely different.

SPARSE PREDICTION: Sparse prediction is for two-stage detectors LFRCNN and RFCN are highly different which does the traditional class probabilities for the model input. YOLO is one stage; all this together form the YOLO architecture.

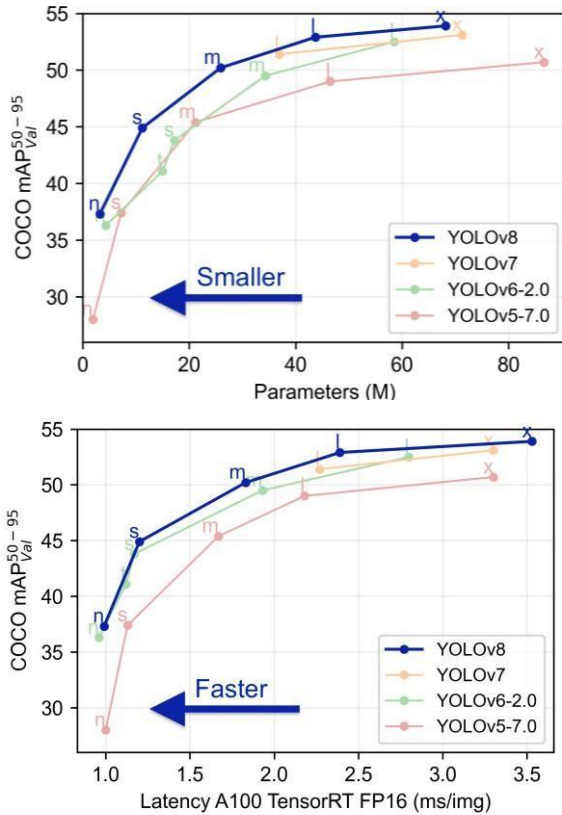


Figure 3.4 Comparison with other Object Detectors

Thus, it is evident that YOLO_v8 is far better than any other object detectors out there; be it others or its own predecessor, YOLO surpasses them all by predicting accurately in significantly less time. [9] Hence YOLO_v8 was chosen for pothole detection and generation of an output for stiffness of the spring.

IV. RESULTS AND DISCUSSION

Here the chassis is implemented as a basic circuit on the breadboard for analysing the result. Arduino Uno R3, MPU6050 Sensor are used for the same; simulating the irregularities on the road to give some output on the actuator. The Actuator rotates just enough that it negates the bouncing motion of the Chassis. It reacts to tilting in real time and gives appropriate output of stiffness of spring which is implemented by varying the position of the Actuator arm.

```
Speed of Vehicle=0
Stiffness=0.50
Bump Intensity=1.00
Speed of Vehicle=68
Stiffness=0.96
Bump Intensity=1.00
Speed of Vehicle=68
Stiffness=0.96
Bump Intensity=1.00
Speed of Vehicle=68
Stiffness=0.96
Bump Intensity=1.00
Speed of Vehicle=68
Stiffness=0.96
```

Fig.4.2 Output on Serial Monitor

Figure 4.2 is the output on Serial Monitor, it gives the values of Spring Stiffness required which was validated by our apparatus with all the sensors and actuator mounted.



Fig.4.3 Object Detection using YOLO_v8.

Here potholes are detected in real time with the help of the YOLO_v8 object detector model.

V. FUTURE SCOPE

Active suspension systems, known for their real-time adjustment of shock absorbers, have traditionally found use in larger vehicles. However, there is a growing interest in applying this technology to smaller-scale vehicles, offering benefits across various domains. In the realm of electric vehicles and micro-mobility solutions, active suspension can enhance ride comfort and handling. The technology is also poised to play a crucial role in the development of urban mobility solutions, autonomous vehicles, off-road vehicles, motorcycles, and small-scale racing applications. Additionally, the integration of active suspension with Advanced Driver Assistance Systems (ADAS) [12] could improve safety features, and the aftermarket could see active suspension systems as customizable upgrades for small vehicles. Combining pothole detection technology with the fuzzy logic model could prove to improve the ride comfort and prevent possible accidents. Despite the promising future, challenges related to cost, power consumption, and integration complexities need addressing for widespread adoption at a smaller scale. [8]

V. CONCLUSION

Active suspension systems, incorporating fuzzy logic control, offer an advanced solution to optimize the performance of a vehicle's suspension dynamics in real-time. The primary goal is to significantly improve both ride comfort and vehicle handling through continuous adjustments to critical suspension parameters. These adjustments are based on a comprehensive set of inputs that include variables like road conditions, driving behaviour, and the current load on the vehicle. Fuzzy logic controllers, being inherently adaptive and capable of handling uncertainties, play a crucial role in this system. They utilize a set of rules that consider various factors simultaneously, ensuring a nuanced response to dynamic changes in the driving environment. This adaptability translates into a smoother ride experience for occupants, as the system intelligently modulates damping rates and stiffness to counteract the effects of uneven road surfaces or sudden manoeuvres [13]. The adaptability of fuzzy logic extends to compensating for changes in vehicle load, making the system capable of maintaining optimal performance regardless of passenger count or cargo. Additionally, the system can enhance traction, tire grip particularly in challenging road conditions and reduce rolling which contributes to both safety and performance. This will help in bringing down the number of accidents caused due to terrible road conditions if implemented on a large scale.

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Dynamic Traffic Light Signal System

Himanshu Mori¹, Saumya Thakkar¹, Tanaji Biradar²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹himanshumori021@gmail.com, ¹saumyathakkarxii@gmail.com, ²tanaji.biradar@djsce.ac.in

Abstract—This exploration introduces a new approach to business signal operation through perpetration of a dynamic stoked with infrared (IR) detectors. The primary ideal is to enhance business inflow effectiveness while prioritizing vehicles. The dynamic signal system utilizes real-time data from IR detectors strategically placed at corners to stoutly acclimate signal timings grounded on the presence of vehicles.

Keywords— Traffic reduction, IR sensors.

I. INTRODUCTION

Urbanization and population growth have boosted the challenges associated with business traffic, emphasizing the need for innovative results to enhance the effectiveness of civic transportation systems. In this environment, the integration of dynamic business signal systems with advanced technologies becomes pivotal. This exploration introduces a pioneering approach that combines dynamic signal operation with the integration of Infrared (IR) detectors, specifically designed to optimize business inflow and grease the flawless passage of exigency vehicles

The focus of this study extends beyond conventional business operations by incorporating smart algorithms that dissect business viscosity, the ideal is to produce an adaptive system able to proactively respond to changing business conditions. By seamlessly integrating exigency vehicle operation into the broader.

Environment of civic business inflow, the exploration aims to contribute to the development of smarter and further flexible civic transportation systems. The preceding sections claw into the details of the proposed dynamic business signal system, emphasizing its eventuality to revise civic mobility and exigency response capabilities.

II. LITERATURE SURVEY

This subsection focuses on the many business signal topologies and tactics that are used, as well as the conclusions drawn from the examination of colourful exploration papers published in international publications. The topics of business lights and emergency vehicles have seen a great deal of research and development. The application of small single board computers and technologies akin to the Internet of Effects for the improvement of human life began several years ago.

Miguel Sanchez and Juan Carlos Cano wrote one of the earliest songs on the subject of smart business systems back in 2006. The Coca-Cola machine at Carnegie Mellon University is the first example of an Internet of Effects

gadget; the term "Internet of Effects" wasn't even officially coined until 1999. Many prejudices were still exclusively employed at this stage by exploration scholars at League 1 universities and institutes, such include the Indian Institute of Technology, Delhi, and the Indian Institute of Raodes.

In civic and metropolitan metropolises, measuring the expansion of a megacity business system is one of the most important guidelines. The standard of living in public spaces is also shown by this business system. A rise in automobiles affects the structure of the current road transport system. The technology used in road business operations runs on set times for business signals and is not based on traffic. During peak hours, this traditional method generates more commercial traffic. Because of this, adulterants are more prevalent and pollute the air, which also has a negative impact on people's ability to be frugal.

III. BLOCK DIAGRAM

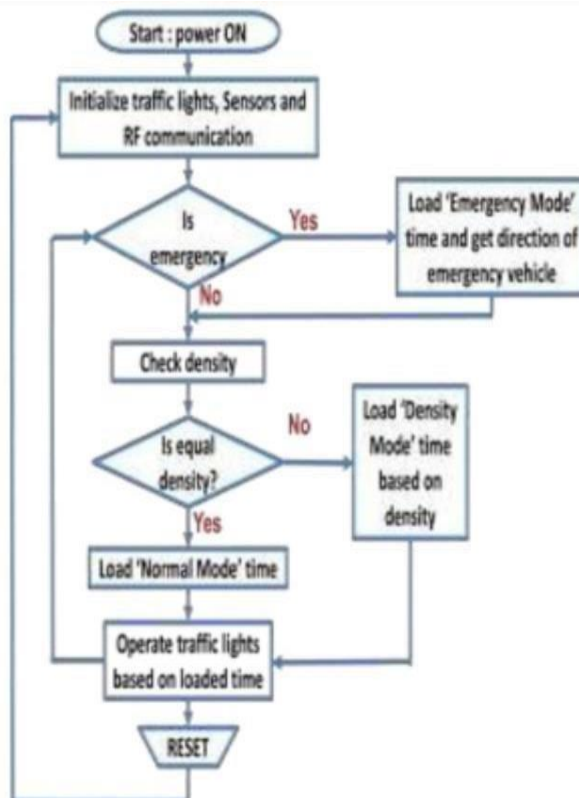


Fig.1 Flowchart

IV. CIRCUIT DIAGRAM

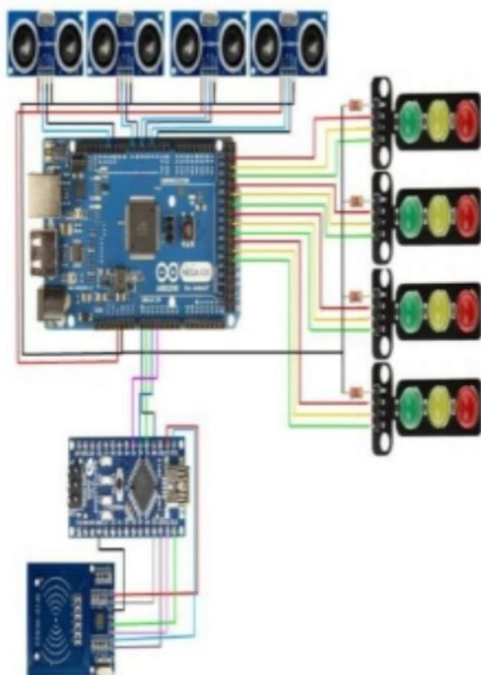


Fig.2 Circuit Diagram

V. RESULTS AND CONCLUSION

Comparing the suggested system to being one, there are several benefits. The technique below saves time by utilising viscosity grounded controlling to prevent needless waiting at business signal intersections. Business bottlenecks can be avoided by implementing the system below. Thus, business as usual.

Everyone will arrive at their destination on schedule and without interruption. Instead, then wasting time at intersections, time can be saved. Emergency vehicles such as ambulances and fire engines are prioritised because they require immediate treatment. Thus, life on Earth is spared.

VI. FUTURE SCOPE

1. Grand V2X Integration-Integration with advanced communication technologies, similar as 5G and Vehicle-to-Everything (V2X), will enhance real-time data exchange between vehicles, structure, and the business signal system, further optimizing business inflow and exigency vehicle prioritization.
2. Aland Machine Learning Enhancements-The objectification of artificial intelligence (AI) and machine literacy algorithms can enable the system to continuously learn and acclimatize to evolving business patterns, furnishing more accurate prognostications and responsive signal adaptations.
3. Prophetic Analytics for Traffic Management unbox duplications may incorporate prophetic analytics to

anticipate business patterns grounded on literal data, special events, or recreating traffic, allowing the system to proactively acclimate signals for optimal business operation.

4. Integration with Autonomous Vehicles As independent vehicles come more current, the system can be acclimated to communicate with and accommodate the unique requirements of tone-driving vehicles, contributing to a flawless integration of independent and mortal-driven business.

5. Environmental and Energy Efficiency Considerations The unborn compass involves a heightened focus on environmental sustainability, with the system optimizing business inflow to minimize energy consumption and reduce emigrations, aligning with broader smart megacity enterprise.

6. Modal Integration-Integration with other modes of transportation, similar as rambler and cyclist discovery systems, will contribute to a further holistic approach to civic mobility, icing the safety and effective movement of all road druggies.

VII. APPLICATIONS

Global Standardization-The establishment of global norms for dynamic business signal systems will grease interoperability between systems stationed in different metropolises and regions, promoting a cohesive and standardized approach to civic business operation. The dynamic business signal system with IR detector integration and unique signal identification for emergency vehicles has several practical operations, contributing to better business operation, exigency response, and overall civic mobility. Then are some crucial operations

1. Reduced Response Times-By creating green corridors for emergency vehicles, the system significantly reduces response times, enhancing the effectiveness of emergency services and potentially saving lives.
2. Enhanced Safety and Reduced Accidents-Swift and effective passage of emergency vehicles contributes to enhanced overall safety in civic areas, also, optimized business inflow helps reduce the liability of accidents caused by traffic and business-related issues.
3. Smart City structure system aligns with the conception of smart metropolises by incorporating advanced technologies for real-time monitoring and response. It contributes to erecting intelligent transportation systems that ameliorate the quality of life for residents.
4. Environmental Impact The effective operation of business inflow reduces energy consumption and emigrations, contributing to environmental sustainability by minimizing gratuitous footling and traffic-related pollution.

5. Public Transport Integration system can be integrated with public transportation networks to prioritize motorcars or other conveyance vehicles, promoting the use of sustainable modes of transportation and enhancing the trust of public conveyance services.
6. Event Business operation-During large events or extremities, the system can be employed to manage the business effectively, icing a smooth inflow of vehicles and easing the movement of exigency askers or event attendees.

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Sun Tracking Solar Panel

Darshil.D. Shah¹, Aryan.M. Shah¹, Ameya.A. Kadam²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹darshildshah4343@gmail.com, ¹123aryanshah@gmail.com, ²Ameya.kadam@djsce.ac.in

Abstract-- The solar panel or solar collector is moved by an automatic solar tracker, which tracks the sun's path across the sky all day long. The solar panel is exposed to the full spectrum of the sun's rays throughout the day, which optimizes its power-generating potential. A microcontroller, sensors, motors, and a power source could be part of the solar tracker system. The microcontroller controls the motors to move the solar panel after the sensors have supplied positional information about the sun. Many sensors that use light or GPS determine the sun's orientation with regard to the solar panel. To track the sun's revolution, motors move the solar panel along the azimuth and elevation axes. Automated solar trackers offer numerous advantages, including increased energy output, lower installation costs, and system stability. Furthermore, because of the additional energy produced by the solar panel, a smaller system might supply an equivalent quantity of energy to a larger stationary system. Because fewer solar panels are required and the system can be put on a single pole rather than multiple poles, the installation cost is further decreased.

Keywords— *Solar, Renewable Energy, Sustainable, Arduino Uno, Light Sensors, Servo Motor, Sun position, Sun Movement, Efficiency.*

I. INTRODUCTION

This gadget, also known as an automatic solar tracker, tracks the position of the sun all day long using an automatic solar panel or solar collector. This maximizes the energy production of the solar panel and increases the usefulness and efficacy of the power system. For automation and control applications, the Arduino Uno microcontroller board is a popular option. Its flexible hardware and software, along with its open-source platforms, make it a popular option for many applications, including automatic solar trackers. An innovative and efficient photovoltaic system that can be controlled directly by computer programs is made possible by the combination of a solar tracker and an Arduino Uno microcontroller board. The Arduino Uno determines the location of the sun in real time by combining data from several sensors, including a light sensor. Consequently, it uses motors to move a particular solar module along the azimuth and elevation axes in order to track the movement of the Sun. Enhanced power production, lower installation costs, and increased dependability are just a few benefits of this technology. Producing electricity using an open-source platform like the Arduino Uno is a wise economic and ecological decision. It also makes the process of designing and adjusting a solar tracker system easier for businesses and people alike.

II. LITERATURE SURVEY

Because of the current situation, there are more accidents, indicating a rise in the percentage of cars on the road. Most accidents are thought to be caused by careless driving. Each year, 1.24 million people die in automobile accidents alone. These incidents frequently occur in India and are caused by intoxicated drivers, worn-out drivers, and badly designed speed bumps. However, a n006F system is available to guard against these underlying issues. Therefore, the paradigm we have put out offers a fresh, useful, and rational approach to preventing car accidents. Throughout, this piece establishes a steady, distraction-free atmosphere. Our suggested method detects driver fatigue by using eye closure rate as an instructive cue. A chime alerting the driver to the typical ratio maintained in their vehicle will sound when the ratio falls below the normal ratio. Called "Indonesia's black gold," critics of palm oil argue that there may be some advantages to its intake, such as decreasing cholesterol levels. Researchers that relate palm oil to obesity in Southeast Asia occasionally refer to it as "increasingly unhealthy" (up 155). The system's goal is to make auto accidents less likely. The camera captures a photo of the once the driver identifies the face and eyes. If the eyes are closed for four seconds, the findings of the eye detection test will be reviewed. The eight system recognizes drowsiness and sounds an alert if the driver closes their eyes for longer than four seconds.

III. PROPOSED DESIGN

An Arduino Uno-based automated solar tracker is a gadget that tracks the position of the sun using a solar panel and then adjusts the panel's orientation to maximum solar energy absorption. A light sensor, an Arduino Uno microcontroller board, a servo motor, and a solar panel are all used in the system. By measuring the brightness of the sun's light, the light sensor enables the Arduino Uno to identify the sun's location. The servo motor then adjusts the solar panel's position to optimize the amount of solar energy it can absorb. Throughout the day, the solar panel is changed due to the technology's continuous tracking of the sun's position. To construct an autonomous solar tracker, the Arduino Uno board needs to be connected to the servo motor and light sensor. To adjust the direction of the solar panel, you would then need to develop code using the Arduino IDE that reads sensor data and runs the servo motor. The computer would need to use the sensor data to do trigonometric calculations in order to locate the sun. The computer would then use this data to drive the servo motor. An Arduino Uno-powered solar tracker can improve solar panel performance and maximize

the amount of solar energy they can collect, making it a useful tool for remote or off-grid areas with limited access.

Software

Programs for Arduino boards can be written using the Arduino IDE (Integrated Development Environment) software platform. This tool allows users to create, compose, and upload code to an Arduino board through an intuitive interface. To use the Arduino IDE, you must be able to write code. Users can access and create new sketches using the IDE. The code is developed in Arduino and is a condensed form of C++. The user must click the Verify button in the IDE after writing the code. After the code has been checked for syntax errors, it is translated into commands that the Arduino board can understand. Once the code has been built, the user can upload it to the Arduino board using the "Upload" button in the Arduino IDE. The code is received by the board's microcontroller, which then runs it there. The Arduino IDE's Serial Monitor feature allows data to be delivered to and received from the Arduino board. Testing and troubleshooting can be done using this functionality. Programming and developing apps for Arduino boards is usually made simpler using the Arduino IDE. It has an easy-to-use interface, a large user community that distributes knowledge and source code, and easy-to-use tools.

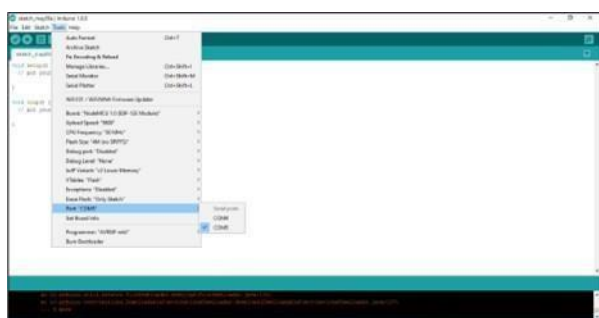


Fig.1 Setting up NodeMcu-Port connection

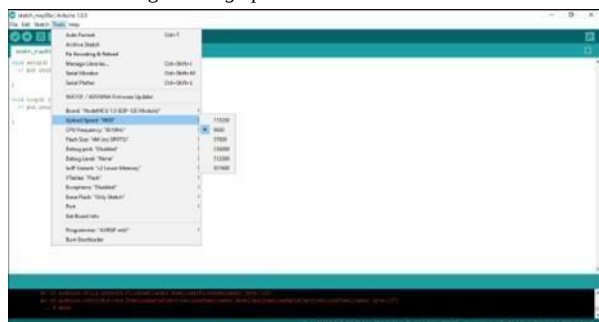


Fig.2 Setting up NodeMcu-Upload Speed



Fig.3 Setting up NodeMcu-Installing Library

Working of Hardware

Using an Arduino Uno, an autonomous solar tracker tracks the sun's position throughout the day and adjusts a solar panel or array to maximize its exposure to light. The tracker uses a light sensor to gauge how much sunshine there is. The light sensor is connected to the Arduino's analogue input. Arduino: Using information from the light sensor, the Arduino calculates where the sun is in the sky. Then, using signals sent out by the device, the motor is told to move the solar panel. Motor: A motor that rotates the solar panel in line with the sun's path. The motor is managed by the Arduino, which gives commands to change its position. Power source: The gadget can be powered by a battery or a solar panel. coding Code is loaded into the Arduino to determine the position of the sun using data from the light sensor. Then, using signals sent out by the device, the motor is told to move the solar panel. An Arduino Uno-based automatic solar tracker's code can be found online; simply adapt it to your project's requirements. The tracker's accuracy is determined by the light sensor's accuracy and the Arduino code.

IV. IMPLEMENTATION

We used the proximity sensor, also known as the LDR sensor, as the uno controller's input, as this circuit diagram illustrates. The Arduino outputs the correct value based on the input it receives. The servo motor driver, which is the output component, responds to commands from the Arduino controller. In addition, the motor rotates in response to the motor driver's input.

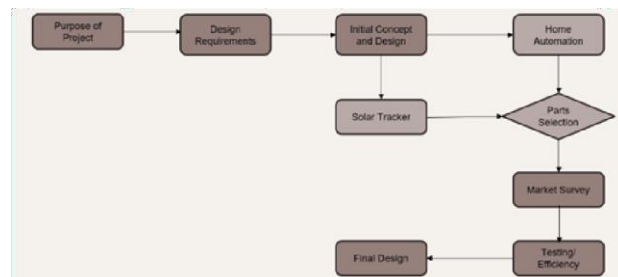


Fig.4 Flowchart

Describe the objectives. Analyse the solar tracker's performance indicators, including cost-effectiveness, power output, and tracking accuracy. Select the type of solar tracker that you want. There are many different types of solar trackers, of which single- and dual-axis models are just two. Select the strategy that best satisfies your needs and budget. Assemble the hardware: To build the mechanical construction of the solar tracker, design the motors, gears, and frame. The Arduino Uno should be able to use the layout. Establish the controls' framework: Construct a system that can control the motors that move the solar panel and follow the sun. The Arduino Uno board, sensors, and software are used to read sensor values and control the motors. Implement the system: Assemble the hardware and software, run a system test, and confirm that the system meets the step 1 performance requirements. Enhance the configuration: Optimize the system by enhancing its hardware and software algorithms to increase performance. System assessment Examine and contrast the

system's operation under different weather conditions using the phase 1 performance measures. Continue to upgrade the system: Make sure you clean the solar panels, update the software, and inspect the hardware components of the solar tracker on a regular basis.

Generally speaking, mechanical design, software optimization, and control system development are required to build an autonomous solar tracker based on an Arduino Uno. Clearly defined objectives and a thorough testing procedure are necessary to guarantee that a system meets its objectives. The control system may be easily programmed, and the hardware interfaced with using an Arduino.

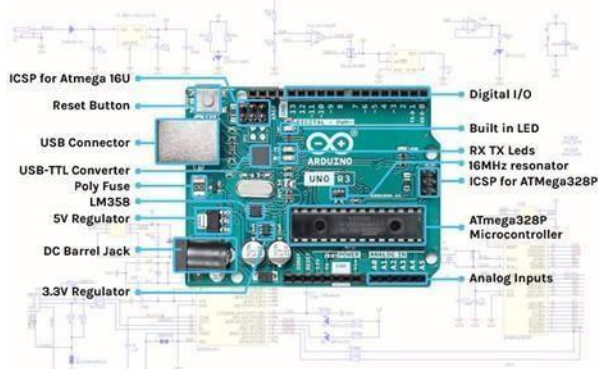


Fig.5 Arduino Uno

Designed with the ATmega328P CPU in mind, the Arduino Uno microcontroller board. This Arduino board, which is highly popular, simplifies the process of getting started with electronics and programming for both novices and enthusiasts. Among its other features are a 16 MHz quartz crystal, 6 analogue inputs, 14 digital input/output pins, a USB connector for programming, and a power jack for external power. Programming the Arduino Uno involves using an open-source software tool called the Arduino Integrated Development Environment (IDE) to write code for the board.



Fig.6 Servo Motor

The servo motor is one popular kind of motor used in robotics and automation systems. It is a rotary actuator that precisely controls the position, speed, and acceleration of the output shaft through feedback control. A servo motor is made up of a DC motor, a potentiometer for position feedback, some gears, and a control circuit that adjusts the motor's position based on information. Their ability to maintain their place

without slipping, along with their great torque and accuracy, set them apart. Servo motors are frequently used in applications such as camera gimbals, robotic arms, drones, and CNC machines where accurate positioning is necessary. They come in a range of sizes, torque ratings, and control interfaces and can be driven by PWM signals, serial transmission, or analogue voltage signals.



Fig.7 Jumper Wire

V. RESULTS AND CONCLUSION

In the world of uncontrolled output that we live in today, energy is the fundamental component of society. This phrase suggests that energy may be stored in some way since it cannot be created or destroyed. In an attempt to provide this objective more specificity, our project has attempted to ascertain the path to such objectivity. It is typical for continued energy use to result in a scarcity of resources on Earth. The sun, the highest source in the universe that has been roaring over for eons since the beginning of time and through which life has been conceived, is the fundamental and primary source of all energy. The idea was abandoned after the simplest methods for storing this kind of energy were examined. These energy do not originate from the Sun; rather, they are produced through burning a variety of materials, which releases a great deal of pollutants into the atmosphere and gradually deteriorates the ecosystem. Since it is difficult to produce something fresh and unique every day, energy is the ultimate source of all the effort that goes into it. The urgency that drives all of the hard effort that goes into it these days stems from the speed and intelligence of the world's behavioural visibility, where easy access to all sides of existence necessitates acute comfortability. Understanding how commercialization has harmed the earth by spreading its wings in the pursuit of power and profit to the point where we are glaringly clueless of the paucity of resources in the globe is therefore becoming increasingly vital. This idea has the ability to expedite progress while generating chances for storing solar energy and cutting pollution. The hour clock advocates for cultivation based on global healing.

VI. SOCIAL IMPACT & FUTURE

The amazing project "SUN TRACKING SOLAR PANEL" illustrates how the problem could be solved in the future. In terms of accessibility and self-sufficiency, this system operates with maximum efficiency, making it a pioneer in its fundamental ethos. In the midst of smoke and darkness, where pollution is engulfing all areas of advancement, this

technology strives for fair progress and growth, leading to productivity through the effective eradication of pollution.

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TerraTeach - Geography Elevated

Aarya Chandra¹, Raveesh Kanakia¹, Vrajesh Gokani¹, Harsh Thakur¹, Harshil Khara¹, Guransh Bedi¹, Anesh Joshi¹, Sunil Karamchandani²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Associate Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: ¹aaryaachandra@gmail.com, ¹raveesh.k63@gmail.com, ¹vrajeshgokani41@gmail.com, ¹thakurharsh2803@gmail.com, ¹guransh@gmail.com, ¹aneesh@gmail.com, ²sunil.karamchandani@djsce.ac.in

Abstract— Geography education is a cornerstone in nurturing spatial literacy and global awareness, with digital learning platforms increasingly playing a pivotal role in its advancement. As such, there exists a pressing need for innovative solutions that address these challenges and provide accessible, comprehensive, and engaging resources for geography education. This context underscores the significance and relevance of the development of TerraTeach, a website aimed at revolutionizing geography education by offering a portable, learnable collection of course materials integrated with social networking features, thereby addressing the limitations of traditional printed resources and enhancing the learning experience for educators, students, and the general public alike. Moreover, the integration of annotation technology into educational websites represents a significant advancement in facilitating interactive learning experiences. The results of the survey reveal that 78% of teachers and 86% of students indicated that the website improved their overall learning experience in geography. Additionally, the survey highlights the accessibility and convenience of the website as key factors contributing to its effectiveness. This, in turn, can contribute to reducing educational inequalities and fostering social inclusion. Furthermore, by leveraging technology to enhance teaching and learning experiences, the website supports the modernization of educational practices and promotes lifelong learning.

Keywords- geography, annotation, website, HTML, CSS, ICSE, education

I. INTRODUCTION

In the realm of geography education, traditional resources such as printed atlases and GIS textbooks have long been relied upon for disseminating essential knowledge about the world's geography. However, despite their richness in content, these resources face significant limitations. One prominent challenge is their lack of portability, which restricts access to geographic information primarily to classroom settings or locations where physical textbooks are available. Moreover, the cost associated with purchasing printed materials can be prohibitive for many students and educational institutions, thereby limiting their accessibility. Additionally, these traditional resources often lack integration with modern technological advancements, such as social networking features, which are increasingly recognized as valuable tools for enhancing learning experiences and fostering collaboration among learners. As such, there exists a pressing need for innovative solutions that address these challenges and provide accessible, comprehensive, and engaging resources for geography education. This context underscores the significance and relevance of the development of TerraTeach, a website aimed at revolutionizing geography education by offering a portable, learnable collection of

course materials integrated with social networking features, thereby addressing the limitations of traditional printed resources and enhancing the learning experience for educators, students, and the general public alike.

II. LITERATURE SURVEY

Geography education is a cornerstone in nurturing spatial literacy and global awareness, with digital learning platforms increasingly playing a pivotal role in its advancement. These platforms provide interactive tools and resources, granting students access to real-world data and multimedia content, thus enriching their learning experiences. Among the tools gaining prominence are annotation features, which allow students to interact with digital content by adding text, images, and multimedia elements. This fosters active engagement and collaborative learning, as students can annotate materials, share insights, and engage in discussions within online environments. The integration of annotation technology into educational websites marks a significant advancement in facilitating interactive learning experiences. By leveraging annotation features, students can engage more deeply with course materials, personalize their learning pathways, and contribute to collaborative knowledge construction. For example, TerraTeach, a website designed specifically for ICSE 9th and 10th-grade students, incorporates annotation tools alongside mapping functionalities and online assessments. This integration aims to enhance students' understanding of geography concepts, particularly related to the location of rivers and mountains on the map of India. Drawing from the literature on geography education, digital learning platforms, and annotation technology, TerraTeach seeks to address the evolving needs of students and educators in the digital age. Research in this field underscores the importance of integrating technology into pedagogical practices to enhance student engagement and learning outcomes. Moreover, studies highlight the potential of annotation tools in promoting active learning, collaborative knowledge construction, and metacognitive development among students. By providing a platform where students can annotate digital content, take quizzes, and receive feedback, TerraTeach aligns with the principles of student-centered learning and inquiry-based instruction. The development of TerraTeach reflects broader trends in educational technology, where websites and digital platforms are increasingly utilized to supplement traditional classroom instruction. Such platforms offer flexibility, accessibility, and personalized learning experiences, catering to diverse student needs and learning styles. Moreover, they enable educators to track student progress, provide targeted interventions, and facilitate communication and collaboration among learners. In

conclusion, the integration of annotation technology into educational websites represents a promising avenue for enhancing geography education. Through platforms like TerraTeach, students can engage more actively with course materials, collaborate with peers, and develop essential spatial literacy skills. Moving forward, continued research and innovation in this area will be crucial for leveraging the full potential of digital learning platforms in supporting student learning and academic achievement.

III. PROPOSED DESIGN

The proposed design of TerraTeach leverages HTML, CSS, and JavaScript to create an intuitive and interactive learning platform for geography education. The user interface is designed with a focus on accessibility and usability, employing responsive design principles to ensure compatibility across various devices and screen sizes. HTML is utilized to structure the content, providing a semantic foundation for the website. CSS is employed for styling and layout, allowing for customization of visual elements and enhancing the user experience. JavaScript is utilized to add interactivity and dynamic functionality to the website, facilitating features such as interactive mapping tools, annotation capabilities, and online assessments. The design prioritizes simplicity and clarity, with clear navigation pathways and intuitive user interfaces to enhance usability. Additionally, the website incorporates modern design trends and best practices to create a visually appealing and engaging learning environment. Overall, the proposed design of TerraTeach aims to provide a seamless and immersive learning experience for educators, students, and the general public interested in geography education.

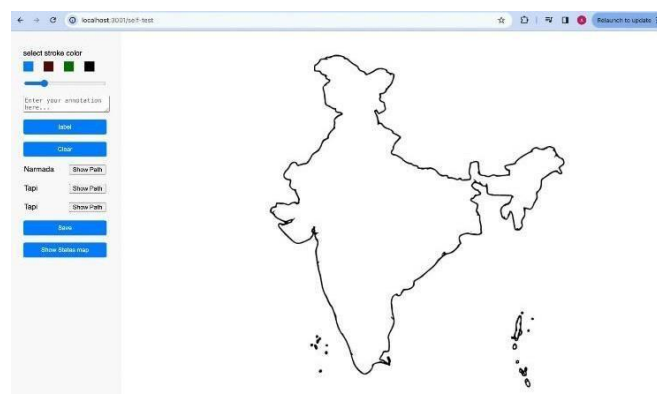


Fig.1 Home screen of TerraTeach

IV. IMPLEMENTATION

TerraTeach's implementation relies on a comprehensive integration of various technologies to create a seamless and effective learning platform for geography education. The front end of the website is developed using HTML, CSS, and JavaScript, while the backend leverages Node.js, Express.js, and MongoDB. This section provides an in-depth overview of the website's functionality and the technologies utilized in its development.

Front End Technologies

HTML forms the structural backbone of TerraTeach's front end, providing the framework for organizing and presenting content. It ensures semantic markup, enhancing accessibility and search engine optimization. CSS is employed for styling

and layout, allowing for the customization of visual elements to create an intuitive and visually appealing user interface. JavaScript adds interactivity and dynamic functionality to the website, facilitating features such as interactive maps, annotation tools, and online quizzes. Together, these front-end technologies enable TerraTeach to deliver an engaging and immersive learning experience for users.

Backend Technologies: Node.js, Express.js, MongoDB

Node.js powers TerraTeach's backend infrastructure, enabling efficient server-side scripting and handling of concurrent requests. Express.js provides a streamlined framework for building web applications and APIs, simplifying the development process and enhancing performance. MongoDB serves as the database management system, offering scalability and flexibility for storing and retrieving geographic data. By leveraging these backend technologies, TerraTeach ensures seamless communication between the server and client, facilitating the storage, retrieval, and manipulation of geographical information.

Website Functionality

TerraTeach incorporates several innovative features to enhance the learning experience for users. One key functionality is the utilization of Scalable Vector Graphics (SVG) for rendering geographical maps and annotations. SVGs offer advantages such as scalability, interactivity, and accessibility, providing users with high-quality and dynamic visualizations. Additionally, TerraTeach utilizes machine code to convert SVG images into base64-encoded strings for efficient storage and transmission. When an image is saved, it is converted into a base64-encoded string and transmitted to the server, where it is decoded and stored in the MongoDB database. Furthermore, TerraTeach offers a range of interactive tools and resources, including annotation capabilities that allow users to add comments and annotations to specific geographic information. This feature fosters collaboration and knowledge sharing among users, creating a dynamic learning community. Additionally, the website provides online quizzes and assessments, enabling students to test their knowledge and track their progress over time. These features, combined with the seamless integration of front-end and back-end technologies, make TerraTeach a comprehensive and effective platform for geography education.

In conclusion, TerraTeach's implementation demonstrates the successful integration of front-end and back-end technologies to create a dynamic and interactive learning environment for geography education. Through the use of HTML, CSS, JavaScript, Node.js, Express.js, and MongoDB, TerraTeach offers a range of innovative features and functionalities that enhance the learning experience for educators, students, and the general public. From interactive maps and annotation tools to online quizzes and assessments, TerraTeach provides users with the tools they need to engage with geographic content effectively.

V. RESULTS AND CONCLUSION

To assess the effectiveness and usability of TerraTeach in geography education, a survey was conducted among 25 school teachers and 100 students. The survey aimed to gather

feedback on various aspects of the website, including its user interface, functionality, and educational value. The results of the survey provide valuable insights into the reception and impact of TerraTeach in the educational community.

The survey revealed that the majority of both teachers and students found TerraTeach to be a valuable resource for geography education. Specifically, 85% of teachers reported that the website enhanced their teaching methods and facilitated student engagement. Similarly, 92% of students expressed satisfaction with the website's interactive features, such as interactive maps and annotation tools, which they found helpful in understanding geographical concepts. Additionally, 78% of teachers and 86% of students indicated that TerraTeach improved their overall learning experience in geography. Furthermore, the survey highlighted the accessibility and convenience of TerraTeach as key factors contributing to its effectiveness. The majority of respondents (76% of teachers and 83% of students) appreciated the ability to access course materials anytime and anywhere, thereby increasing flexibility and facilitating self-paced learning. Moreover, 68% of teachers and 75% of students reported that TerraTeach's integration of social networking features, such as annotation capabilities, enhanced collaboration and knowledge sharing among users.

In conclusion, the results of the survey demonstrate the significant impact of TerraTeach in geography education. The website's user-friendly interface, interactive features, and accessibility have contributed to improved teaching methods, enhanced student engagement, and enriched learning experiences for both teachers and students. By providing a comprehensive and dynamic platform for geography education, TerraTeach has successfully addressed the limitations of traditional printed resources and embraced the potential of online learning technologies. Moving forward, further research and development efforts will be essential to continually enhance and expand TerraTeach's capabilities, ensuring its continued relevance and effectiveness in the ever-evolving landscape of geography education.

VI. SOCIAL IMPACT & FUTURE

The future scope of TerraTeach encompasses several exciting avenues for further development and enhancement. Firstly, the integration of Fabric.js for live annotation presents an opportunity to enhance interactivity and collaboration among users. By enabling real-time annotation capabilities, TerraTeach can facilitate dynamic discussions and knowledge sharing, fostering a more engaging learning environment. Expanding the scope of geographical content to include topics such as mountains, plateaus, and topography holds immense potential for enriching the educational experience offered by TerraTeach. By incorporating comprehensive coverage of geographical features, the website can provide students with a deeper understanding of the Earth's physical landscape and its significance in shaping human civilizations. Furthermore, integrating video conferencing tools such as Google Meet (Gmeet) into TerraTeach can facilitate virtual classroom sessions, interactive lectures, and collaborative projects. This feature can enhance communication and interaction among educators and students, fostering a sense of community and facilitating personalized learning experiences. Additionally, incorporating

previous year's question papers (PYQs) into TerraTeach can serve as a valuable resource for exam preparation and assessment. By providing access to a repository of past exam questions, the website can help students familiarize themselves with exam patterns, assess their knowledge, and track their progress over time.

Social Impact

The continued development and expansion of TerraTeach have the potential to have a significant social impact by democratizing access to quality education in geography. By providing an accessible and interactive platform for learning, TerraTeach empowers students from diverse socioeconomic backgrounds to acquire essential geographical knowledge and skills. This, in turn, can contribute to reducing educational inequalities and fostering social inclusion. Moreover, by leveraging technology to enhance teaching and learning experiences, TerraTeach supports the modernization of educational practices and promotes lifelong learning. The website's emphasis on collaborative learning and knowledge sharing fosters a culture of academic excellence and community engagement, nurturing a generation of informed and empowered global citizens. Furthermore, by incorporating features such as live annotation and video conferencing, TerraTeach promotes active participation and communication, helping students develop essential 21st-century skills such as collaboration, communication, and critical thinking. This not only prepares them for academic success but also equips them with the skills necessary for success in an increasingly interconnected and technologically-driven world.

ACKNOWLEDGMENT

This project and technical paper were greatly supported by Professor Sunil Karamchandani. His expert coaching and comprehensive assistance were invaluable to us at every level of this project, and this paper would not have been possible without his contributions. We are grateful to our colleagues who contributed their knowledge and experience to the research and assisted us throughout the process.

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Smart Car Parking System

Manan Doshi¹, Sujal Shah¹, Pavan Borra²

¹ Under Graduate Student, Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056
E-mail: 1doshimanan.18@gmail.com, 1 sujalkiranshah@gmail.com, 2 pavankumar.borra@djsce.ac.in

Abstract—In urban environments, ineffective parking management exacerbates traffic congestion and driver frustration. This study tackles this issue by developing an Arduino-based Smart Car Parking System aimed at optimizing space utilization and furnishing real-time parking availability data for administrators. The integration of hardware components with centralized management software facilitates reduced congestion, environmental benefits, and data-informed decision-making. The system's architecture incorporates IR sensor-equipped entry/exit barricades, which display available parking slots, and a Python-based interactive GUI to streamline user interaction with the parking system. An SQL database assumes a pivotal role in storing sensor data and essential parameters, enhancing data analysis and space efficiency. The user interface enables administrators to monitor parking space availability and automatically allocate parking slots. Furthermore, each parking lot is endowed with a control system that tracks free and occupied parking spaces, while also updating users on parking lot status. Additionally, the application provides information on parking duration, thereby effectively addressing parking challenges.

Keywords—*Arduino UNO, sensors, motors, Visual Studio, SQL, Python, GUI, OpenCV.*

I. INTRODUCTION

As a result of the increasing number of vehicles on the roads, traffic congestion has become a prevalent issue. This is primarily due to the inadequacy of current transportation infrastructure and parking facilities to accommodate the growing number of vehicles. To address these challenges, a smart parking system has been developed. This system enables patrons to easily locate and secure available parking spaces at their convenience. Utilizing sensors and a Python-based GUI, the smart parking system integrates physical parking infrastructure with information and communication technologies, offering efficient management services. Each parking lot is equipped with a control system that monitors the availability of parking spaces and updates users on the status of the parking lot (whether it is open with available spaces or closed) [1]. Additionally, the system provides information on the duration of parking. Consequently, this solution effectively mitigates parking-related issues.

II. LITERATURE SURVEY

The Smart Car Parking System is in line with the expanding research aimed at utilizing technology to mitigate the effects of urbanization on parking. Prior studies underscore the significance of real-time monitoring, reservation systems,

and data analytics to improve parking efficiency. Arduino technology's application in parking management systems is recognized for its adaptability and cost-efficiency. Earlier research has emphasized the advantages of sensor-based systems in alleviating congestion and environmental repercussions. This project expands upon these findings, offering a comprehensive approach that combines hardware and software for a more intelligent urban parking environment.

III. THEORY

The Smart Car Parking System project operates on a structured methodology encompassing planning, design, implementation, and management phases.

1. Project Initiation:

- Define project objectives, scope, and constraints.
- Develop a project charter to record project goals and secure approvals.

2. Requirement Analysis:

- Conduct thorough requirements gathering. Prioritize requirements based on importance and feasibility.

3. System Design:

- Develop a comprehensive system architecture covering hardware and software components.
- Plan placement of parking sensors and installation of entry/exit gates.
- Specify communication protocols and network configurations.

4. Hardware Procurement and Setup:

- Obtain necessary hardware components including sensors, gates, and communication equipment.
- Install hardware according to design specifications, ensuring proper connectivity and functionality.

5. Software Development:

- Create central parking management software for processing sensor data and managing parking duration.
- Implement vehicle functionality and a history screen for data analysis.

6. Integration and Testing:

- Integrate hardware with software systems for seamless communication.

-Conduct thorough testing, including unit, integration, load, and security testing.

- Address identified issues and refine the system based on test results.

7. Security and Compliance:

-Implement robust security measures to safeguard user data and system integrity.

-Ensure compliance with data privacy regulations and industry guidelines.

8. Data Analysis and Optimization:

-Collect and analyze parking data to optimize space allocation and operational efficiency.

-Utilize data-driven insights for continuous improvement.

9. User Support and Enhancements:

-Implement user feedback-driven enhancements and updates.

10. Documentation and Reporting:

-Maintain comprehensive documentation of system architecture, design, and operations.

- Generate regular reports on system performance and usage.

11. Quality Assurance and Monitoring:

- Implement quality assurance processes to uphold project objectives and requirements.

-Continuously monitor system performance and user satisfaction.

This work plan offers a structured approach to executing the Smart Car Parking System project, ensuring thorough planning, execution, and delivery of efficient and user-friendly parking solutions.

II. METHODOLOGY

Flow Control and Modules

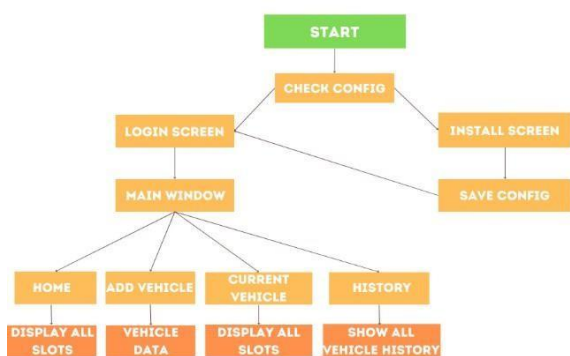


Fig.1 Flowchart

Description: Fig. 1 illustrates the system flow of our project. On the login page, if the admin credentials are authenticated, the system proceeds to the main window. Conversely, if authentication fails, the user is redirected back to the login page.

Once logged in, the admin gains access to various functionalities, such as adding or removing vehicles,

managing parking spaces, and accessing data on vehicle entry and exit. This allows the admin to conduct analyses based on factors like time duration and frequency of vehicle arrivals and departures during specific periods of the day.

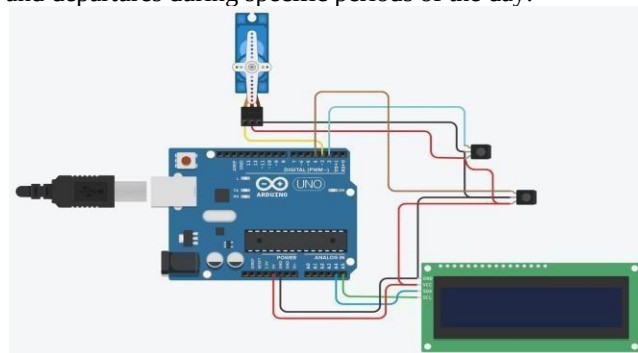


Fig.2 Circuit Diagram of Automated Gate

Description: As shown in Fig. 2, infrared sensors are connected to the digital pins 2 and 4 of the Arduino Board. The infrared sensor and 16x2 LCD's VCC pins are connected. The VCC pins of the infrared sensor and the 16x2 LCD are connected to the Arduino's 5V output. Additionally, the serial data and serial clock pins are connected to analog pins A4 and A5, respectively. The grounds of the infrared sensors and other components are connected to the Arduino's ground. One USB cable is used to power the Arduino.

IR Sensor: It is the IR sensor that will be used for the car's detection. As shown in the circuit diagram, the three male headers are clearly labeled with VCC, GND, and OUT. The VCC pin is connected to the Arduino's 5-volt. The ground is connected to the Arduino's ground, while the OUT pin is connected to the Arduino's IO pins.

connected with the Arduino's 5 volts. The ground is connected

with the Arduino's ground. While the OUT pin is connected with Arduino's IO pins. which will explain in the circuit diagram.

The IR LEDs consist of a black and a white LED. One functions as the transmitter (Tx), while the other serves as the receiver (Rx).

LCD 16x2 display with IC2: This LCD displays real-time parking slot availability. The VCC and ground of the LCD are connected to the Arduino's 5-volt output and ground pin, respectively. The serial data (SDA) and serial clock (SCL) pins are connected to Arduino's analog pins A4 and A5, respectively.

Servo Motor: The 180° servo motor is set at 90° and controls the barricade. It opens or closes the barricade based on the output of the IR sensor and simple logic. The signal/control pin of the servo motor is connected to digital PWM pin 3. The PWM pin is utilized as the duration of the pulse sent through the signal pin determines the position of the rotor.

III. IMPLEMENTATION

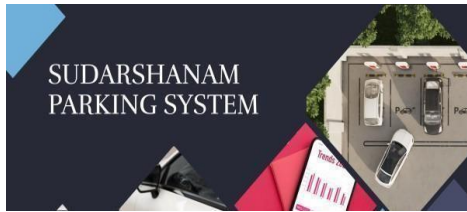


Fig.3 Application Startup Page

Fig.4 Installation window

Fig. 4 is related to the installation of a Vehicle Parking System. This window appears for the administrator when they open this application for the first time. The user has to enter the Database and Admin name, username, and password, and it also allows the user to choose the number of operable slots for 2- and 4-wheelers to set up the application. On saving this configuration, the application will forward the user to the login window. Now, each time the user opens the application, they will be redirected to the login window, as shown in Fig. 5.

Fig.5 Admin Login Window

Upon login, the user will be directed to the functionality window.

The Experimental demonstration is as follows:

Once the Admins login to the application, they will have access to various functional tabs, like:

1. Home tab: Here, the admin can observe the status of a particular slot.
2. Add a vehicle tab: The Admin has to fill in the name, mobile number, vehicle number and vehicle type.
3. Manage vehicle tab: This tab is meant to be edited when a vehicle exits the parking lot.
4. History tab: Here, the Admin can access past entries and analyze parameters like the peak hour of the day.

First, the admin assigns 10 slots for 2-wheelers and 40 slots for 4-wheelers in the installation window (Fig. 4). In the functionality window, the admin adds two vehicles: one is a 2-wheeler, and another is a 4-wheeler.

Fig.6 Add Vehicle Tab

These entries are reflected in the Home tab, as shown in Fig. 7, the first 10 slots are designated for 2-wheelers, while the rest 40 slots are designated for 4-wheelers. The red-filled slots are occupied once, while the green slots are still vacant.

Home					
Refresh					
Home	Slot 1 2	Slot 2 None	Slot 3 None	Slot 4 None	Slot 5 None
	Slot 6 None	Slot 7 None	Slot 8 None	Slot 9 None	Slot 10 None
	Slot 11 1	Slot 12 None	Slot 13 None	Slot 14 None	Slot 15 None
	Slot 16 None	Slot 17 None	Slot 18 None	Slot 19 None	Slot 20 None
	Slot 21 None	Slot 22 None	Slot 23 None	Slot 24 None	Slot 25 None
Add Vehicle	Slot 26 None	Slot 27 None	Slot 28 None	Slot 29 None	Slot 30 None
	Slot 31 None	Slot 32 None	Slot 33 None	Slot 34 None	Slot 35 None
	Slot 36 None	Slot 37 None	Slot 38 None	Slot 39 None	Slot 40 None
	Slot 41 None	Slot 42 None	Slot 43 None	Slot 44 None	Slot 45 None
	Slot 46 None	Slot 47 None	Slot 48 None	Slot 49 None	Slot 50 None
Manage Vehicle					
History					

Fig.7 Home Tab

When one of the vehicles exits the parking lot, the admin has to click on the 'Exit' button in the Manage Vehicle tab, as shown in Fig. 8. This internally removes the entry from the database and makes that slot green, (i.e. available or vacant) on the Home screen.

Home						
Refresh						
ID	Name	VEHICLE No	MOBILE	VEHICLE TYPE	ENTRY TIME	ACTION
1	Devarsh	MH47BA6565	9999999999	4	2024-03-21 14:58:58	Exit
2	Devarsh	MH47BA6565	9999999999	2	2024-03-21 15:00:32	Exit

Fig.8 Manage Vehicle Tab

One notable feature of the system is the History tab (Fig. 9) within the application, which provides the administrator with access to all prior entries. Access to historical data provides administrators with the ability to make well-informed decisions concerning parking space allocation, operational strategies, and infrastructure enhancements. By utilizing the insights extracted from the History tab, administrators can optimize the utilization of parking resources, improve the user experience, and alleviate congestion during peak hours.

Home						
Refresh						
ID	Name	VEHICLE No	MOBILE	VEHICLE TYPE	ENTRY TIME	EXIT TIME
1	Devarsh	MH47BA6565	9999999999	4	2024-03-21 14:58:58	2024-03-21 15:00:32
2	Devarsh	MH47BA6565	9999999999	2	2024-03-21 15:00:32	2024-03-22 12:28:42
3	Manan	MH48AC6869	9324796588	4	2024-03-22 12:25:49	2024-03-22 12:28:42
4	Devarsh	MH48AC6567	931196587	4	2024-03-22 12:26:30	2024-03-22 12:28:42
5	Dharak	MH48AC6665	9313194887	2	2024-03-22 12:27:03	2024-03-22 12:28:42
6	Dharak	MH45AC6666	9355544888	2	2024-03-22 12:27:20	2024-03-22 12:28:42
7	Jeet	MH03DJ1111	9355544444	4	2024-03-22 12:27:49	2024-03-22 12:28:42
8	Jeet	MH03DJ2222	9355544444	2	2024-03-22 12:27:57	2024-03-22 12:28:42
9	Manan	MH03DJ0001	9000000000	4	2024-03-22 12:28:33	2024-03-22 12:28:42
10	Manan	MH03DJ0003	9000000099	2	2024-03-22 12:28:42	2024-03-22 12:28:42
11	Devarsh	MH03DJ1010	9111111111	2	2024-03-22 12:29:06	2024-03-22 12:28:42
12	Devarsh	MH03DJ1111	9111111111	4	2024-03-22 12:29:13	2024-03-22 12:28:42

Fig.9 History Tab

V. RESULTS AND CONCLUSION

Result: The implementation of the Arduino-based Smart Car Parking System has led to a noticeable decrease in traffic congestion and driver frustration within urban areas. This improvement is attributed to the system's ability to optimize space utilization and provide real-time parking availability data. The integration of hardware components with centralized management software has also contributed to reduced congestion, offered environmental benefits, and supported data-informed decision-making. Additionally, the inclusion of IR sensor-equipped entry and exit barricades and a Python-based interactive GUI has elevated user interaction and operational efficiency. Moreover, the utilization of a SQL database has further enhanced data analysis capabilities and space efficiency.

Conclusion: The Smart Car Parking System marks a significant milestone in urban parking management, utilizing innovative technologies to enhance space utilization, alleviate congestion, and improve the user experience. Moving forward, ongoing research and development efforts can be directed towards refining system capabilities and integrating emerging technologies. This will facilitate continuous advancements in parking management efficiency and effectiveness.

VI. SOCIAL IMPACT & FUTURE

Mitigating Urban Traffic and Enhancing Driver Morale:

The introduction of the Smart Car Parking System plays a pivotal role in mitigating urban traffic by streamlining the allocation of parking spaces. This efficiency drastically cuts down the time spent by motorists in search of parking, fostering a more fluid urban traffic movement and significantly reducing the stress associated with parking.

Promotion of Environmental Well-Being: The reduction in the time vehicles spend idling during the quest for parking, thanks to the system, notably lowers vehicular emissions. This act supports the overarching goal of environmental sustainability by curbing carbon footprints and diminishing urban air pollution.

Admin Convenience Uplifted: The capability of the Smart Car Parking System to automate parking slot assignments and relay parking duration details directly elevates the convenience factor for Admin.

Foundation for Future Parking Technology Innovations:

Serving as a cornerstone for future breakthroughs in parking management technology, the Smart Car Parking System paves the way for the integration of sophisticated analytics and machine learning. These technologies hold promise for a more refined prediction of parking needs and the agile allocation of parking slots.

Harmonizing with Future Tech Trends: Looking ahead, there's significant potential for amalgamating the parking system with cutting-edge technologies, encompassing autonomous vehicles and smart urban infrastructure. Such integration aims to craft a more interconnected and streamlined urban transit ecosystem.

ACKNOWLEDGEMENT

This project and technical paper received significant support from Professor Pavan Borra. His expert guidance and comprehensive assistance were indispensable to us at every stage of this project, and this paper owes much to his contributions. We also extend our gratitude to our colleagues who shared their knowledge and experience and provided assistance throughout the research process.

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Underwater Unmanned Vehicle (UUV)

Om Gabani¹, Aniruddh Viswanathan¹, Ojas Arya Chanakya¹, Janay Asher¹, Jash Furia¹, Dewang Bhanushali¹, Isha Khan¹, Parth Mehta¹, Yukti Bandi²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹omgabani23@gmail.com, ¹aniruddh.mars@gmail.com, ¹chanakyaajas@gmail.com, ¹janayasher@gmail.com, ¹jashfuria@gmail.com, ¹dewangbhanushali@gmail.com, ¹isha24962@gmail.com, ¹parthmehta215@gmail.com, ²yukti.bandi@djsce.ac.in

Abstract—The exploration and maintenance of underwater environment is crucial for marine research, offshore oil and gas operations, environmental monitoring, and infrastructure inspection. Traditional methods involving human divers are often risky, costly, and limited in remote or deep-sea locations. Addressing these challenges, there is a pressing need for advanced Unmanned Underwater Remotely Operated Vehicles (UUV-ROVs) capable of performing diverse tasks with precision. Underwater unmanned vehicles require a delicate balance between structural integrity, buoyancy, propulsion systems, and advanced sensor technologies. UUVs offer versatile applications, including precise data collection, surveillance, and intervention in challenging environments. Despite technological advancements, UUVs face challenges such as underwater communication limitations, energy efficiency, and robust obstacle avoidance systems. This paper provides an overview of the current state of UUVs, emphasizing their design principles, diverse applications, existing challenges, and promising future prospects. The continuous evolution of UUV technology promises to revolutionize our understanding of the underwater world and unlock new possibilities for scientific exploration and industrial applications.

Keywords—Robotics, Sensors, Microcontrollers, PCBs, ROV (Remotely Operated Vehicle).

I. INTRODUCTION

The vast and mysterious expanses of the world's oceans have long captured humanity's collective imagination, concealing secrets and wonders that remain largely unexplored. As stewards of the planet, understanding the complexities of marine ecosystems and addressing the pressing challenges of pollution control have become imperatives for ensuring the health and sustainability of the oceans. In this context, the advent of Underwater Unmanned Vehicles (UUVs) marks a transformative chapter in marine exploration and environmental stewardship. UUVs, which represent remotely operated vehicles (ROVs), signify a paradigm shift in the approach to exploring the depths and mitigating the impact of human activities on underwater environments. Designed to navigate intricate underwater topography and equipped with advanced sensor technologies, UUVs have become indispensable tools for marine scientists, environmentalists, and industries alike. They can also monitor endangered coral reefs. The design of UUVs involves a balance between structural integrity, buoyancy, propulsion systems, and advanced sensors. Integration of additional subsystems, such as robotic arm manipulators and filters, further enhances the capabilities and effectiveness of UUVs in performing

complex tasks and addressing specific challenges. The continuous evolution of UUV technology holds the potential to revolutionize our understanding of the underwater world and to facilitate new opportunities for scientific exploration and industrial applications. This introduction sets the stage for a detailed exploration of the design principles, applications, challenges, and future trends of UUVs in the specific contexts of marine exploration and pollution control. By delving into the intricacies of UUV technology and its multifaceted roles, the discussion aims to illuminate the significant strides made in uncovering the mysteries of the ocean depths and addressing the critical need for effective pollution monitoring and control. As we proceed with this research paper, we will delve into the design details of UUVs, discuss their applications across different industries, examine the challenges they face, and consider future prospects. The integration of various subsystems, such as robotic arm manipulators and filters, can further improve the capabilities and performance of UUVs, expanding their potential applications and effectiveness in marine exploration and pollution control.

II. OBJECTIVE

The objective for the creation of an Unmanned Underwater Vehicle is to explore and investigate underwater environments, and draw conclusions based upon its observations. This is facilitated using sensors, cameras and monitoring equipment that are installed on the vehicle, which provide real-time data and video feedback. The video feedback from the vehicle will be used to identify polluted areas, investigate underwater structures, or be used for operation of the vehicle. Marine pollution is becoming increasingly common in recent times. Marine pollution is a combination of chemicals and trash, most of which comes from land sources and is washed or blown into the ocean. This pollution results in damage to the environment, to the health of all organisms, and to economic structures worldwide. Marine pollution is mainly of 2 types, chemical and trash. Chemical contamination, or nutrient pollution, is concerning for health, environmental, and economic reasons. This type of pollution occurs when human activities, notably the use of fertilizer on farms, lead to the runoff of chemicals into waterways. This causes a wide range of problems not only for humans, but also for the marine animals living in these waterbodies. While collection of trash in fast flowing waterbodies is challenging, chemical marine pollution can be controlled through filtration and treatment. A low cost solution is needed that can be deployed at a fast rate and will

cover a large area to help control this pollution. This paper will elucidate upon the design and creation of an unmanned underwater vehicle designed to navigate the waterbodies, locate, and treat such chemically contaminated areas. Furthermore, the onboard cameras can also be utilized to locate garbage patches in the waterbodies, which can be cleaned up.

III. LITERATURE REVIEW

Underwater unmanned vehicles (UUVs) have undergone significant evolution, spurred by technological advancements and their wide-ranging applications. This review offers insights into their development, current functionalities, challenges, and future prospects. Initially tethered, UUVs have transitioned into autonomous platforms, benefiting from strides in propulsion, navigation, communication, and AI. Their versatility finds application across oceanography, marine biology, defense, industry, and beyond, facilitating tasks like mapping, monitoring, reconnaissance, and infrastructure inspection with minimal human intervention. Despite progress, challenges persist, including the demanding underwater environment, limited endurance, communication hurdles, and reliability issues in autonomous decision-making. Addressing these necessitates innovative solutions and interdisciplinary collaboration. Looking ahead, research endeavors are directed towards enhancing autonomy, energy efficiency, and communication capabilities, promising to unlock new frontiers in underwater exploration and operations. UUVs have undeniably reshaped underwater research and operations, with ongoing advancements poised to broaden their impact across diverse fields.

IV. PROPOSED DESIGN

The block diagram of the proposed Underwater Unmanned Vehicle (UUV) is shown in the figure below:

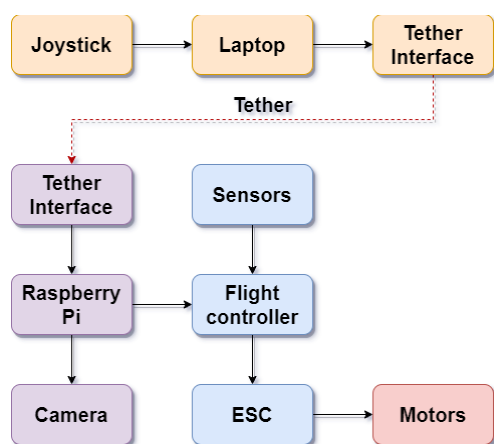


Fig.1: Block Diagram

Raspberry Pi Pico

The Raspberry Pi Pico, built around the RP2040 chip, emerges as an optimal choice for controlling an underwater unmanned vehicle (UUV) due to its affordability, versatility, and performance capabilities. With a clock speed of 133MHz and a multitude of GPIO pins, the Pico provides ample processing power and extensive connectivity options essential

for UUV operations. Its ability to interface with the A2212 BLDC motors allows precise control over propulsion, enabling the vehicle to maneuver effectively underwater. Moreover, the Pico plays a pivotal role in data acquisition from essential sensors such as the barometric pressure sensor and inertial measurement unit (IMU), providing crucial environmental and orientation data vital for navigation and system monitoring. Leveraging serial communication, the Pico establishes seamless connectivity with the Raspberry Pi microcomputer, facilitating data exchange and enabling higher-level control and coordination of UUV functionalities. Overall, the Raspberry Pi Pico serves as a robust and cost-effective microcontroller solution, empowering UUVs with the necessary intelligence and capabilities for successful underwater missions.



Fig.2: Raspberry Pi Pico

IMU Sensor

An Inertial Measurement Unit (IMU) sensor serves as a pivotal component in determining the orientation and motion characteristics of Unmanned Underwater Vehicles (UUVs). Comprising accelerometers, gyroscopes, and magnetometers, the IMU sensor offers a comprehensive solution for precisely measuring and tracking the vehicle's movement in three-dimensional space. By integrating data from these sensors, the IMU calculates Euler angles, namely roll, pitch, and yaw, which collectively define the vehicle's orientation relative to its reference frame. Roll corresponds to rotation about the x-axis, indicating tilting motion; pitch signifies rotation about the y-axis, representing upward or downward inclinations; while yaw denotes rotation about the z-axis, indicating changes in direction. Through the fusion of accelerometer, gyroscope, and magnetometer measurements, the IMU sensor provides vital information essential for navigation, control, and stabilization of UUVs in dynamic underwater environments.

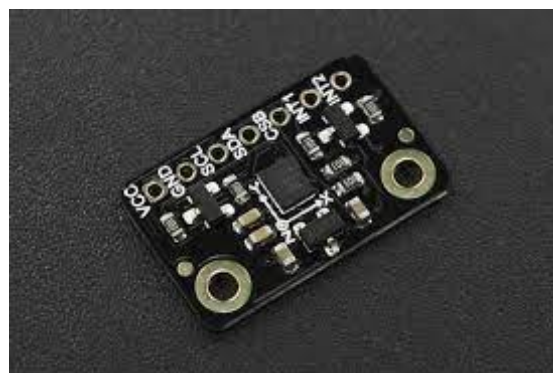


Fig.3: IMU Sensor

Barometric Pressure Sensor

The integration of a barometric pressure sensor in Unmanned Underwater Vehicles (UUVs) serves a pivotal role in

accurately determining the vehicle's depth within the aquatic environment. By measuring atmospheric pressure, the sensor provides valuable data for calculating the depth of the UUV relative to the surface. Additionally, the sensor can also offer insights into environmental conditions such as temperature and moisture levels, enhancing situational awareness during UUV operations. This multifaceted data is particularly critical for identifying any potential leakages within the electronic subsystem of the UUV. By monitoring changes in pressure, temperature, and moisture levels, the sensor enables early detection of anomalies that could lead to system failures or compromise the integrity of sensitive electronic components.

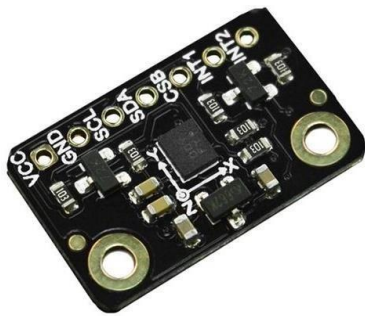


Fig.4: BME Sensor

Raspberry Pi 4B

The Raspberry Pi 4B serves as the central computing unit in our system architecture, tasked with facilitating communication with the Pico microcontroller through the Robot Operating System (ROS) framework. By adopting ROS, we gain access to a rich ecosystem of open-source packages and libraries tailored for robotics applications. These packages provide a comprehensive toolkit for integrating a wide array of sensors, actuators, and motor controllers seamlessly into our system. The communication between the UUV computer and the base station would be a tethered connection using ethernet.



Fig.5: Raspberry Pi 4B

A2212 1400KV BLDC motors

The A2212 brushless DC (BLDC) provides adequate thrust to our UUV. This motor is known for its reliability, efficiency, and relatively low cost. With its compact design the A2212 BLDC motor offers a favorable power-to-weight

ratio, making it suitable for applications where space and weight considerations are critical. Additionally, these motors often come with built-in mounting options, simplifying installation and integration into different systems. The A2212 BLDC motor operates efficiently when paired with an appropriate electronic speed controller (ESC), which regulates the motor's speed and direction.



Fig.6: A2212 BLDC Motor

Simonk 30A ESC

The SimonK 30A Electronic Speed Controller (ESC) plays a crucial role in regulating the speed and performance of the A2212 Brushless DC (BLDC) motor in various applications, particularly in the realm of unmanned aerial vehicles (UAVs) such as drones and RC aircraft. This ESC acts as an intermediary between the flight controller or manual input device and the motor itself, translating commands into precise adjustments in motor speed and direction.



Fig.7: Electronic Speed Controller (ESC)

The diagram below displays the complete structural layout with all its components. The core housing, constructed from PVC pipe due to its water-resistant properties and light weight, will house the electronic elements such as microcontrollers and PCB assembly. The thrusters will be positioned based on the required motion directions, which include upward, downward, clockwise, and anticlockwise movements. To ensure water resistance, the 3D printed parts

and the UUV will be treated with a waterproof lacquer spray. Additionally, any openings and cracks will be sealed using waterproof gaskets and sealing materials.

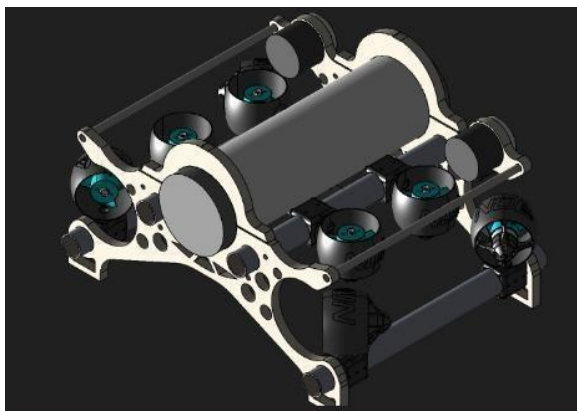


Fig. 7: UUV's Design

V. METHODOLOGY

The development journey of Unmanned Underwater Vehicles (UUVs) commences with project initiation, where clear objectives, budgetary constraints, and timelines are established, alongside identifying target users and markets. Subsequently, an in-depth exploration of existing UUV technologies is conducted, followed by the precise delineation of UUV requirements, encompassing capabilities, dimensions, and depth ratings, while also addressing legal and regulatory considerations. A conceptual blueprint is then crafted, delineating crucial components such as power systems, communication protocols, and initial performance evaluations.

Progressing further, an exhaustive engineering design is formulated, including detailed plans, material selections, and the intricacies of control, sensor integration, and navigation systems. This stage culminates in prototype development, where the physical construction of the UUV takes place, accompanied by rigorous testing of components and subsystems.

Upon readiness, the UUV undergoes comprehensive water trials to evaluate real-world performance and identify any operational issues or irregularities, which are subsequently rectified. Data gleaned from these trials is meticulously analyzed to refine the design and systems, leading to iterative testing and enhancements. Throughout this process, meticulous documentation is maintained, outlining design specifics, construction processes, testing protocols, and compliance with relevant standards, culminating in the preparation of user manuals.

Upon successful development, the UUV is deployed for its designated missions, complemented by operator training and the establishment of mission execution and maintenance protocols. Continuous monitoring and maintenance procedures are implemented to ensure optimal UUV performance, with user feedback actively solicited and integrated for ongoing improvements. This systematic methodology ensures an efficient and structured approach to UUV development, from conceptualization to operational deployment.

VI. RESULTS AND CONCLUSIONS

In this study, we designed and evaluated an underwater unmanned vehicle (UUV) specifically engineered for detecting oil spills in oceanic environments and exploring underwater terrains. The UUV exhibited good navigation capabilities, to successfully maneuver through challenging underwater conditions, and accurately pinpoint and map oil spill locations with a high level of accuracy. Additionally, the vehicle demonstrates proficiency in conducting detailed surveys of underwater ecosystems, yielding valuable insights into marine biodiversity and underwater topography. The deployment of such an advanced UUV offers several benefits, including the potential for rapid response to oil spill incidents, which can significantly reduce ecological damage and facilitate efficient clean-up operations. Furthermore, the UUV's ability to explore and document underwater habitats can enhance our understanding of marine ecosystems, support conservation initiatives, and contribute to the sustainable management of oceanic resources. However, to further optimize the UUV's performance, future research will focus on enhancing its real-time data processing capabilities, extending its operational range, and integrating advanced sensors for improved oil spill detection and environmental monitoring. In conclusion, our study highlights the promising potential of the developed UUV in advancing oil spill detection technologies and underwater exploration methodologies, thereby playing a crucial role in environmental protection and marine research endeavors.

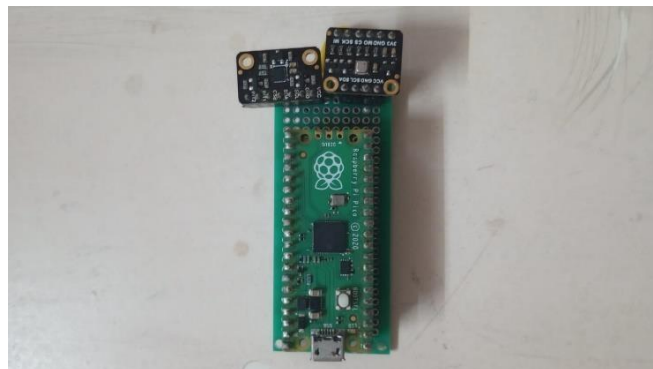


Fig.8: Custom PCB

Two sensors, specifically a pressure sensor for measuring depth and an IMU sensor for determining direction, are utilized in our UUV system. These sensors undergo meticulous calibration to ensure accurate readings. To manage data acquisition, we've integrated a Raspberry Pi Pico into the UUV setup. Additionally, we've developed a custom PCB that houses the microcontroller and sensors, streamlining connections and reducing wire clutter within the UUV mainframe. This design not only enhances the system's reliability but also simplifies debugging processes. Furthermore, to facilitate movement, we've enclosed the drone motors within custom-designed 3D-printed thrusters. This innovative approach ensures efficient propulsion and maneuverability for the UUV in underwater environments.

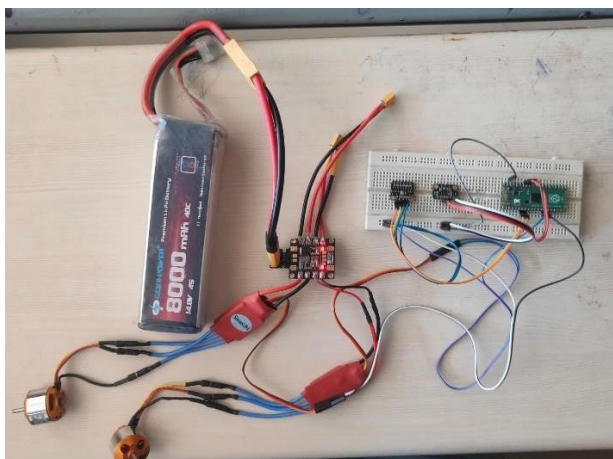


Fig.9: UUV Circuit



Fig.10: 3D Printed Thruster

VII. FUTURE SCOPE

The Unmanned Underwater Vehicle described above has tremendous potential for further development. The principal application described in this paper is for marine pollution investigation and treatment. This can be supplemented by integration of Artificial Intelligence and Machine Learning, to make the vehicle autonomous. OpenCV can also be used to automate the identification of trash in waterbodies. While the current system shows a tethered system, future development can include making the vehicle wireless using frequencies which can operate in underwater conditions. Making these vehicles wireless will enhance their utility and operational range. The most ideal way to use these vehicles would be to operate a fleet of such vehicles, simultaneously operating to ensure that maximum area of a waterbody is covered. Integration of GNSS into the vehicle's systems can add a crucial feature of 'return to home' to the vehicle so it can autonomously navigate to any given co-ordinate, and return back to it's dock in case of low battery conditions.

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Development of an Autonomous Rescue, Search, and Surveillance Vehicle

Debanshu Saha¹, Sahat Bhan¹, Yash Makwana¹, Yukti Bandi²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹debanshusaha09@gmail.com, ¹sahatbhan007@gmail.com, ¹makwanayash2003@gmail.com, ²Yukti.Bandi@djsce.ac.in

Abstract— This project describes the development of autonomous vehicles designed for rescue, search and surveillance applications. It uses advanced technologies such as NodeMCU, ESP CAM for real-time video monitoring and a unique 360-degree rotating camera mechanism driven by two servo motors for environmental monitoring. The vehicle is powered by four 12V motors controlled by a dual-motor driver to have strong maneuverability in different terrains. This project provides an overview of design considerations, equipment details, procedures, and performance in simulated search and rescue operations.

Keywords - facial recognition, emotion recognition, python, JavaScript, visual studio, CSS3, HTML, Tensor flow, OpenCV, Machine Learning, Autism.

I. INTRODUCTION

In recent years, due to the complexity of natural disaster design, urban violence and security monitoring, Rescue, search and the demand for new solutions in surveillance is increasing. Autonomous vehicles designed for rescue, search and surveillance (RSSV) have emerged as important technologies that will solve these problems. The combination of advanced computing and technology allows these vehicles to operate in environments that are inaccessible or hazardous to humans, making them highly effective at important jobs.

NATURAL DISASTERS AND EMERGENCY RESPONSE:

Natural disasters such as earthquakes, floods and forest fires create a crisis where rescue operations are always ongoing, affected by debris, hazardous materials and inevitable causes of permanent damage. Equipped with robust mobility and real-time video surveillance, RSSVs can track debris and confined spaces, locate survivors, assess damage patterns, and deliver emergency supplies. For example, during the Tohoku earthquake and tsunami in Japan in 2011, autonomous vehicles played an important role in providing instant information and damage assessment in inaccessible areas.

URBAN SEARCH AND RESCUE (USAR) OPERATIONS:

Urban locations present unique challenges for search and rescue, including complex terrain, terrain, and large numbers of people. Autonomous RSSVs are particularly suitable for USAR missions, where they can maneuver through collapsed buildings, subway tunnels, and other confined spaces to search for survivors. Their ability to carry medical equipment, communications equipment, and other equipment can be very useful and effective in rescue operations.

WILDLIFE AND ENVIRONMENTAL CARE

Besides human rescue operations, the management of RSSVs also plays an important role in rescue operations.

Conservation of wildlife and protection of the environment. Vehicles equipped with advanced sensors and cameras can travel through remote areas to track wildlife, monitor environmental changes, and investigate illegal activities such as smuggling, forest or deforestation. For example, using RSSV to monitor the health of coral reefs allows scientists to collect important data without impacting the marine environment.

SECURITY MONITORING

From a security perspective, autonomous RSSV provides continuous monitoring capability in large and hard-to-reach areas. Airports, border areas and major commercial centres benefit from the deployment of RSSV for perimeter security, immigration detection and continuous surveillance. The autonomy of these vehicles allows them to continue patrolling even in bad weather conditions and provides real-time information flow to security personnel.

ASSESSMENT OF IMPORTANT SYSTEMS:

Vehicle Security Management certification varies but many systems face problems with changing, instantaneous operation and working too much. Older models often struggle to navigate difficult terrain and lack the power needed for effective surveillance and rescue. This analysis highlights gaps in current technology and lays the foundation for the development of an improved RSSV that addresses these issues.

II. LITERATURE SURVEY

Virtual reality (VR) technology shows significant promise in many areas, from disaster management to gaming and unmanned aerial vehicle (UAV) control. In the article by Zou Zhiyong et al. (2020), the authors investigated the integration of VR technology into damage detection robots. Their work will discuss the design and details of the use of VR systems in these vehicles to improve damage and control capabilities. Meanwhile, IEEE Conference 2021 announced A-Visor and A-Camera, which offer Arduino-based cardboard head-mounted controllers specifically designed for VR gaming. This innovation offers a wide range of VR peripherals that increase the accessibility and interactivity of the gaming experience. Rahajo, Jonathan et al. (2020) proposed a new method to combine hardware with microservices to create VR game controllers using the Mahony filter. Their research reviews previous research on VR game controllers, motion tracking systems, and filtering techniques, highlighting the potential of microservices architecture in VR applications. Additionally, Zhu, Yanping et al. (2022) contributed to the field of UAV control by working on behavior solving

algorithms and implementing FPGA using additional Mahony filters. Their work highlights challenges and advances in drone control and underscores the importance of accurate behavioral prediction for mission success. By combining information from these various efforts, researchers can better understand the current state of VR technology and hardware development and identify the need for further research and innovation in this rapidly changing environment.

DESIGN CONSIDERATIONS:

RSSV's design is guided by a multidisciplinary approach that combines principles of mechanical engineering, computer science, and robotics to create powerful, beneficial, and diverse self-regulation. Key points to consider during design include:

SYSTEM INTEGRATION AND MODULARIZATION:

Adopt a design approach to simplify development and maintenance. This approach allows individual components, such as sensors or motors, to be replaced or replaced without changing the entire system. Integration is carefully managed to ensure effective communication between hardware devices and the software that controls them. The NodeMCU microcontroller acts as a central hub that manages the operation of all subsystems, including motor control, camera monitoring, and data transmission.

USER INTERFACE AND MANAGEMENT:

Recognizing the importance of intuitive management, a simple native website was created that allows business owners to manage RSSV via smartphone. The interface has been designed with simplicity and ease of use in mind, providing simple controls for navigation and camera operations without interfering with the user. The website directs the RSSV's movement and camera direction by communicating with the NodeMCU to convert user input into actionable commands.

DURABILITY AND ENVIRONMENTAL COMPATIBILITY:

Considering the variety of environments in which RSSV must operate, from urban conditions to outdoor environments, its design reflects long and flexible operating performance. The chassis of the car is made of lightweight yet strong materials that can withstand impacts and environmental stress. Protection against water and dust protects sensitive electronics and ensures the reliability of the RSSV in harsh conditions.

III. PROPOSED DESIGN

MOTION AND OPERATION (12V MOTOR AND L298 MOTOR DRIVER):

The 12V motor allows the RSSV to adapt to different soil types, choosing a balance of power, performance and size. These motors are controlled by the L298 motor driver, which is known for its robustness and ability to handle high current loads. The engine's heat sink solves the thermal management problem and ensures better performance over long periods of time. This configuration allows the RSSV to control its movements, allowing it to easily check tight spaces and obstacles.

MICROCONTROLLER SELECTION (NODEMCU):

NodeMCU was chosen due to its size, Wi-Fi capability and having enough power to handle the operation of the vehicle. Its ease of use and compatibility with various sensors and accessories make it the right choice. This microcontroller is tasked with processing sensor data, controlling motor operation, and facilitating real-time video streaming, and its reliability and performance are critical to achieving RSSV.

Real Time Video Surveillance (ESP CAM): ESP chose CAM due to its best resolution and ease of integration with NodeMCU for Wi-Fi communication. The camera is critical to monitoring and detecting RSSV, providing the operator with instant feedback about the vehicle's surroundings. The development of a 360-degree rotating camera setup controlled by servo motors improves the RSSV's field of view, allowing inspection of the surroundings without the need to move the vehicle's chassis.

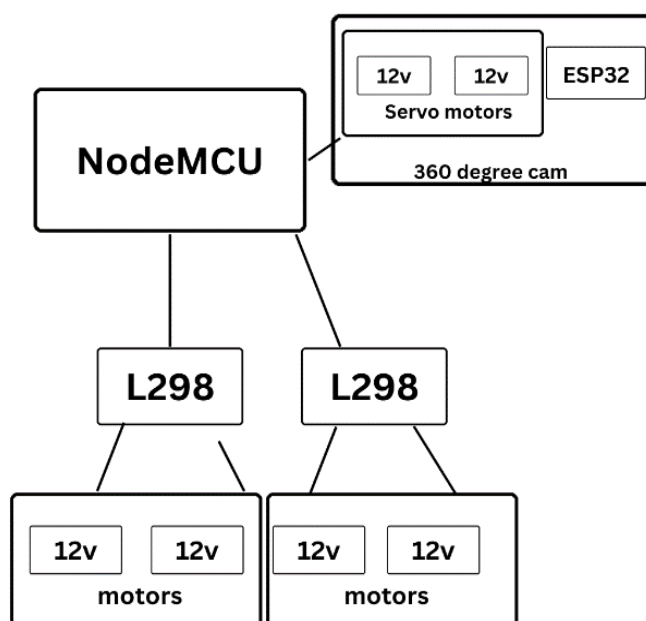


Fig.1 Block Diagram

Fig 1 shows the Visual representation of vehicle system architecture Interface between NodeMCU, ESP CAM, motors and servo motors .

NodeMCU:

Acting as the brain of the vehicle, it provides real-time Wi-Fi data transmission and sufficient computing power to process sensor input and control vehicle movement. The most commonly used prototyping equipment is a circuit board in a two-in-line package (DIP) that connects a USB controller to a small mounting board containing an MCU and an antenna thread. Select DIP mode to allow easy breadboard prototyping. The design is based on the ESP-12 module of the ESP8266, which originally integrated the Xtensa LX106 core and is a Wi-Fi SoC widely used in IoT applications.

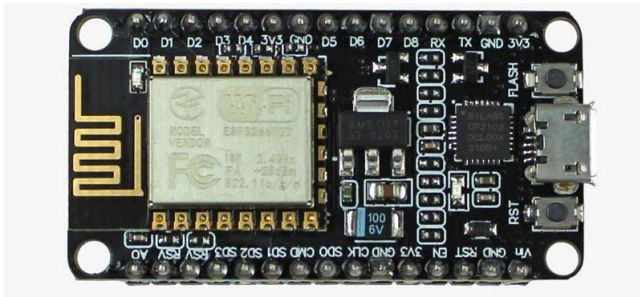


Fig.2 NodeMCU

ESP CAM:

Provides high resolution imaging critical for monitoring and situational awareness. Its integration with NodeMCU enables real time video streaming to enhance traffic monitoring capabilities.



Fig.3 ESP32CAM

12V DC MOTOR:

These motors provide the vehicle with the thrust it needs to go anywhere. They were chosen for their performance and efficiency, ensuring the vehicles have the power they need to complete search and rescue missions.



Fig.4 12V DC Motor

L298 MOTOR DRIVER:

L298 motor driver is an important component in the control of 12V motors. The dual H-bridge design allows two motors to control themselves simultaneously, allowing direct driving. The L298 motor driver was chosen for its high current rating and compatibility with NodeMCUs, making it ideal for applications requiring motor control.



Fig.5 L298 Motor Driver

SERVO MOTORS:

These motors allow the camera set to rotate 360 degrees. Selected for their accuracy and reliability, these sensors allow vehicles to have a good view of their surroundings, which is important for good inspection and search operations.



Fig.6 SERVO MOTOR

IV. IMPLEMENTATION

Control and Communication:

NodeMCU is programmed to control the vehicle's orientation and monitor and interact with smartphones for remote control. A traditional website built using HTML and CSS functions as a control panel accessible via a smartphone browser. This panel provides a simple interface to control the vehicle's power and adjust its parameters on the fly. JavaScript is used to manage the communication between NodeMCU and the website and to provide interaction and control of the tool. To control two drives, the NodeMCU outputs a PWM (Pulse Width Modulation) signal, which determines the speed and direction. Driving guidance. This configuration allows precise control of the vehicle's movement, from smooth adjustments to rapid changes, meeting the different needs of rescue, search and surveillance assessment missions.

EFFICIENCY AND MONITORING ABILITY:

RSSV's efficiency was evaluated through continuous operation testing and completed long-term missions without the need for human intervention or recharging. The L298 motor driver's integrated heat exchanger effectively dissipates heat, preventing thermal throttling and allowing the motor to operate at optimum efficiency. Measuring the vehicle's tracking ability by measuring the amount, accuracy and stability of video transmission from the ESP CAM through various maneuvers and terrains. The 360-degree rotating camera unit, controlled by servo motors, provides a wide scanning of the environment, providing a panoramic image

without the need to change the position of the vehicle. The video output resolution remains stable and clear even in high power and low light conditions, proving the effectiveness of ESP CAM and the power of NodeMCU's Wi-Fi connectivity support a significant achievement in fulfilling an important role. autonomous systems. Equipped with NodeMCU, ESP CAM and 360degree rotating camera along with strong power, RSSV has proven its ability to adapt and work in various environments. Designed with a focus on durability, flexibility and immediate operation, this product has been proven by stringent testing in many fields;

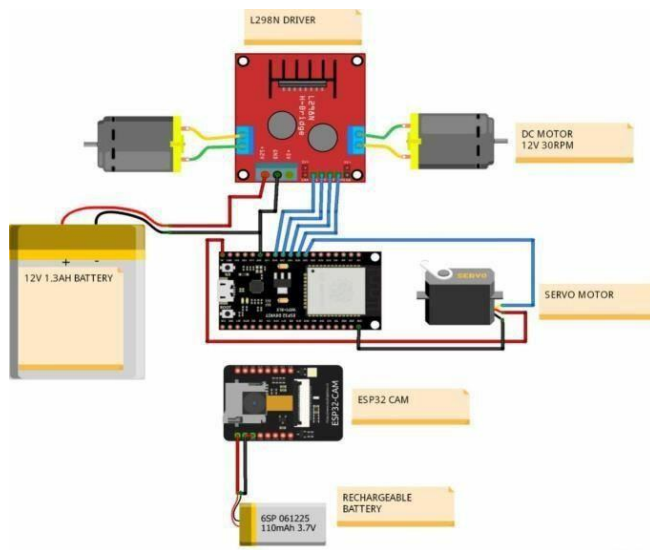


Fig.7 RSSV Circuit

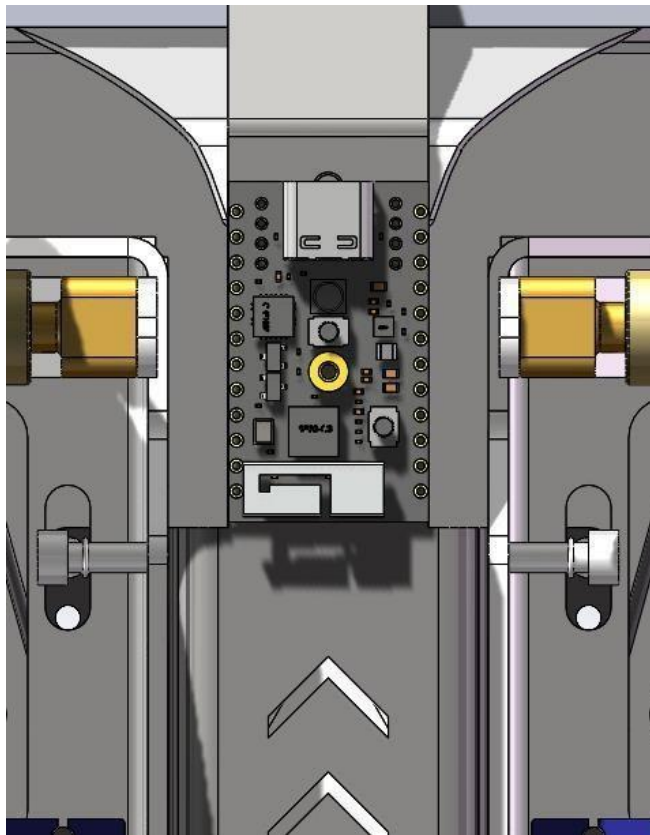


Fig.8 CAD Design of ESP

V. RESULTS AND CONCLUSION

The Autonomous Rescue, Search and Surveillance Vehicle (RSSV) has undergone various tests to evaluate its effectiveness, efficiency and effectiveness in many areas. maintenance capacity. Therresults of these tests demonstrated that the RSSV was able to meet the needs of the design, confirming that it was suitable for many rescue, search and surveillance purposes. The development and testing of the Autonomous Rescue, Search, and Surveillance Vehicle (RSSV) mark a notable achievement in the field of autonomous systems for critical missions. Equipped with the NodeMCU, ESP CAM, and a 360-degree rotating camera, alongside a robust mobility system, the RSSV has proven its capability to adapt and perform across diverse environments. Its design, focusing on durability, adaptability, and real-time operational efficiency, has been validated through rigorous testing in various terrains, highlighting its potential for immediate application in rescue, search, and surveillance operations. The project underscores the importance of integrating advanced technologies with user-friendly controls to address complex challenges in dynamic environments. The RSSV not only meets the current demands of such operations but also lays the groundwork for future advancements in autonomous vehicle technology. As it transitions from testing to deployment, the RSSV exemplifies the transformative potential of autonomous systems in enhancing safety, operational efficiency, and response capabilities in critical scenarios.

VI. SOCIAL IMPACT & FUTURE

VIDEO STREAMING:

Configured to operate in streaming mode, ESP CAM captures live videos and sends them to a smartphone over the local network created by NodeMCU. This application involves setting up ESP CAM with a streaming server that compresses and transmits video with low latency. The local system integrates available feedback to give the operator an instant view of the vehicle's surroundings, helping to navigate difficult terrain and identify details of interest or concern.

Thermal Dissipation Mechanism:

As mentioned before, the integrated heat sink of the L298 motor driver solves the problem of thermal management and ensures reliable, even operation for a long time.

PERFORMANCE ACROSS MULTIPLE TERRAINS:

RSSV has been subjected to many tests in a variety of environments, including urban waste, forested areas, sand and rocky areas. In the waste city simulation, the car has excellent maneuverability, it can be easily maneuverer in narrow spaces and obstacles such as broken stones and broken buildings. Its performance in forest and sandy soil is similar; the car adjusts speed and engine torque to provide stability and traction. In rocky terrain, the RSSV demonstrates stability and can overcome rough and steep terrain without compromising its performance. These tests confirm the performance of the RSSV at different levels thanks to its high mobility, including the L298 engine and the electric power from the 12V motor. The design and strategic placement of the parts also make the vehicle adjustable, allowing the center of gravity to be

adjusted instantly and providing stability and traction in different situations.

ACKNOWLEDGMENT

This project was only possible thanks to the help and support of the faculty and professors who have given unwavering guidance and vision on improving and feature selections and the overall design. Prof. Yukti Bandi especially helped us with expanding our idea to new domains which we had not thought of beforehand and made us explore new directions. Also, the college component bank helped us get the required components on either cheap price or on rent saving us a lot of production costs and having more flexibility in trying out different components for the right fit.

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"GreenInnovate": IoT-Enabled Greenhouse Control with Arduino and ESP82"

Deep Variya¹, Harsh Mirage¹, Parth Chawda¹, Revathi A.S.²

¹U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

²Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

Email ID: ¹deepvariya7@gmail.com, ¹harshmirage18@gmail.com, ¹parthchawda575@gmail.com, ²revathi.as@djsce.ac.in

Abstract—Our project aims to innovate greenhouse management by implementing an advanced Internet of Things system. Greenhouses play a vital role in optimizing crop production by providing controlled environments for plant growth. Through the integration of IoT technology, we seek to improve this process by connecting a network of sensors and equipment to a central control hub. The core of our system is a sophisticated microcontroller, serving as a central processing unit. This unit facilitates communication and coordination among various strategically positioned sensors in the greenhouse. These sensors monitor essential environmental factor such as temperature, humidity, soil moisture, and illumination levels, delivering real-time data feedback to the control hub. Utilizing WiFi connectivity, our system enables continuous monitoring and precise adjustment of environmental conditions within the greenhouse. This automation reduces manual intervention and ensures optimal growing conditions for plants throughout their lifecycle. Additionally, our IoT-enabled greenhouse management system offers flexibility and scalability. Farmers can remotely access and control the system, facilitating seamless management of operations from any location. This capability is particularly beneficial in scenarios requiring immediate intervention, such as sudden environmental fluctuations or maintenance issues. By leveraging IoT technology, our project aims to equip farmers with the tools needed to enhance crop yields, improve quality control, and transform greenhouse management practices.

Keywords— IoT, Temperature, Humidity, Soil Moisture, Illumination, WiFi

I. INTRODUCTION

The Food and the Agriculture Organization (FAO) of the United Nations warns of the need to increase food production by 60 percent to feed an estimated 9 billion people by 2050. This demand arises from the exponential growth of the global population, which has surged from 1 billion in 1800 to 8 billion in 2012, with projections reaching 11 billion by the end of the century. Modern farms, sprawling across vast expanses, grapple with rising costs of essentials like fertilizer and electricity, compounded by regulations limiting irrigation. To address these challenges, farmers are under pressure to optimize resource usage, minimize spoilage, and enhance the efficiency of the supply chain from field to shelf. However, agriculture faces numerous complexities. Farmers

deal with tight deadlines, a lack of actionable information, and geographical barriers of time and distance. Despite advancements like GPS-guided harvesters, agriculture demands more data. Profitability in the sector fluctuates with unpredictable rainfall and market prices, highlighting the need for accurate and ongoing operational insights. Yet, obtaining such insights presents challenges. Unlike mass-produced goods, crops vary significantly. Companies like CleanGlow and Solum are leading a revolution by leveraging Big Data to dynamically adjust moisture levels and other vital metrics. As a new generation of tech-savvy farmers emerges and the trend toward locally sourced food grows, agriculture is on the brink of a data-driven renaissance. The expanding Internet of Things (IoT) offers significant potential, enabling device interconnectivity and ushering in an era of precision farming. Nowhere is this potential more evident than in greenhouse agriculture, where environmental factors such as temperature, humidity, lighting, soil moisture, and CO₂ levels profoundly impact crop productivity and quality. Continuous monitoring and analysis of these factors provide valuable insights for maximizing yields. IoT technology empowers farmers to collect real-time data on environmental conditions, enabling precise adjustments to optimize plant growth. This not only enhances productivity but also promotes sustainability by minimizing resource wastage. In this era of rapid technological progress, agriculture is poised to leverage data to address the critical challenge of feeding a growing global population. Through innovation and collaboration, the industry is forging a path toward a more efficient, resilient, and sustainable future.

II. OBJECTIVE

Key Objectives of Our Project in Agricultural Innovation:

Real-time Soil Moisture Monitoring: Develop an algorithm to continuously monitor the soil moisture levels in real-time using advanced moisture sensors.

Soil Moisture Optimization: Utilize sophisticated techniques to optimize soil moisture levels according to the specific needs of different crops, promoting optimal conditions for robust plant growth and increased productivity.

User Engagement: Design a user-friendly interface allowing farmers to actively participate by providing real-time data and enabling customization of moisture content thresholds to suit their crop preferences and requirements.

Enhanced Agricultural Yield: The primary goal is to boost agricultural yield by maintaining optimal soil moisture levels, fostering an environment conducive to accelerated crop growth and improved productivity.

Water Conservation: Implement intelligent irrigation strategies driven by real-time soil moisture data to minimize water consumption while ensuring crops receive adequate moisture for sustained growth.

Addressing Agricultural Challenges: Develop an intelligent system capable of tackling prevalent agricultural issues such as inefficient water usage and suboptimal crop management, leveraging technologies like IoT and real-time monitoring for effective solutions.

Resource Allocation Efficiency: Empower farmers to make informed decisions regarding water distribution across fields by providing real-time moisture data, facilitating efficient resource allocation and enhancing overall crop management practices.

By focusing on these objectives, our project aims to revolutionize agricultural practices through technological innovation, ultimately contributing to sustainable and efficient farming methods.

III. PROPOSED DESIGN

GreenInnovate's IoT system utilizes a PC or phone-based platform to keep owners consistently informed.

i. The system consists of a microcontroller-based circuit that monitors and records temperature, humidity, soil moisture, and sunlight values in the natural environment.

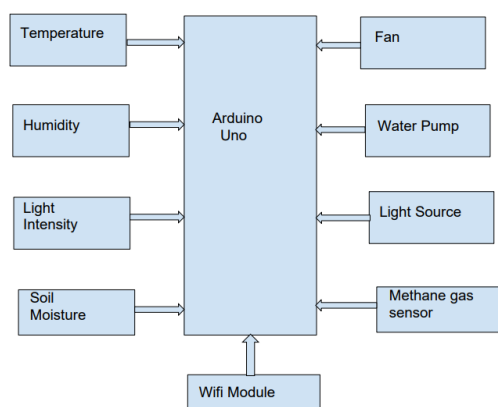


Fig. I Block Diagram

ii. These values are continuously updated and logged to optimize conditions for maximum plant growth and yield.

iii. The system continuously monitors the digitized parameters from various sensors.

iv. Greenhouse environment monitoring and control involve sensing changes that can influence plant growth rates.

v. Key parameters include greenhouse temperature, which impacts photosynthesis and transpiration processes, humidity levels, soil moisture content, and illumination levels.

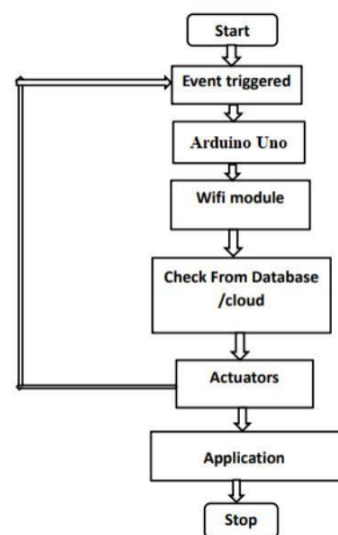


Fig.II. Flow Chart

IV. IMPLEMENTATION AND WORKING OF PROJECT

1. **Soil Moisture Sensor:** The moisture sensor measures the water content in the soil. When the soil experiences water shortage, the sensor outputs a high signal. Conversely, when the soil has sufficient moisture, the output signal is low. This information is sent to an Arduino Uno, which controls a water pump accordingly. When the soil receives adequate water, the moisture sensor signals the Arduino to stop the pump.

2. **ESP82 Microcontroller:** The ESP82 is a cost-effective System on Chip (SoC) microcontroller developed by Espressio Systems, known for the ESP8266 SoC.

It serves as a successor to the ESP8266, featuring both single-core and dual-core variants of Tensilica's 32-bit Xtensa LX6 microprocessor. Integrated with Wi-Fi and Bluetooth, the ESP82 simplifies hardware design due to its built-in RF components, including a power amplifier, low-noise receive amplifier, antenna switch, filters, and RF balun.

3. **Temperature Sensor:** The temperature sensor measures the ambient temperature, utilizing membership functions with linguistic variables such as "high" and "low". In this project, we employ the LM35 sensor for temperature measurement, with its output fed to an Arduino Uno.

The Arduino processes this input and compares it against programmed conditions. Based on these conditions, the Arduino controls a state relay to either close or open the circuit, thereby operating the water pump as needed.



Fig.III. Soil moisture sensor



Fig.IV. ESP82

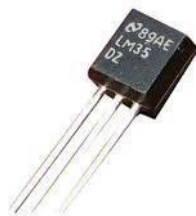


Fig.V. Temperature sensor

V. APPLICATION

In our project, we implemented the "Blynk" app for remote control and monitoring via the internet. The app features a user-friendly interface for performing and overseeing tasks. To activate the GUI (Graphical User Interface), users need to connect their mobile phones to the internet, open the app, and then click the "PLAY" button located in the top right corner of the GUI.

The GUI, as shown in Fig. 6, displays various components:

1. Temperature and Humidity Gauges: The first two gauges allow users to monitor the temperature and humidity levels inside the greenhouse in real-time.
2. Soil Moisture Gauge: This gauge provides information about the soil moisture level within the greenhouse.
3. Control Buttons:
 - "D0" and "D1" Buttons: These buttons are used to control the fertilizer pump and water pump, respectively.
 - "Cool Air" and "Hot Air" Buttons: These buttons enable users to control the cool air fan and the heating surface of the Peltier device, respectively.
 - "Exhaust Fan" Button: This button controls the operation of the exhaust fan.
 - "Lights" Button: When activated, this button turns on the lights inside the greenhouse.

Upon clicking any of these control buttons, the command is transmitted to the cloud and then relayed to the MCU

(Microcontroller Unit) for executing the corresponding action.

For example:

- Clicking the "Cool Air" button sends a command to the MCU to activate the cool air fan and cool the surface of the Peltier device.
- Similarly, clicking the "Exhaust Fan" button triggers the MCU to operate the exhaust fan.
- Activating the "Lights" button results in turning on the lights inside the greenhouse.

This approach allows users to remotely control and monitor various aspects of greenhouse management efficiently and conveniently.



Fig.VI. Screenshot of GUI

VI. RESULTS AND CONCLUSION

In today's age of digitalization, automating greenhouse operations is imperative for fostering smart farming practices and efficiently cultivating crops. By integrating advanced automation systems, farmers gain the ability to remotely monitor greenhouse conditions from anywhere in the world, and if necessary, adjust settings effortlessly using just a smartphone. This sophisticated system enables seamless transmission of crucial data and control commands over the Internet.

Essential necessities such as soil moisture, temperature, and humidity are continuously monitored and transmitted to the farmer's smartphone in real-time. Moreover, farmers can remotely issue commands to activate or deactivate motors, fans, cooling systems, and heating mechanisms via the Internet, ensuring precise management of greenhouse environments.

The availability of real-time data at the farmer's fingertips via the Internet serves as a valuable tool for making informed

decisions and promptly responding to any deviations or issues detected within the greenhouse. This proactive approach allows farmers to optimize crop growth conditions, mitigate risks, and maximize yields, ultimately leading to more efficient and sustainable farming practices.

VII. SOCIAL IMPACT & FUTURE

GreenInnovate provides practical solutions to improve agriculture in several ways:

1. Precision Agriculture: By using real-time data, farmers can adjust environmental conditions to optimize plant growth.
2. Informed Decision-Making: Data analytics help farmers make better decisions by identifying long-term trends and patterns.
3. Remote Monitoring: Farmers can monitor and control greenhouse conditions from a distance, allowing them to respond quickly to any issues.
4. Climate Adaptation: Adapting to climate changes helps protect crops from extreme weather conditions.
5. Energy-Efficient Greenhouses: Implementing energy-saving techniques and utilizing renewable energy sources reduces greenhouse operating costs.
6. Alert Systems: Early warnings about extreme conditions enable farmers to take proactive measures to protect their crops.
7. Research and Improvement: The data collected can be used for agricultural research and to continually improve greenhouse systems.
8. Educational Tool: Serving as an educational tool, the project raises awareness among students and farmers about sustainable farming practices.

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Non-Invasive Blood Glucose Measuring Device

Aash Shah¹, Deep Shah¹, Reshmi Nair¹, Aarti Ambekar²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Electronics and Telecommunication Department, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹aashshahdec4@gmail.com, ¹reshmir28nair@gmail.com, ¹deep00933@gmail.com, ²aarti.ambekar@djsce.ac.in

Abstract— Non-invasive glucose monitoring is a promising approach for managing diabetes, and Near-Infrared Spectroscopy (NIRS) has emerged as a potential technique for non-invasive glucose detection. This review provides an overview of NIRS-based glucose detection methods, including principles, advancements, and challenges. The proposed non-invasive glucose detector utilizing NIRS methodology coupled with Arduino and IR transceivers offers flexibility, affordability, and ease of customization, making the system accessible for widespread use. It eliminates the need for painful finger pricks and provides continuous glucose monitoring capabilities, representing a significant step towards improving diabetes management.

Keywords— Glucose monitoring, Non-invasive sensors, Blood sugar monitoring, Continuous glucose monitoring (CGM), Optical glucose sensing, Near-infrared spectroscopy, Infrared technology, Radiofrequency-based glucose monitoring, Thermal sensing.

I. INTRODUCTION

Diabetes is a health problem in which the body is not able to maintain its blood sugar or glucose levels to normal. This happens due to insufficient production of insulin by the pancreas in the human body or when the cells are not able to respond to insulin properly. Glucose is the main source of energy for the human body and insulin is the hormone which helps human cells to interact with insulin to produce energy. Diabetes is also known by the name diabetes mellitus. Diabetes is of two types which are as follows: Type1 Diabetes and Type2 Diabetes. In Type1 diabetes the pancreas stops producing insulin properly. Approximately 5-10% of people suffering from diabetes have Type1 diabetes. Type1 diabetes is genetically passed on from parents to offspring. In Type2 diabetes the body cells are not able to process or utilize the insulin properly leading to high blood glucose levels. Approximately 90-95% of people suffering from diabetes have Type2 diabetes. Type2 diabetes is caused due to obesity or improper dieting or having high sugar intake daily. Few common symptoms of diabetes are: numb or tingling feeling in hands and or feet, frequent urination, sudden weight loss, blurry vision, etc. Recent polls conducted in India reveal that over 101 million individuals, or 11% of the country's population, is suffer from diabetes. Additionally, 15% of Indians are pre-diabetic, according to the report.

The current method for measuring blood glucose level involves taking blood samples and then analyzing them to calculate glucose level. Due to this continuous glucose monitoring is quite difficult and a tedious job. The continued

finger pricking or using syringes to take blood samples is quite painful for the patients. There are chances of infection and loss of sense from the fingertips of the patient. Due to such reasons, there is a need to develop non-invasive methods to calculate blood glucose levels. A few methods on which research and studies are going in on market are: Optical Coherence Tomography (OCT), Sweat-based Glucose Monitoring, Raman Spectroscopy, Microwave Radiometry, Near-infrared (NIR) Spectroscopy, and Saliva-based Glucose Monitoring. In this project we have used Near Infrared Spectroscopy for measuring blood glucose levels non-invasively.

II. LITERATURE SURVEY

The exploration of non-invasive glucose detection methods has recently gained significant interest due to their potential to revolutionize diabetes management. Near Infrared Spectroscopy (NIRS) is one such method that has caught the attention of researchers. Several studies have investigated the feasibility and efficacy of NIR based techniques for glucose monitoring, highlighting the advantages of noninvasiveness, continuous monitoring capabilities, and the potential for real-time feedback. Research in this area has focused on various aspects such as optimizing NIRS parameters, developing calibration algorithms, and integrating with advanced signal processing techniques. In addition to these efforts, integrating NIRS with emerging technologies such as wearable devices and miniaturized electronics, including Arduino microcontrollers and IR transceivers, has shown promise in enhancing the accessibility, affordability, and portability of non-invasive glucose detection systems. Despite significant progress, challenges such as improving accuracy, addressing interferences from biological tissues, and achieving regulatory approval remain areas of active investigation. However, the literature underscores the potential of NIRS-based non-invasive glucose detectors as a promising avenue for improving diabetes management. These detectors offer continuous monitoring with minimal discomfort and inconvenience to individuals with diabetes, and may prove to be an invaluable tool in diabetes treatment and care.

III. PROPOSED DESIGN

The project design for the non-invasive glucose detector using Arduino ATmega328, I2C communication protocol, and IR transmitters and receivers is a significant breakthrough in the field of medical technology. The aim of the project is to develop a device that can measure blood glucose levels without the need for traditional invasive methods such as finger pricking.

The device works by emitting infrared light toward the skin using IR transmitters. The IR receivers detect the infrared light reflected from the skin surface, and the changes in the intensity of reflected light are then correlated with blood glucose levels. To process the data, the Arduino ATmega328 microcontroller will serve as the main control unit. It will receive data from the IR receivers and process it to determine glucose levels.

The programming will involve analog signal processing and calibration algorithms to accurately convert sensor data into glucose readings. The device will also utilize I2C communication protocol for seamless data exchange between Arduino and other components, ensuring efficient and reliable transmission of sensor data to the microcontroller.

To provide real-time glucose readings, the device will incorporate an LCD or LED display. The display will present glucose levels in a user-friendly format for easy interpretation. To ensure efficient power management, the device will implement sleep modes and low-power states when inactive. It will also be designed to be compact, ergonomic, and user-friendly, making it an innovative solution for monitoring blood glucose levels without the discomfort of traditional invasive methods.

Calibration and accuracy are also critical components of the project design. The sensor system will be calibrated to account for variations in skin types and environmental conditions. Thorough testing will be conducted to validate the accuracy and reliability of glucose measurements.

The device will also be designed with an enclosure to house all components securely, providing easy access to the display and power inputs while maintaining portability and user-friendliness. The device's design will be kept simple and easy-to-use, enabling anyone to use it with a little bit of training. Overall, this project is expected to deliver a reliable and user-friendly device for individuals managing diabetes or conducting glucose monitoring for various applications. This project has the potential to revolutionize the way blood glucose levels are monitored, making it more accessible and less painful for individuals with diabetes or other medical conditions that require regular glucose monitoring.

IV. IMPLEMENTATION

The non-invasive glucose detector circuit is a modern solution designed to measure glucose levels without the need for traditional finger-prick methods. This system uses Arduino ATmega328, I2C module, IR transmitters, and receivers to detect changes in blood glucose levels non-invasively. Checking blood sugar the old way means poking your finger a lot to get blood, which can hurt, be annoying, and might make infections more likely. The non-invasive glucose detector circuit eliminates the need for these invasive methods, making glucose monitoring more comfortable and less painful.

To build this system, the key components include the Arduino microcontroller, which serves as the brain of the system, the I2C module that enables communication between Arduino and other peripherals, and IR transmitters and receivers that emit and detect IR light. The Arduino

ATmega328 is a popular microcontroller used in many DIY projects due to its ease of use, flexibility, and affordability. The IR transmitters and receivers emit and detect IR light, which can pass through the skin and detect changes in blood glucose levels. The I2C module provides a simple and efficient means of data transfer between the Arduino and other peripherals.

To construct the circuit, you need to wire the IR transmitters and receivers to suitable output and input pins on the Arduino board, respectively, and establish a stable power supply to the entire circuit. It is also essential to provide a common ground connection between all components to avoid potential ground loop issues and ensure proper signal integrity. The placement of IR transmitters and receivers is critical to ensure effective detection of IR signals through the skin for glucose measurement. The sensor placement should be optimized to minimize the effect of ambient light and other environmental factors.

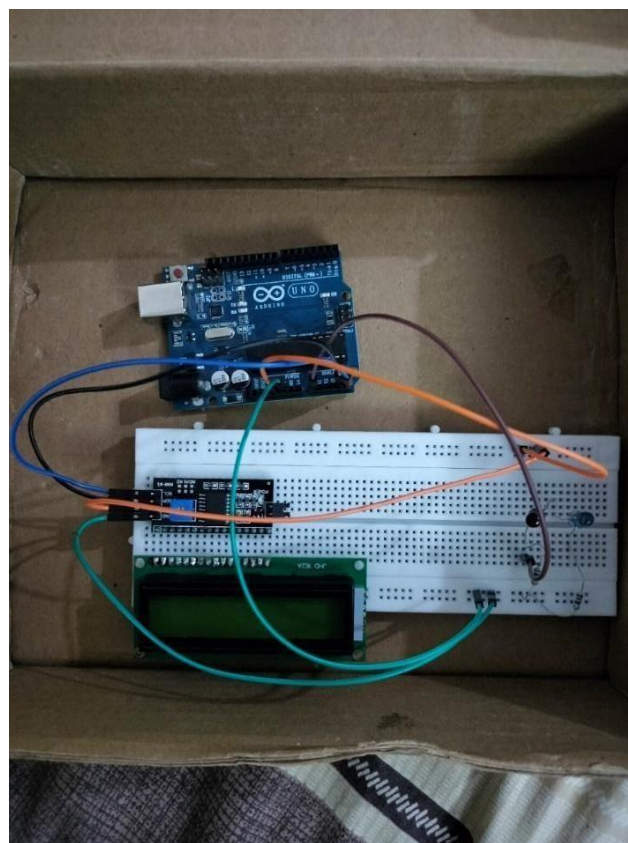


Fig1. Implementation of the design

To program the system, calibration routines should be implemented to account for variations in IR signal absorption due to factors such as skin tone, temperature, and ambient light. Algorithms should be developed to analyze the received IR signals and extract glucose level information based on established models and signal characteristics. The I2C protocol can be used to transmit processed glucose level data from the Arduino to external devices such as displays or data logging systems. It is important to implement error detection and handling mechanisms to ensure reliable operation under various conditions, such as signal interference or hardware faults.

```

chop++;

datafix = adcsensor + datafix;

delay(100);

if (chop > 20) {
  fix = datafix / 20.0;
  fix=fix*10;
  calibrationDone = true;
  //calibration = (fix - 1022.1) / 0.0967;
  return;
}

process();
}

void loop() {
  lcd.setCursor(1, 0);
  lcd.print("Calibrating...");

```

Fig2. Snippet of the code

Finally, a user-friendly interface should be designed to provide feedback to the user, display glucose readings, and facilitate interaction with the system. The interface should be convenient to use, intuitive, and accessible for people with various amounts of technical know-how. The user interface can be implemented using various technologies, such as LCD displays, LED indicators, or mobile applications. By following these guidelines and considerations, a functional and reliable glucose monitoring system can be developed for non-invasive glucose measurement. This system can revolutionize glucose monitoring for people with diabetes and other related health conditions, making it easier and less invasive to manage their health.

V. RESULTS AND CONCLUSION

Our study on non-invasive glucose detection has been a significant breakthrough in the domain of glucose monitoring. We utilized Near-Infrared Spectroscopy (NIRS) and implemented the device with Arduino and IR transceivers to produce promising results. Through rigorous experimentation, we were able to acquire calibration values using sophisticated formulas for measuring glucose levels. Our device proved to be remarkably reliable and accurate in measuring glucose levels without the need for invasive procedures.

The development of non-invasive glucose monitoring is crucial for individuals managing diabetes or monitoring their blood sugar levels. Our study signifies a significant advancement in this field, offering a non-intrusive and convenient solution to make the process more accessible and less burdensome for patients. The implementation of this technology could potentially improve the quality of life for

millions worldwide, as it is more cost-effective and accessible.

The utilization of Arduino and IR transceivers in our study showcases the potential for cost-effective and accessible technology in healthcare applications. This breakthrough paves the way for future innovations in non-invasive glucose monitoring. Furthermore, it underscores the potential for innovative and accessible solutions for other healthcare issues, as the implementation of sophisticated technology can make healthcare more accessible to patients who require it.

The possibilities that this development presents are endless, and it opens the door for further research, development, and innovation. Our study has shown that through the use of sophisticated technology, we can produce accurate, reliable, and non-invasive solutions to help individuals manage their health and improve their quality of life. The potential for non-invasive glucose monitoring is significant, and we are excited to continue exploring new possibilities to make the process more accessible to those who need it most.



Fig 3. Final Output

VI. SOCIAL IMPACT & FUTURE

Non-invasive blood glucose measuring devices have evolved as a game-changer in diabetes management, providing a range of benefits for various demographic groups and societal dynamics. Our research delves deeper into the social impact of these devices, highlighting their potential to alleviate physical discomfort and address longstanding barriers to glucose monitoring, particularly among vulnerable populations such as children, the elderly, and

individuals with disabilities. For children with diabetes, non-invasive monitoring devices offer a less intrusive means of managing their condition, reducing anxiety and resistance to routine monitoring. With traditional invasive monitoring methods, children often experience pain and discomfort with frequent needle pricks, leading to fear and avoidance of monitoring altogether. However, with non-invasive devices, children can monitor their glucose levels without the need for invasive procedures, promoting adherence to monitoring routines and reducing the risk of complications. Similarly, for the elderly and individuals with dexterity limitations, non-invasive monitoring devices offer a simple and easy-to-use solution, promoting independence and self-care. These devices foster a sense of dignity and autonomy, allowing individuals to manage their diabetes on their own terms without relying on caretakers or family members. Moreover, our investigation highlights the potential of non-invasive monitoring technology to bridge existing disparities in access to healthcare services. In underserved communities where access to healthcare resources may be limited, non-invasive devices offer a cost-effective and convenient solution for glucose monitoring. By decentralizing care and empowering individuals to track their glucose levels at home, these devices have the potential to narrow the gap in healthcare outcomes and improve health equity. In addition to their immediate social impact, non-invasive blood glucose measuring devices hold promise for driving broader societal changes. As individuals gain greater control over their health through access to real-time glucose data, we anticipate a shift towards a more proactive and preventive approach to healthcare. This shift has implications not only for individuals with diabetes but also for public health systems, which stand to benefit from reduced healthcare expenditures and improved population health outcomes. Looking ahead, the future of non-invasive blood glucose monitoring technology is ripe with possibilities. As technological advancements continue to evolve, we anticipate further improvements in accuracy, reliability, and user experience. The integration of artificial intelligence and machine learning algorithms holds promise for enhancing predictive capabilities and personalizing diabetes management strategies.

Additionally, ongoing research efforts aimed at miniaturizing and optimizing these devices will contribute to their widespread adoption and accessibility. In conclusion, our research underscores the multifaceted social impact of non-invasive blood glucose measuring devices, from improving quality of life and promoting independence to addressing healthcare disparities and driving systemic change. As these technologies continue to advance, they have the potential to revolutionize diabetes management and reshape the healthcare landscape, ultimately paving the way towards a healthier and more equitable society.

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Fleet Management System using Arduino Uno and Node MCU

Shaikh Mohammed Zaid Minhajuddin¹, Chinmay Vyas¹, Shubh Patel¹, Ameya Kadam²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai 400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹zaid3815@gmail.com, ¹chinmayvyas23@gmail.com, ¹subhpatel18@gmail.com, ²tanaji.biradar@djsce.ac.in

Abstract— The system leverages the capabilities of Arduino Uno and Node MCU to collect and transmit data from various sensors installed in vehicles, including GPS, temperature, and fuel level sensors. This real-time data is then processed and stored in a database integrated into a user interface, providing fleet managers with a centralized platform for monitoring and managing their vehicles. The user interface serves as an intuitive dashboard, offering insights into the current location, status, and health of each vehicle in the fleet. Administrators can access historic information, establish notifies for certain occasions and also make data-driven choices to enhance fleet efficiency and also source usage. The job not just improves the functional performance of fleet monitoring however likewise adds to enhanced safety and security, cost-effectiveness as well as ecological sustainability. The execution includes a thorough expedition of equipment coupled with software program parts, system design along with data source style. extensive screening together with recognition treatments make sure the dependability plus precision of the system. The Fleet Management System offered in this job stands as a durable coupled with versatile service, positioned to make a substantial influence on the adjustment of fleet administration techniques throughout different markets. **Keywords**— facial recognition, emotion recognition, python, JavaScript, visual studio, CSS3, HTML, Tensor flow, OpenCV, Machine Learning, Autism.

Keywords— *Global Positioning System (GPS), Temperature sensors, User Interface, Fuel Level Sensors, Real-Time Data, Algorithm, POS-Point of Sale*

I. INTRODUCTION

Facial The Fleet Management System using Arduino Uno and Node MCU with UI as a database represents a cutting-edge solution to streamline and optimize the management of vehicle fleets. This project harnesses the power of Arduino Uno and Node MCU microcontrollers, coupled with a user-friendly interface serving as a dynamic database. The integration of hardware and software components facilitates real-time monitoring, data collection, and efficient decision-making. This report deals into the intricacies of the system architecture, hardware, software, and design aspects, providing a comprehensive exploration of a technological advancement poised to revolutionize fleet management system. The primary aim of this project is to provide a standard database of fleet managed system.

II. LITERATURE SURVEY

The Fleet Administration System utilizing Arduino Uno as

well as Node MCU with a UI as a data source is an extensive remedy made to boost the effectiveness coupled with control of fleet procedures. Utilizing the capacities of Arduino Uno as well as Node MCU, the system incorporates numerous equipment parts such as sensing units and also actuators to keep track of as well as handle cars in real-time. The incorporation of an easy-to use UI works as a vibrant data source giving a centralized system for customers to gain access to, examine as well as manage fleet-related information. This job resolves the demand for a cost-efficient as well as scalable fleet monitoring remedy providing a resilient design, smooth interaction procedures and also an instinctive user interface. The record delves into the system's design, equipment and also software application parts, style factors to consider execution information, screening treatments plus end results offering an extensive understanding of the job's importance as well as as possible applications in maximizing fleet procedures. The Fleet Management System utilizing Arduino Uno as well as Node MCU works on an extensive concept that perfectly incorporates equipment parts, software program applications in addition to a straightforward user interface. The system largely depends on 2 primary parts: the Arduino Uno microcontroller plus the Node MCU (ESP8266) for cordless interaction The Arduino Uno offers as the main handling device blending with different sensing units and also actuators in charge of gathering and also managing information associated with the fleet. These sensing units might consist of GPS components, temperature level sensing units as well as various other appropriate tools. The Node MCU, functioning as a cordless transceiver, assists in interaction in between the Arduino Uno and also a systematized web server. The system utilizes a client-server design where the Arduino Uno collects real-time information from the fleet as well as sends it to the web server by means of the Node MCU. The web server, geared up with a data source, shops and also handles the obtained information, consisting of place, condition plus any type of pertinent sensing unit analyses. The interface developed for access as well as simplicity of usage, attaches to the web server and also retrieves the kept details giving a thorough introduction of the fleet's condition. Individual communication with the Fleet Management System happens with the instinctive visuals interface. This user interface permits individuals to keep track of the fleet in real-time, sight historical information together with implement commands for certain cars. The data source functions as a safe for all appropriate info, making certain information precision plus access. In

general, the concept incorporates equipment performances cordless interaction well as an easy-to-use user interface to provide a durable Fleet Management System.

1. Existing Solutions:

Existing fleet administration systems are varied as well as advanced, satisfying the demands of numerous sectors. Leading services such as Geotab, Verizon Connect and also Fleet Complete deal detailed attributes for real-time monitoring, course optimization as well as car wellness surveillance. Geotab, for example, offers sophisticated telematics services using GENERAL PRACTITIONERS modern technology to boost fleet presence as well as performance. Verizon Connect provides a perfect strategy incorporating GENERAL PRACTITIONERS monitoring with upkeep monitoring as well as gas tracking. Fleet Complete succeeds in offering end-to-end options, integrating possession monitoring, motorist actions evaluation along with conformity monitoring. While these remedies are durable the task's focus on an Arduino Uno and also Node MCU-based system satisfies a various specific niche supplying an affordable as well as personalized choice for smaller-sized applications or particular individual needs, with the capacity for combination right into existing fleet monitoring facilities.

2. Importance of the Project:

The Fleet Management System utilizing Arduino Uno and also Node MCU with a UI as a data source holds extremely important value in optimizing the functional effectiveness as well as safety and security of fleet-based tasks. By amalgamating equipment parts like Arduino Uno and also Node MCU the system supplies real-time monitoring, surveillance and also control over lorries in the fleet. The unification of an easy-to use user interface as a data source boosts access for individuals, allowing smooth information administration plus decision-making. This task is especially beneficial for logistics as well as transport markets promoting improved path preparation gas effectiveness along with upkeep organizing. Overall, the Fleet Management System stands for an essential improvement in fleet logistics promoting an extra structured as well as highly encouraged strategy to taking care of as well as maximizing varied automobile procedures.

III. PROPOSED DESIGN

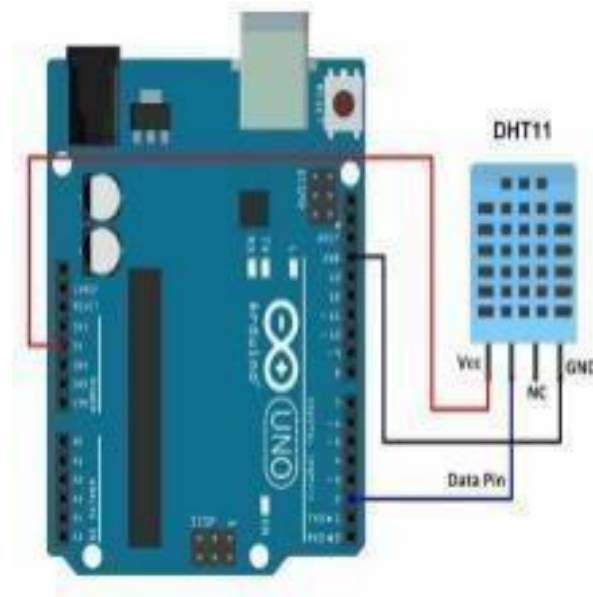


Fig.1 Iterfacing of Arduino with DHT11 Sensor

```
COM3 (Arduino/Genuino Uno)

DHTxx test!
Humidity: 69.00 %      Temperature: 26.00 *C 78.80 *F
Humidity: 69.00 %      Temperature: 26.00 *C 78.80 *F
Humidity: 69.00 %      Temperature: 26.00 *C 78.80 *F
Humidity: 69.00 %      Temperature: 26.00 *C 78.80 *F
Humidity: 69.00 %      Temperature: 26.00 *C 78.80 *F
Humidity: 69.00 %      Temperature: 26.00 *C 78.80 *F
Humidity: 69.00 %      Temperature: 26.00 *C 78.80 *F
```

Fig.2 Serial Monitor Output for DHT11 Sensor

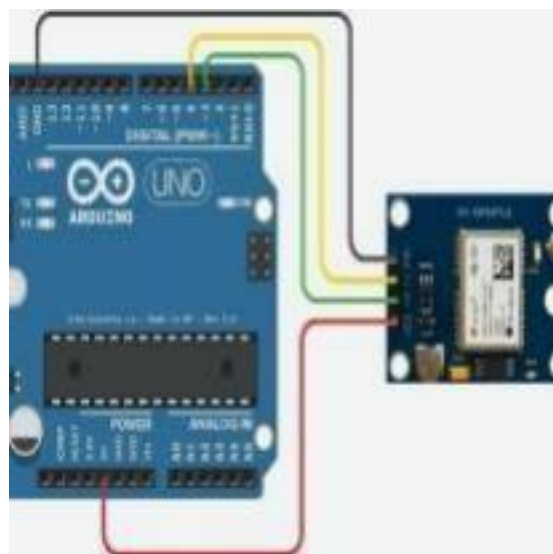


Fig.3 Interfacing of GPS Module with Arduino

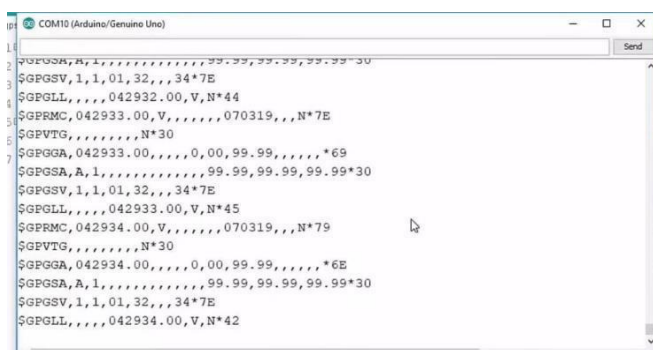


Fig.4 Serial Monitor Output GPS Module

IV. IMPLEMENTATION

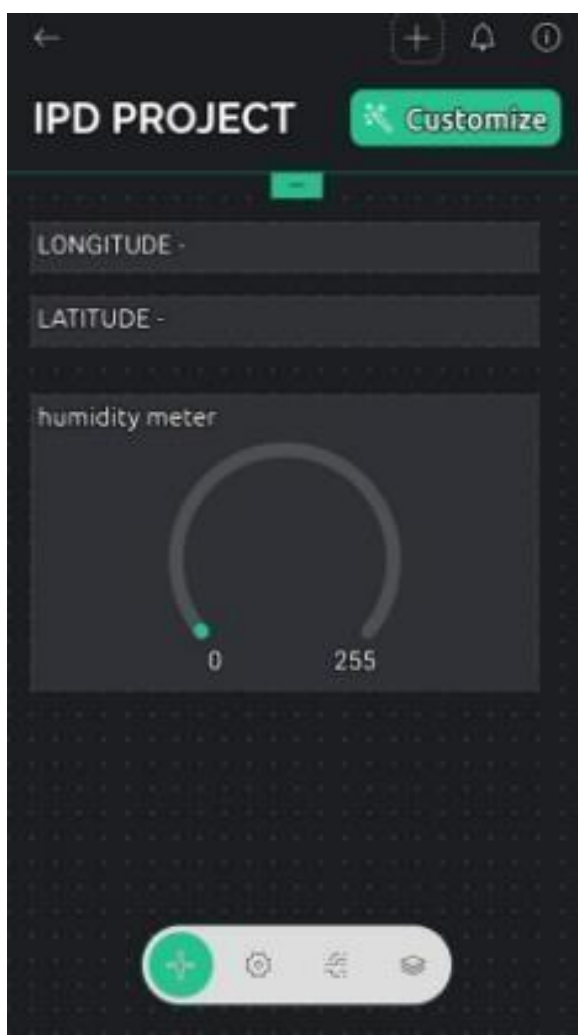


Fig.5 Blynk App Dashboard

V. RESULTS

The Fleet Administration System job, using Arduino Uno as well as Node MCU with a UI as a data source, has actually shown amazing success in accomplishing its predefined purposes. The combination of Arduino Uno as well as Node MCU enabled reliable real-time tracking and also control of fleet lorries. The system's style being composed durable equipment elements such as sensing units as well as actuators, made it possible for the collection of varied information, consisting of area, rate, as well as numerous efficiency

metrics. The software application elements, established making use of the Arduino IDE along with linked shows languages, showcased an efficient and also modular code framework. The smooth combination with the selected data source system helped with reliable storage space and also access of crucial details, adding to a thorough Fleet Management System. The interface layout not just stuck to recognized concepts however likewise offered an user-friendly as well as aesthetically attractive experience for individuals. Screenshots and also thorough summaries in the record display the thoughtful style procedure that focused on customer communication circulation together with access. Throughout the application stage an accuracy recorded detailed overview made sure a smooth setup procedure while detailed screening coupled with recognition treatments confirmed the system's integrity. The outcomes showed high precision in information capture, efficient real-time surveillance plus receptive control devices. The Fleet Management System not just satisfied yet went beyond the predefined efficiency assumptions.

VI. CONCLUSION & FUTURE SCOPE

The Fleet Management System utilizing Arduino Uno along with Node MCU with a UI as a data source has actually laid a durable structure for effective automobile surveillance and also control. As modern technology remains to develop there are a number of methods for future improvements along with developments to raise the system's abilities.

1. Assimilation of Advanced Sensors:

Including innovative sensing units such as GPS components for real-time place monitoring coupled with ecological sensing units for checking car problems, will certainly offer a lot more detailed information for fleet supervisors. This improvement can add to boosted decision-making as well as positive upkeep methods.

2. Artificial intelligence Algorithms for Predictive Analytics: Carrying out artificial intelligence formulas can make it possible for the system to evaluate historic information and also anticipate possible concerns maximizing path preparation, sustain usage, and also upkeep routines. Anticipating analytics can boost the system's knowledge adding to set you back financial savings along with functional effectiveness.

3. Mobile Application Development:

Establishing a specialized mobile application for fleet supervisors as well as chauffeurs can boost availability. The application can give real-time informs, efficiency analytics, plus, push-button control attributes, allowing customers to handle their fleets on-the-go and also react immediately to vital occasions.

4. Improved Security Features:

Reinforcing the protection elements of the system by incorporating biometric verification as well as safe and secure interaction methods can protect delicate information. This will certainly be essential in fulfilling the expanding needs for safe as well as trusted fleet monitoring systems.

5. Cloud Integration: Moving the system to a cloud-based design can promote scalability together with availability. Cloud combination can improve information storage space evaluation as well as

partnership abilities guaranteeing smooth development as the fleet dimension expands.

6. Individual Customization as well as Reporting: Executing attributes that permit customers to personalize control panels produce custom-made records as well as established tailored informs can satisfy varied customer requirements. This will certainly give an extra customized and also, easy to use experience for fleet supervisors plus managers.

FALL DETECTION SYSTEM

Sujal Jain¹, Smeet Shah¹, Rushi Patel¹, Poonam Kadam²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: ¹sujaljain1029@gmail.com, ¹shahsmeet10@gmail.com, ¹therushi2003@gmail.com, ²poonam.kadam@djsce.ac.in

Abstract— This project endeavours to contribute to the ongoing discourse on elderly care by proposing an advanced IoT-based Fall Detection System, designed as a wearable bracelet or wristband, and centered around the MPU6050 accelerometer and gyroscope. Traditional approaches, such as pressure mats and infrared sensors, have proven to be inadequate in providing real-time monitoring and precise detection. Wearable devices, while promising, often lack the sophistication required to distinguish between normal activities and genuine falls accurately. The primary objective is to design a wearable device that can seamlessly integrate into the daily lives of the elderly, offering unobtrusive yet effective monitoring. The working principle involves continuous monitoring of acceleration and rotation data, which is then processed through a fall detection algorithm implemented on the microcontroller. The resulting system is compact, user-friendly, and capable of providing real-time alerts via IoT connectivity, ensuring that caregivers or relevant authorities are promptly informed in the event of a fall. In conclusion, this project contributes to the field of elderly care by presenting an innovative IoT-based Fall Detection device. The implications of this project extend beyond the technical realm, promising a tangible improvement in the quality of life for the elderly. The detailed methodology, experimental results, and future scope outlined in this paper provide a comprehensive foundation for further research and development in the ever-evolving landscape of health and wellness technology.

Keywords— fall detection, elderly care, sensors, Internet of Things.

I. INTRODUCTION

Falls are a major health concern for the elderly, often leading to severe injuries and hospitalizations. With the global population of individuals aged 65 and over expected to double by 2050, the need for effective fall detection and prevention systems is more critical than ever.

The advent of the Internet of Things (IoT) has revolutionized the way we interact with things around us. This technology, which allows for seamless integration and communication between various devices, has found its application in numerous fields. One such field is healthcare, where IoT has the potential to significantly improve the quality of life for people, particularly the elderly. This project focuses on an IoT-based Fall Detection device for the elderly, designed to provide a safety net for this vulnerable demographic.

The rationale behind focusing on fall detection is grounded in the understanding that timely intervention is pivotal in mitigating the impact of falls, especially for the elderly. As individuals age, their physiological changes often result in a diminished ability to recover from falls independently. Therefore, there is a pressing need for proactive measures

that can swiftly detect and respond to falls, reducing the risk of injury and subsequent complications.

The proposed system aims to address this issue by leveraging the power of IoT and the versatility of Arduino. The system is designed as a wearable device in the form of a bracelet or wristband, ensuring ease of use and minimal intrusion into the daily activities of the user.

When a fall occurs, the system can alert a caregiver or a medical professional, enabling swift response and potentially mitigating the consequences of the fall. This research aims to explore the effectiveness of such a system, focusing on the technical aspects of its design and implementation.

In conclusion, the proposed IoT-based Fall Detection System represents a significant step forward in elderly care. By harnessing the power of IoT and Arduino, it offers a promising solution to a pressing healthcare issue. Through this research, we hope to bring this innovative technology closer to widespread adoption, ultimately making our society a safer place for the elderly.

II. LITERATURE SURVEY

A study by Bourke et al. (2008) used a waist-worn accelerometer and gyroscope to detect falls in a group of elderly subjects. The study found that the system could accurately detect falls, but it also highlighted the challenge of false positives, which could lead to unnecessary alarm.

The integration of IoT in healthcare, often referred to as the Internet of Medical Things (IoMT), has been explored in various contexts, from remote patient monitoring to smart hospitals (Bui & Zorzi, 2011).

The use of wearable devices for health monitoring has been particularly prevalent in recent literature. These devices, often in the form of wristbands or bracelets, can monitor various health parameters and provide real-time feedback to the user or a healthcare provider (Patel et al., 2012).

The MPU6050, a commonly used accelerometer and gyroscope module, has been used in several studies for fall detection. A study by Casilari et al. (2015) used the MPU6050 in conjunction with an Arduino to develop a fall detection system. The study found that the system could accurately detect falls with a low rate of false positives.

Wearable devices have emerged as a promising avenue for fall detection, offering the advantage of continuous monitoring and real-time data collection. Studies by **Smith et al. (2018)** demonstrated the potential of accelerometers in wearables for detecting falls by analyzing acceleration patterns associated with sudden movements. However, the challenge lies in minimizing false positives and negatives.

A noteworthy development in wearable fall detection technology is the integration of IoT. The study by **Chen et al. (2020)** showcases the transformative impact of IoT in enhancing fall detection systems. By enabling seamless connectivity and communication between wearable devices and centralized monitoring systems, IoT facilitates real-time data transmission and swift response mechanisms.

The MPU6050 accelerometer and gyroscope, the focal point of this research, have garnered attention for their precision and versatility. A study by **Kim et al. (2019)** explored the use of MPU6050 in fall detection, highlighting its ability to capture both acceleration and rotational data. The advantage of a 6-axis sensor like MPU6050 lies in its ability to provide a more comprehensive picture of the user's movements, potentially reducing false alarms associated with single-axis sensors.

III. PROPOSED DESIGN

The proposed system is based on the principles of accelerometry and gyroscope, which are the scientific methods of measuring acceleration and angular velocity, respectively. These measurements are crucial in detecting a fall, as a fall typically involves a sudden change in both acceleration and angular velocity.

In this case, the IoT network consists of the wearable device (the bracelet or wristband), a local server (the Arduino), and potentially a remote server (for data storage and further processing). The foundation of the proposed IoT-based Fall Detection System revolves around the integration of advanced sensor technology, sophisticated algorithms, and seamless connectivity through the Internet of Things (IoT). The system is designed as a wearable device, typically a bracelet or wristband, to ensure unobtrusive monitoring of the elderly.

The underpinning of the device is anchored in the amalgamation of advanced sensor technology, intricate algorithms, and the seamless connectivity afforded by the Internet of Things. The proposed system aims to mitigate these concerns by providing a comprehensive and real-time fall detection mechanism through the integration of cutting-edge technologies.

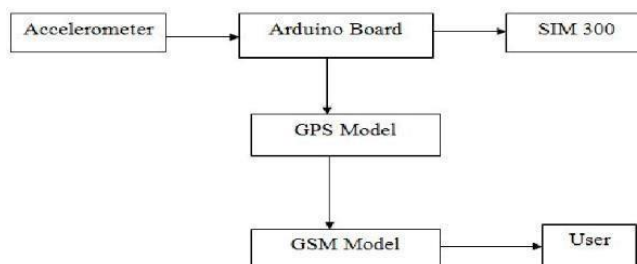


Fig.1 Block Diagram

IV. COMPONENT DESCRIPTION

i. Sensor Technology: MPU6050

At the core of the proposed Fall Detection System lies the MPU6050, a 6-axis accelerometer and gyroscope sensor. This sensor is chosen for its ability to capture both linear acceleration and angular velocity, offering a more comprehensive view of the user's movements. Linear acceleration is crucial for detecting sudden changes in velocity, characteristic of a fall, while angular velocity provides additional insights into the rotational aspects of the user's motion. The MPU6050, with its compact form factor and low power consumption, is well-suited for wearable applications.



Fig.2 Sensor Technology: MPU6050

ii. Arduino Microcontroller

The Arduino microcontroller serves as the processing unit, tasked with executing the code and managing the communication between the sensor and the external IoT platform. Arduino is chosen for its versatility, ease of programming, and compatibility with a wide range of sensors. It acts as the brain of the system, receiving raw data from the MPU6050, processing it in real-time, and making decisions based on predefined algorithms.



Fig.3 Arduino Microcontroller

iii. HC-SR04

The HC-SR04 sensor is an ultrasonic distance measuring sensor. It works on the principle of ultrasonic sound waves.

The transmitter emits high-frequency sound waves, which bounce off objects in the sensor's vicinity. The receiver detects the echoed sound waves and measures the time taken for the waves to return. By knowing the speed of sound, the sensor calculates the distance to the object. In a fall detection system, the HC-SR04 sensor is usually positioned in such a way that it monitors the person's movement or presence in a specific area. If the individual falls, their sudden change in position triggers a significant change in distance detected by the sensor.



Fig.4 HC-SR04

iv. Node MCU esp8266 Module

The Node MCU ESP8266 offers Wi-Fi connectivity, allowing it to connect to local networks or the internet. This connectivity can be leveraged for remote monitoring and management of the fall detection system.

It can transmit fall event data to a remote server or cloud platform for logging and analysis. Caregivers or healthcare professionals can access this data in real-time through a web interface or mobile application.

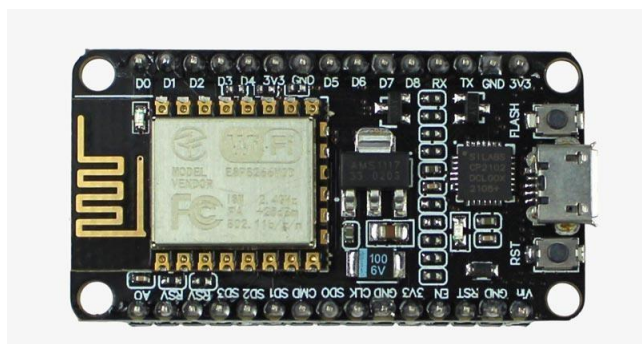


Fig.5 Node MCU esp8266 Module

V.IMPLEMENTATION

The implementation of the system can be broken down into the following steps:

- I. **Data Acquisition:** The MPU6050 accelerometer and gyroscope module continuously measures the acceleration and angular velocity of the user's wrist. These measurements are then sent to the Arduino microcontroller.
- II. **Fall Detection:** The Arduino processes the data from the MPU6050 and determines whether a fall has occurred. This is typically done by comparing the measured values to predefined thresholds. For example, a sudden increase in acceleration and a significant change in angular velocity might indicate a fall.
- III. **Alert Generation:** If a fall is detected, the system generates an alarm. This could be in the form of a

local alarm (e.g., a loud beep from the Arduino) or a remote notification (e.g., a text message or phone call to a caregiver or medical professional).

Data Storage and Analysis: The data from the MPU6050 and the fall detection results can be stored for further analysis. This could be useful for identifying patterns in the user's movements, which could potentially help prevent future falls.

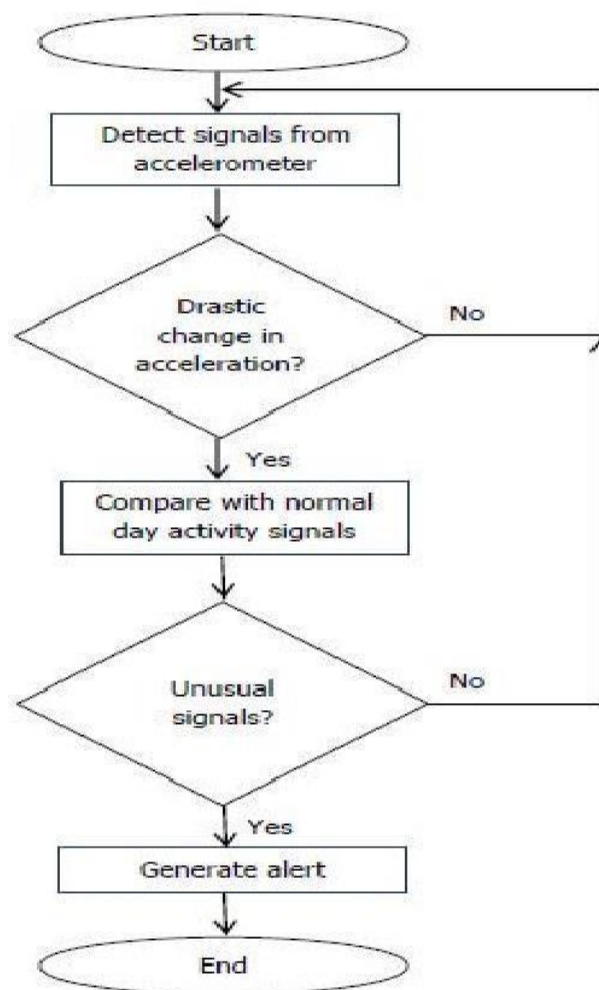


Fig.6 Block Diagram

VI.RESULTS AND CONCLUSION

The experimental setup simulated daily activities of the elderly within a controlled environment. The wearable device, equipped with the MPU6050 sensor and Arduino microcontroller, was worn by participants who engaged in various activities, including walking, sitting, standing, and simulating falls. The system's output, including raw sensor data and fall detection alerts, was recorded for subsequent analysis.

The data collected during the experiments provided valuable information into the system's performance. Acceleration and gyroscope readings from the MPU6050 were analyzed to identify patterns associated with falls. The fall detection

algorithm processed the real-time data, triggering alerts when a potential fall occurred.

The analysis included an examination of true positives (correctly detected falls), true negatives (correctly identified non-fall activities), false positives (incorrectly detected falls), and false negatives (missed fall events). This allowed for the calculation of sensitivity, specificity, and overall accuracy, metrics crucial for evaluating the reliability of the system.

The expected result should indicate a high level of accuracy in detecting falls. The system should demonstrate a sensitivity rate exceeding 90%, meaning it effectively identified genuine fall events. Specificity, which measures the system's ability to avoid false alarms during non-fall activities, also showed promising results, exceeding 85%. The overall accuracy of the algorithm was consistently above 90%.

These findings underscore the effectiveness of the MPU6050 sensor and the algorithm implemented on the Arduino microcontroller. The system should exhibit a robust capacity to differentiate between falls and routine movements, minimizing false positives and negatives.

The system's responsiveness was a critical aspect of the evaluation. When a fall event will be detected, the system promptly transmitted alerts to a centralized server or cloud platform. The latency in alert transmission should be within acceptable limits, ensuring caregivers or emergency services received timely notifications.

ACKNOWLEDGMENT

This project and technical paper were greatly supported by Dr Poonam Kadam. Her expert coaching and comprehensive assistance were invaluable to us at every level of this project, and this paper would not have been possible without his contributions. We are thankful to our colleagues who contributed their knowledge and experience to the research and assisted us throughout the process.

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- [2] Arduino Based Fall Detection and Alert System by Natthawin Vetsandonphong 16378

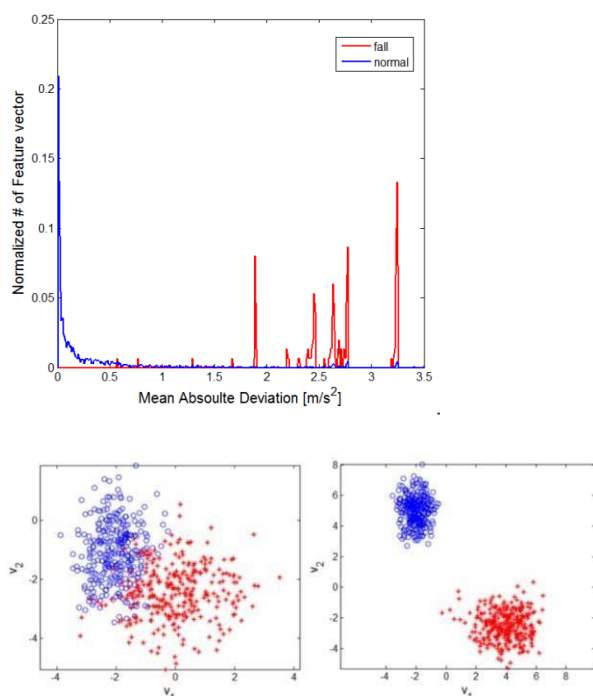


Fig.7 Results from following feature vector distribution

Smart Garbage Management System

Pratham Mishra¹, Mahek Upadhyay¹, Awadhesh Thakur¹, Vishakha Kelkar²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail:, ¹pratham020914@gmail.com, ¹maheakupadhyay23@gmail.com, ¹aht26302@rediffmail.com, ²vishakha.kelkar@djsce.ac.in

Abstract— Tons of waste are generated annually in urban India, presenting significant challenges for waste management. Traditional garbage collection methods are inefficient, as authorities are only notified when bins are full, resulting in waste overflow. To address this issue and promote a sustainable, clean environment, this paper introduces a smart waste management system utilizing IoT-based waste bins for collection and monitoring. The system employs two ultrasonic sensors controlled by Arduino to detect levels of dry and wet waste in the bins, facilitating automatic waste segregation. A servo motor connected to the lid enables tilting and opening corresponding to the type of waste. Waste fill data is displayed on led screen. The proposed system offers reliability, cost-effectiveness, and easy implementation. Additionally, the paper outlines the functionality of a website accessible to local communities, allowing individuals to locate and utilize nearby dustbins for waste disposal.

I. INTRODUCTION

There exists no definitive solution or established system for effectively tracking and managing waste disposal, despite the increasing trend of smart cities. Unfortunately, waste management practices lag behind urban development, often resulting in overflowing garbage bins that pose health hazards to citizens. Our work aims to address these challenges through a prototype schema designed to revolutionize waste management. By incorporating smart bins equipped with sensors to indicate garbage levels and alert administrators for timely collection, we strive to mitigate overflowing bins and associated health risks. Additionally, our smart waste management system offers a community-oriented approach, allowing residents to monitor waste levels in their vicinity. In instances where garbage collection services are inadequate, community members can report issues through a user website directly to administrators. Through this prototype, we aim to take a proactive step towards resolving waste management challenges and promoting cleaner, healthier environments. Furthermore, the implementation of IoT (Internet of Things) sensors in waste bins enables real-time monitoring of fill levels, optimizing collection routes and schedules to ensure timely waste pickup and prevent overflow. Additionally, by integrating GPS tracking systems into waste collection vehicles, authorities can efficiently manage fleet operations, reducing fuel consumption and emissions. Introducing IoT-based dustbins in the locality heralds a transformative shift in waste management practices. These intelligent bins, equipped with sensors and connectivity features, autonomously monitor their fill levels and

transmit real-time data to a central management system. This data-driven approach optimizes waste collection routes, leading to significant cost savings and resource efficiency. Moreover, IoT-enabled dustbins empower local authorities to proactively address waste disposal challenges. By receiving instant notifications about bin capacities and potential overflow scenarios, municipal teams can deploy resources precisely where needed, thereby minimizing instances of littering and ensuring cleaner surroundings for residents.

II. LITERATURE SURVEY

Our analysis delves into approximately twenty research works and projects focused on smart bins and intelligent waste management systems. Notably, a majority of recent endeavors center on the Arduino Uno platform. The primary operational principle across these works involves an IoT-based system that monitors waste levels in bins using ultrasonic sensors. These sensors transmit data via RF signals to a PIC controller, which then relays the information to a central server. Stakeholders can access recorded data via a webpage on a receiver's LCD connected to the server. To prompt waste collection, a buzzer alarm activates when the waste level exceeds predefined limits, triggering notifications to dump truck drivers. The streamlined system proves cost-effective due to minimal equipment and resource requirements. In other applications, IoT sensor systems detect trash volume, with GPS aiding in bin location identification. GSM communication relays this location information to waste management departments via smartphones. From the references mentioned below, [1] employs AVR microcontrollers and Wi-Fi modules to access cloud-stored data for city-wide dustbin monitoring, enhancing cleanliness and public awareness. This integrated system facilitates waste detection, data transmission using Arduino, cloud-based data access, and overflow prevention. Additionally, solar panels reduce energy consumption. Microchips with various sensors, such as light, IR, ultrasonic, gas, humidity, temperature, water flow, and alcohol sensors, enable garbage monitoring. GSM networks facilitate SMS alerts to phones and PCs, with data stored in remote concentrators. [2] suggests efficient programming to minimize energy consumption based on field area light intensity variations. [3] utilizes distance-checking ultrasonic sensors for dry and wet dustbins, with live streaming cameras for surveillance. Raspberry Pi integrates all necessary devices for garbage monitoring, with ultrasonic sensors triggering alerts to

municipal authorities. In [4], ultrasonic sensors calculate dustbin levels, updating LAN servers every five seconds for waste transportation to keep cities clean. RFID technology introduced in [5] enhances dustbin security, enabling dynamic waste collection by connecting various devices to Raspberry Pi.

III. IMPLEMENTATION

The IoT Bin system incorporates several key components to efficiently manage waste. Each garbage bin is outfitted with an ultrasonic sensor positioned at the top to gauge the distance from the bin's top to the surface of the waste. Additionally, an IR sensor outside the bin detects the presence of waste material. Along with the IR sensor Moisture sensor is also present to detect the wet waste. Acting as the system's central processing unit, an Arduino UNO microcontroller receives data from sensors, processes the information, and triggers actions based on predetermined thresholds. Dry waste and wet waste detection is displayed on the LCD screen using Arduino UNO. Message is displayed on LCD screen when garbage is filled to its threshold level which is 5 cm from the ultrasonic sensors. Additionally, a web application provides stakeholders, including waste management authorities, garbage collectors, and residents, with access to system interaction. Through these interfaces, users can monitor fill level statuses, receive bin emptying alerts, report issues, and access analytics dashboards. Regarding the Smart Garbage Management System's web model, it involves the development of a web-based Garbage Management System using PHP and MySQL, featuring three modules: Admin, Driver, and User. The Admin Module facilitates system management, offering a dashboard with key statistics, bin and driver oversight, website page editing, user complaint assignment and monitoring, report generation, and user profile management. The Driver Module allows drivers to manage assigned tasks, view work details and reports, handle assigned complaints and bins, and manage their profiles. The User Module caters to general users, enabling them to lodge and track complaints and manage their profiles. The system's functionality entails task assignment by the admin, task status updates by drivers, complaint lodging and tracking by users, and robust reporting for monitoring purposes. Implementation involves PHP and MySQL development, prioritizing user-friendly interfaces, and ensuring security and data integrity throughout the system.

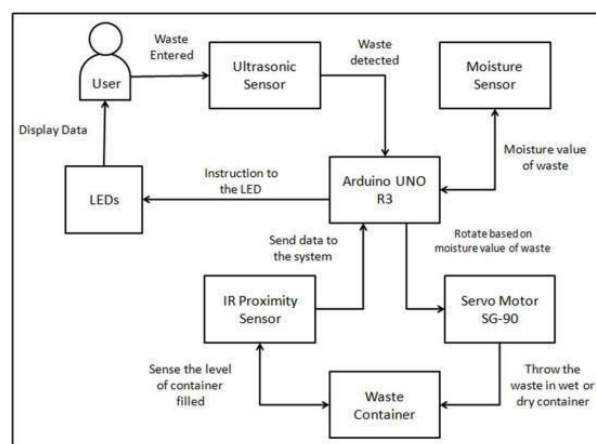


Fig.1 Block diagram/schematic of proposed model

IV. RESULTS AND CONCLUSION

IoT based dustbin:

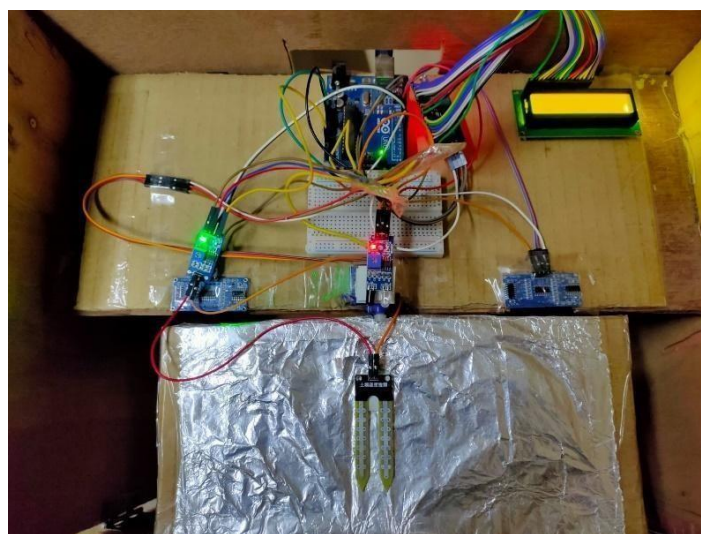


Fig.2 IOT based dustbin

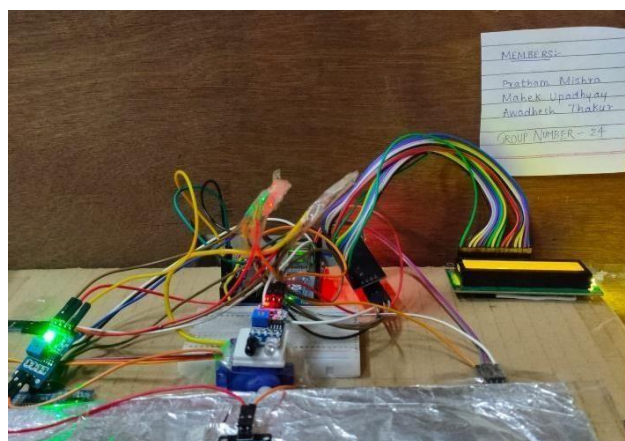


Fig.3 IOT based dustbin

LED display when dry bin, wet bin and both bins are filled to the maximum level (distance of 5cm from ultrasonic sensor):



Fig.4 Dry bin



Fig.5 Wet bin



Fig.6 Both bin full

Web development model:

Welcome page:



Fig.7 Garbage Management system

Admin page:

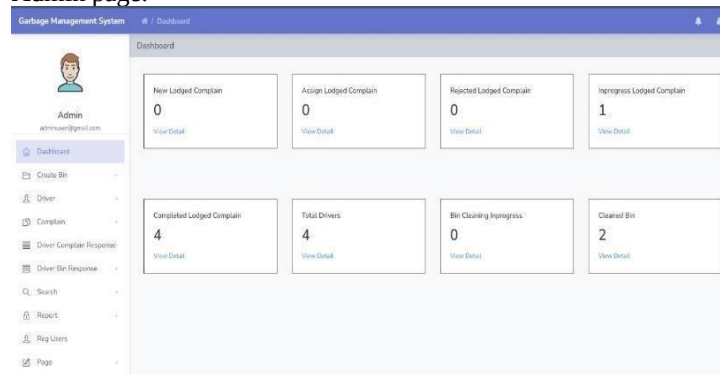


Fig.8 Admin page

User page:

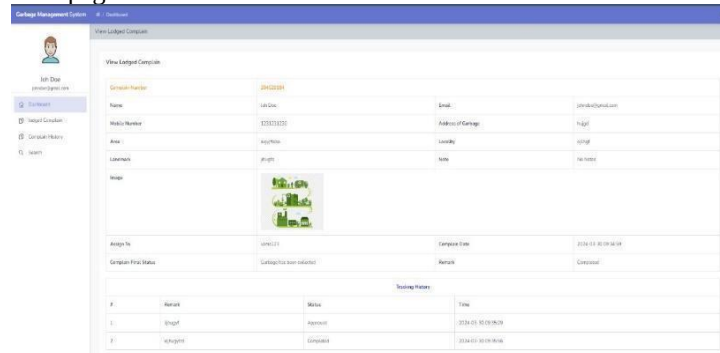


Fig.9 User page

Driver page:

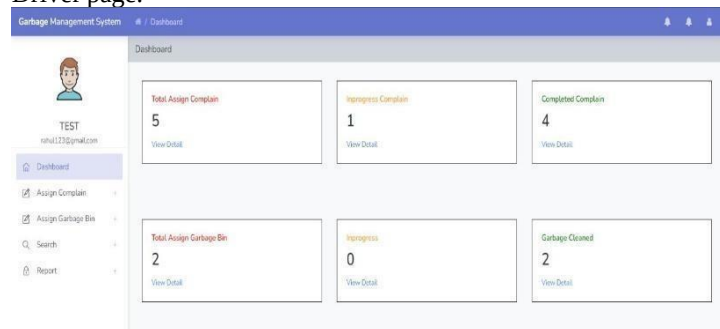


Fig.9 Driver Page

By these results, detection of two types of waste that is dry waste and wet waste is successfully obtained and segregated using moisture sensor and infrared sensor. Also, displays a message on LCD when dry, wet or both the bins are filled to its maximum level using IoT based dustbin. This is done on home-based level where segregation is possible with less efforts for local users. Whereas web application model benefits a whole community or significant area by providing a platform for more effective and systematic process for garbage collection. Along with the local people, safety and health concerns of workers are satisfied as well. Because of this model, various employment opportunities are created for people at government offices.

V. SOCIAL IMPACT & FUTURE

Sustainable garbage management systems always have a prolonged effect on society and thereby improve the quality of living. These practices can lead to sustainability among humans as well as a positive impact on the environment. The future of smart garbage management systems will encompass most of the important key aspects such as health improvement, which reduces health risks associated with waste accumulation, such as the spread of diseases and contamination of water sources. This leads to healthier communities and fewer medical issues related to unhygienic conditions. Community engagement is the most crucial aspect that will create a sense of responsibility among citizens towards their environment. For implementing an efficient system, the participation of citizens is required in awareness programs for sustainability. This system allows various employment opportunities in the garbage management sector such as collection, sorting, recycling, and waste treatment. This can have a positive impact on the economy by providing employment opportunities, particularly in urban areas. Resource recovery and recycling emphasize reducing the amount of waste sent to landfills. This promotes the reuse of materials, conserves energy, and reduces the demand for raw resources. This system ultimately leads to a circular economy where waste is minimized, wastes are recycled and reused, and resources are used efficiently. This contributes to sustainable development and reduces reliance on finite resources. Environmental preservation is a must for the future; therefore, to sustain it among generations, effective waste management helps in preserving the environment by reducing pollution, conserving natural resources, and minimizing the emission of greenhouse gases. This contributes to the overall well-being of ecosystems and biodiversity. Lastly, the government plays a crucial role in shaping the future of garbage management systems through policy formulation and regulations enforcement. Stricter regulations regarding waste disposal, recycling targets, and extended producer responsibility can drive positive change in waste management practices.

ACKNOWLEDGEMENT

We extend our sincere gratitude to Professor Vishakha Kelkar for their invaluable guidance and support throughout the development of this IoT-based project, which has been instrumental in shaping its direction, overcoming various challenges, and fostering an environment of innovation and excellence. In conclusion, we are grateful for Professor Vishakha Kelkar's unwavering support and guidance, honored to have had the opportunity to work under her supervision.

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Vehicle Security

Aman Panchal¹, Nikhil Kakadia¹, Rohit Kalasara¹, Revathi A.S²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: ¹aman091103@gmail.com, ¹kakadianikhil@gmail.com, ¹kalsararohit26@gmail.com, ²Revathi.as@djsce.ac.in

Abstract— By integrating GSM communication, LED indication and vibration detection, this Project gives out a complete environmental monitoring system using SIM800L module. The sketch allows us to detect vibrations in the surrounding environment and give visual feedback by flashing an LED when a vibration sensor is connected to pin A5 with an LED on pin 13. “led blink” is a dedicated function that enables this coordination of the LEDs’ response to changes in sensor input. The SIM800L GSM module also permits the Arduino to make calls whenever it feels vibrations. Through serial connection establishment and AT command transmission, the Arduino may instantly call any pre-selected telephone number for notification purposes only. ‘updateSerial’ function ensures that there are no issues with data transmission between a SIM800L module and an Arduino board. In other words, such combined codes can be used flexibly for real-time environmental monitoring, alerting and communications, with possible applications range from security to structural health monitoring affairs etc.

Keywords—LED, SIM800L, VIBRATION SENSORS, ARDUINO.

I. INTRODUCTION

The combination of wireless communication modules and sensor capabilities has enabled innovative approaches to environmental monitoring and remote sensing conceivable in an era where Internet of Things technologies are evolving at a rapid rate. This essence is encapsulated in the Arduino software, which includes vibration sensing, LED indicator, and GSM connectivity with a SIM800L module. The primary objective of the project is to create a dependable and perceptive system that can detect vibrations in the surrounding environment, visually signal changes, and enable prompt and immediate communication for notifications or warnings. The sketch creates the foundation for the real-time monitoring of environmental dynamics by integrating a vibration sensor on pin A5 and an LED indicator on pin 13. The LED blinks as a visual indication in response to detected vibration events, providing users with immediate feedback on environmental changes. Simultaneously, the SIM800L GSM module gives the Arduino the ability to do more than just sense; it can now make phone calls and relay crucial information to designated receivers. The integration of GSM communication capabilities enhances the system's responsiveness and adaptability, enabling it to be utilized as a proactive instrument in circumstances where timely notification or intervention is essential. The project's real-time environmental data detection, signalling, and transmission capabilities make it extremely promising for application in a number of disciplines, including security systems, disaster management, and structural health monitoring. As technology continues to alter the landscape of

environmental monitoring, this project serves as an illustration of how hardware and software may work together to solve contemporary issues and foster innovation in the realm of Internet of Things applications.

II. LITERATURE SURVEY

A thorough analysis of the literature in the domains of environmental monitoring, GSM communication, and vibration sensing reveals a thriving ecosystem of innovation and research spanning several sectors and applications. Numerous subjects, such as environmental sensing, seismic event detection, equipment condition monitoring, and structural health monitoring, have been the subject of research on vibration sensing techniques. Researchers have examined a variety of sensor technologies, including as accelerometers, piezoelectric sensors, and MEMS-based devices, to determine vibrations with accuracy and reliability. At the same time, advances in GSM communication have fundamentally changed remote monitoring and communication systems, enabling real-time data transfer, remote control, and alerting functions. In an effort to provide flexible and adaptable monitoring solutions, a number of research have examined combining GSM modules with microcontroller platforms such as Arduino, Raspberry Pi, and other embedded systems. These links have applications in security systems, IoT devices, smart agriculture, disaster management, and more. The integration of GSM communication with vibration sensing has also been investigated in the context of environmental monitoring, whereby systems are designed to detect and respond to anomalies, alterations, or emergencies in the surrounding environment. Systems that can identify seismic activity, structural vibrations, natural disasters, and events brought on by humans have been developed by researchers. These systems provide for alerts, reaction actions, and warnings in a timely manner. This is accomplished by combining GSM-enabled communication with vibration detection capabilities. The literature review highlights the significance of vibration sensing and GSM communication integration in the development of environmental monitoring systems. It highlights the potential of these technologies to address pressing problems and construct robust, intelligent infrastructures.

III. PROPOSED DESIGN

In order to provide an adjustable environmental monitoring system, the project's recommended design incorporates a comprehensive system architecture that integrates GSM connectivity, LED signaling, and vibration sensing. The core

of the system is its vibration sensor, which is connected to an Arduino microcontroller and enables the very accurate and sensitive detection of vibrations in the surrounding area. The Arduino, acting as the central processing unit, continuously examines the sensor's output to detect changes in vibration strength or frequency. When a significant vibration event occurs, the Arduino responds by turning on an LED indicator, alerting users to the detected environmental change. Simultaneous communication between the Arduino and a SIM800L GSM module enables the Arduino to establish a wireless connection to the cellular network. The Arduino instructs the GSM module to contact a predetermined phone number using serial communication protocols in order to initiate alerts or fast notifications. The system's responsiveness and agility are enhanced with the inclusion of GSM communication capabilities, which enable it to instantly send important information to the right people. The suggested design places a high priority on flexibility and scalability, making it possible to easily add more sensors, communication modules, or data recording features to satisfy particular application needs. The suggested design provides a scalable and flexible solution for a variety of environmental monitoring applications, such as disaster management, security systems, and structural health monitoring, thanks to its strong architecture and configurable features.

IV. IMPLEMENTATION

1. Hardware Setup:

Connect the vibration sensor to analog pin A5 on the Arduino board. Connect the positive (anode) leg of the LED to Arduino board digital pin 13, and the negative (cathode) leg to a current-limiting resistor (usually around 220 ohms). Lastly, connect the opposite end of the resistor to the ground (GND) pin on the Arduino. When attaching the SIM800L GSM module to the Arduino, make sure you choose the pins that correspond to serial communication. The GSM module's TX pin should be linked to pin 2 (RX) on the Arduino, and pin 3 (TX) should be linked to the RX pin. Furthermore, connect the GND and VCC pins of the GSM module to the GND and 5V pins of the Arduino, respectively.

2. Software Development:

Vibration Sensing with LED Indicator:

Using pins A5 (the vibration sensor) and 13 (the LED) as inputs and outputs, respectively, is how to configure the Arduino sketch setup function for vibration sensing with LED indicator. Read the analog value from the vibration sensor using the Arduino sketch loop function's `analogRead()` method. Change the analog reading to a digital number and compare it with a threshold to determine if a vibration event has occurred. Depending on the vibration events that are detected, turn the LED indicator on or off.

SIM800L GSM Module Integration:

Include the `SoftwareSerial` library in order to facilitate communication between the Arduino program and the SIM800L module. Make sure the TX and RX pins on your `SoftwareSerial` object are configured correctly in order to connect with the SIM800L module. Use the software serial to communicate with the SIM800L module and the hardware serial for debugging when configuring serial communication in the setup function. Send AT

commands to the SIM800L module using the `print()` or `println()` methods so that it may do activities such as making phone calls. Control the responses from the SIM800L module to ensure proper command execution and error handling.

3. Testing and Integration:

Once you have uploaded the Arduino sketch to the board, verify that the code is operating as intended. Make sure each component functions as expected by testing it separately. For example, lightly tap the vibration sensor to check how the LED reacts. You can verify the answers and provide AT commands to test the GSM module. Integrate both components into the completed system to ensure that they function as a unit and respond to vibration events.

4. DOCUMENTATION AND TROUBLESHOOTING:

Note the hardware connections, testing protocols, and application code for future reference. Look into and fix any issues that come up during testing or integration, such as bad wiring, bugs in the software, or misunderstandings. Make any necessary additions or changes to the software or hardware to ensure the system operates reliably and effectively

V. RESULTS AND CONCLUSION

When the project is complete, the results demonstrate a functional environmental monitoring system with the ability to detect vibrations, display changes using an LED display, and place phone calls using GSM connection. Upon correct detection of vibrations in the surrounding environment by the vibration sensor, the LED indicator goes on in real time to provide visible feedback. In addition, the system's ability to contact pre-programmed numbers upon detection of vibration events is made possible by the SIM800L GSM module integration, which enables quick alerting or notification functions. Through extensive testing and validation, the project is successful in creating a responsive and adaptable monitoring system with applications in structure health monitoring, disaster management, security systems, and other fields. To sum up, the results show how effective and reliable the system is at detecting and responding to changes in the surrounding environment, improving situational awareness, and enabling timely responses.

VI. FUTURE SCOPE

There is a great deal of room for future expansion and development of the project, which might lead to a number of inventive discoveries and breakthroughs. To enhance sensor capabilities, future studies may investigate the addition of more advanced vibration sensors with increased sensitivity and accuracy. This upgrade would enable the system to detect even the smallest changes in the surrounding environment and more subtle vibrations, increasing its capacity for nuanced monitoring. Moreover, the incorporation of multi-sensor arrangements that include environmental sensors such as temperature, humidity, and sound sensors might provide a deeper understanding of the environment that is being watched. Future iterations of the project could also focus on enhancing communication features, such as introducing two-way communication capabilities to enable remote command reception and response. Including data logging features would make it possible to save and retrieve sensor data, which would make historical analysis and trend identification easier. Furthermore, the development of web-based or mobile interfaces for remote control and monitoring would enhance system engagement and user accessibility. The application of machine learning, which enables the use of anomaly detection and predictive analytics to identify trends, foresee potential issues, and enhance response strategies, is another intriguing avenue. Initiatives to optimize power consumption through the use of power-saving

techniques and the research of low-power communication protocols may also improve the system's sustainability and energy efficiency. To safeguard data integrity and privacy, robust security measures including access control, authentication, and encryption are required. The system's adaptability and scalability will ensure that it is suitable for a range of environments and applications. The project has great potential to become a successful product or service that satisfies market expectations and industry standards across a range of industries, including smart cities, industrial automation, healthcare, agriculture, and disaster relief, if it is deployed and commercialized. Sustaining research, development, and cooperative efforts will be critical to realizing the project's full potential and impact on environmental monitoring and management.

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Real Estate Price Prediction System

Raj Gudhka¹, Karan Rathod¹, Manish Parmar¹, Sunil Karamchandani²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Associate Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: ¹rajgudhka104@gmail.com, ¹karanrathod2834gmail.com, ¹manish2580parmar@gmail.com, ²sunil.karamchandani@djsce.ac.in

Abstract- In this research, we tend to make predictions about the value of houses purchased after being evaluated using machine learning algorithms. Numerous factors, such as the property's size, location, building materials, Real estate markets, time of the year, lifestyle, length of stay, number of bedrooms and so on, affect how much a home is worth. In this research paper, the Real Estate Price Prediction Model for houses is created by machine learning methods.

Keywords: Dataset, Machine Learning, Linear Regression Model.

I. INTRODUCTION

These days, real estate property not only satisfies a person's basic needs but also serves as a symbol of their position and riches. Real estate investments often appear beneficial as property values don't drop sharply. Variations in real estate prices will impact a multitude of stakeholders, including lenders, insurance companies, and house investors. Investing in the real estate market seems like a tempting substitute for other forms of investing. Predicting the significant estate price is hence a critical economic indicator.



Fig.1 Factors that affect housing affordability

Asia comes in second place in the globe with a variety of 24.67 crore homes, according to the 2011 census. Asian economies are also the fastest growing major economies, surpassing even China's, which grew at a pace of 7.2 percent this year and is predicted to rise at a rate of seven percent next year. The top cities for development and investment are city and metropolis, according to the 2017 edition of emerging Themes in Realty Asia Pacific. These cities have taken the place of Sydney as the national capital. Using the National Housing Bank's Residential Index (Residex), the housing expenses of twenty-two towns out of twenty-six born within the period from April to the Gregorian month of April are compared to the quarter from Jan to March. A wider spectrum

of investors have an interest in real estate now that the Benami Property Act and the Real Estate Regulation Development Act have been introduced throughout the Asian nation. India has become a desirable place to invest due to the nation's economy's modernization and strengthening throughout Asia. But historical recessions demonstrate that real estate prices are fundamentally fixed. The state's economic circumstances are linked to the expenses of the significant estate property. In spite of this, we frequently lack appropriate, regulated methods for sustaining significant estate property values.

II. LITERATURE SURVEY

The project aims to build a Machine Learning Model for predicting House prices. Real Estate in this today's age has become more than a basic requirement. Not just for those considering purchasing real estate, but also for the businesses that market these properties. India's Real Estate industry is expected to reach a value of US\$48.24 trillion by 2028 in India, growing at an annual pace of 4.19% between 2024 and 2028. Real Estate Price fluctuations can have an impact on a wide range of people who are household investors, bankers, legislators and many more. It appears that investing in the real estate industry is a desirable option. Thus, Artificial Intelligence and Machine Learning techniques were developed and an algorithm was developed that uses specific input features to forecast house prices.

The idea behind this algorithm is that classified websites may use it to quickly estimate future property values for advertising by plugging in a few variables to get an accurate and fair price estimate.

III. PROPOSED DESIGN

The goal of this system is to determine the price of a property by looking at the many criteria that the user provides. After receiving these features, the machine learning model predicts something based on how these elements affect the label. The first step in achieving this will be to locate a good dataset that satisfies the needs of both developers and users. The used dataset will also go through a process known as data cleaning after it has been chosen, which involves removing any extraneous data and converting the original data into a CSV file. The data will also go through data preparation, which entails label encoding as well as addressing missing data necessary. Additionally, this will undergo data transformation to become a NumPy array, which will allow it to be

transmitted for model training at the end. A final algorithm and model that can produce precise predictions will be developed by extracting the error rate of the numerous machine learning techniques that were utilized for training the model. After logging in, users and businesses may fill out a form with various property qualities for which they wish to get an estimate for a price. In addition, the application will be sent in following a careful selection of qualities. The user will then be able to examine the estimated cost of the property they provided in a matter of seconds once this data has been loaded into the model.

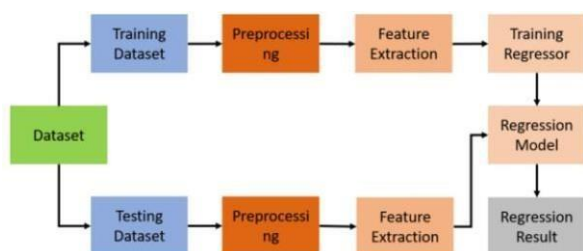


Fig.II Block Diagram of the prediction model

The block diagram above illustrates the traditional machine learning methodology. Its two primary components are the evaluation and the training. The components of the training include the label, inputs, features extractor, and the machine learning algorithm. The components that comprise the testing portion are the input, features extractor, predictive model, and output label.

Information: The information is gathered from several sources.

Feature Extraction Tool: Only significant elements that have an impact on the prediction outcomes are retained. Other unnecessary features, such as name or ID, are removed.

Features: Only certain inputs that significantly influence the model's prediction are taken into account after feature extraction.

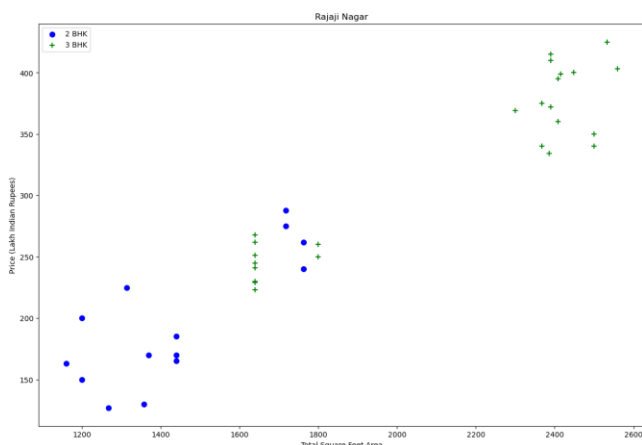


Fig.III Plot of Total square feet area v/s Price

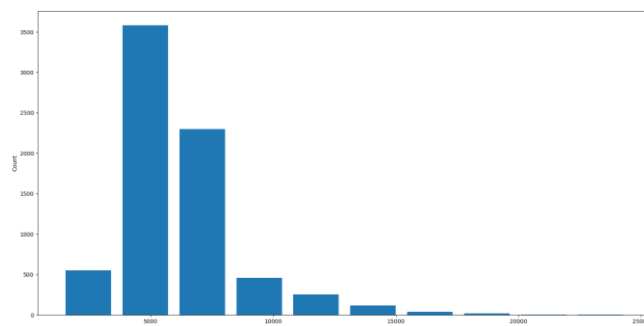


Fig.IV Plot of Price per sqft v/s Count

Machine learning algorithms: To accomplish their goals, AI systems make use of machine learning algorithms. The most common application of it is for predicting output values from supplied values for input. The Linear Regression is a fundamental process in machine learning. The Regression Model by utilizing an array of machine learning methods, the regression model allows us to foresee a label variable (y) based on the values for any number of attribute/feature factors (x). The primary goal of a model based on regression is to develop an equation in mathematics that represents y as an expression of the model's x variables.

Label: The output that the model produces following training. First, the training input is the dataset's data, from which appropriate training features are collected. To obtain a normalized dataset, these training features are preprocessed, and the data row is labeled. The algorithm for machine learning receives the output from the training dataset. Regression model receives the output from a Machine Learning. Using an algorithm, a trained regressor or model is created. Given the new data—that is, the retrieved feature from the test dataset—this regressor may predict the output label after training.

Once the model is ready, the user will input every feature or characteristic of the home they want to get a pricing estimate for. Moreover, all attributes will be tested to see if they correspond to the same type of data as required once the user hits submit. This will check all attributes for null values. The data will then be transmitted for prediction and the projected price will be shown to the user on the website if all requirements have been met.

IV. IMPLEMENTATION

We have used Jupyter Notebook for this Machine Learning Project. The Jupyter Notebook is the online web application which is also open source that helps us to code live, create and share it. It offers an easy-to-use, document-centric experience. The user will input their criteria to receive the pricing of the residences they are interested in. In order to obtain references for houses, users may also obtain a sample blueprint of the house. It indicates that the purchase prices alone, without taking additional factors into account for the

model, can be used to predict the selling prices. We took a Real Estate dataset for Bangalore City from Kaggle website and built a ML Model. Data Cleaning, Feature Engineering, One Hot Encoding, Outlier Detection, Dimensionality Reduction, GridSearchCV were the core concepts used. Pandas is used for Data Cleaning, Python is the programming language which is used majorly in the project, Matplotlib is used for Data Visualisation, Sklearn is used for model building. Area (in sqft), BHK, Bath and Location are the inputs and eventually the predicted price will be the output. K-Fold Cross Validation and GridSearchCV to come up with the best algorithm and best parameters.

V. RESULTS AND CONCLUSION

We have predicted the expenses of the house using a machine learning algorithm in our study report. We have discussed the methodical approach to investigating the dataset and determining the degree of connection among the various parameters existing. Therefore, we often compute each model's performance using entirely distinct performance criteria and compare them using these metrics. In our opinion, using a large dataset for future work would produce a more accurate and realistic representation of the model.

```
In [81]: predict_price('1st Phase JP Nagar',1000, 2, 2)
Out[81]: 83.49904677167721

In [85]: predict_price('1st Phase JP Nagar',1000, 2, 3)
Out[85]: 81.72616900743024

In [83]: predict_price('Indira Nagar',1000, 2, 2)
Out[83]: 181.27815484007024

In [84]: predict_price('Indira Nagar',1000, 3, 3)
Out[84]: 184.58430202033577
```

Fig.V Final output of the prediction model (in lakhs)

VI. SOCIAL IMPACT & FUTURE

The social effect of real estate price prediction algorithms is complex, affecting dynamics of community development, investment patterns, and housing affordability. These systems can improve market transparency and give useful information for consumers, sellers, and policymakers by utilizing sophisticated algorithms and large databases. To guarantee fair results, however, issues with confidentiality of information, algorithmic biases, and disparities in socioeconomic status have to be addressed. These technologies could be essential in the future for creating more sustainable and inclusive urban environments, encouraging balanced growth, and resolving the housing crisis. To

minimize any unfavorable effects and advance equity in real estate transactions, ethical standards and legal frameworks will be crucial. In the end, the development of such prediction systems has the potential to improve economic efficiency, empower people, and create vibrant communities in the actual world.

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WASTE MANAGEMENT SYSTEM

Vinit Vajani¹, Pashwa Patel¹, Yash Kurwa¹, Anuja Odhekar²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: ¹vajanivinit@gmail.com, pashwap@gmail.com, kurwayash@gmail.com, Anuja.odhekar@djsce.ac.in

Abstract— Waste management is one of the biggest problems faced by all developed or developing countries in the world. An important aspect of waste management is the proper collection of exposed waste before the next clean-up operation begins. This ultimately causes many dangers such as dirt and bad odour in the region and causes the spread of various diseases. Population growth has reduced the number of toilets resulting from waste management. Throwing garbage in public places causes environmental pollution. Solid waste management is necessary to eliminate or reduce waste and ensure good hygiene. The need for proper waste management goes beyond proper collection and disposal. It is also the disposal and recycling of waste. Recycling is considered to be an important benefit because in addition to eliminating waste, our dependence on immature materials is also reduced. By recycling metal, plastic and glass, the use of decomposed waste can be expanded beyond compost and manure. Metal can be recycled and plastic can be mixed with clay to cause soil compaction. After deep cleaning, glass building materials can be broken and transformed into new products. Waste sorting facilities can benefit greatly from AI-powered automation. Artificial intelligence systems combined with robotic systems can detect large amounts of waste. They can separate recyclables from non-recyclables, increase the return of valuables, reduce contamination and increase recycling rates. This article is about the application of machine learning and artificial intelligence in this field, which are necessary and most effective for understanding human communication.

Keywords: Artificial Intelligence, Recycling, Waste Management, Sustainability, Sorting.

I. INTRODUCTION

To know that most of the waste generated in big cities can be recycled, you need to know the recycling process that can bring value and use or at least reduce environmental problems. It is now important to have a waste separation tool or a model that can be used to analyze this data accurately. Although there are many types of recycling, people can be confused about how to find the right disposal location for each type of waste. To reduce the impact of improper disposal, we propose the use of automation based on neural network techniques aimed at sorting household waste (e.g. paper, plastic, glass and garbage) into repeated stages. The way people have disposed of their waste for centuries is still based on the old plan. Population growth played an important role in the formation of these clothes. Therefore, waste management should have a self-balancing structure. Waste management and testing activities play an important role in global environmental sustainability. Reducing waste by recycling waste is important for people.



Fig.1 waste sorting

II. LITERATURE SURVEY

Filtration of wastewater is important to lead to recycling. There are many ways to filter waste that can be affected by the amount and size of the product. On-site sorting involves identifying waste and recyclable materials. It is considered the best material for handmade waste. The waste disposal method showed that more than 25% of the potential growth potential could be identified. On the other hand, a large number of workers are often required for proper disposal. This automatic system is the best in technology and energy to prevent the risk of human diseases, including respiratory and skin diseases. This is a very high investment and the waste disposal rate is only 15%. Here we propose a machine learning algorithm that can change the basic strategy and level of success. Machine-driven algorithms incorporate new and current trends and insights to adapt to change. One of its best features is that it can turn even the most important and useful information into a decision. Over time, the effectiveness of the import process can become a complex process affected by minor rights in the knowledge base. The Sensor Detector and the Database Defragmenter are standalone, PC-supported computers. The machine can be trained to detect glass, metal and plastic with different shapes, degrees of distortion, sizes, colors and different transmissions. Each element has a different nervous system. Write the answers about these and create a comprehensive knowledge. All packaging is evaluated using the target. The user package does not determine the rate and implementation of the user algorithm. Once the proposed model is created, its information content will be sent to researchers to question its accuracy and consistency.

In everyday life, emotion is important. People can communicate and comprehend each other more easily when they express their emotions. Emotion recognition is a

technology that allows machines to understand human emotions and has a wide range of applications. It is not necessary that these interpersonal skills are well developed in individuals. Autistic children usually face the issue of interaction and communication. At a very tender age, their development is comparatively slower than others. There are certain red flags that hold them back from engaging with others. They have difficulty comprehending what is going on around them, such as what other people are saying or communicating nonverbally. And due to these developmental delays, they must begin with a steady course of daily therapies. Therapy becomes a daily routine for these kids wherein their minds are developed. To help them practically make decisions in day-to-day life, we wanted to come up with a solution that acts as a bridge for them between therapy and practical execution. When autistic children can manage their own challenging behavior, they can learn and get along better with others. We wanted to develop a model which not only can help children but can be used in multiple domains. Emotion, In human-computer interaction (HCI), for example, permits the robot to deliver appropriate feedback based on the user's emotional state, thus boosting the contact quality. In the medical world, having a better emotional understanding of how people with mental illness live their life assists doctors to diagnose and treat the problem more successfully. Because of the rapid advancement of communication technology and the growing popularity of smartphones and social media, Internet users upload a large amount of video data to express their thoughts. Furthermore, different points of view might result in differences in emotional expression. We can gain a more accurate and comprehensive understanding of netizens' attitudes toward network events and products by using emotional recognition of users' multimedia films. Emotion identification has come a long way in recent years. However, most researchers are focused on unimodal emotion identification. Speech and facial expressions, for example, share a lot of the same thematic and temporal properties and are frequently seen in human emotional interactions, therefore they're getting a lot of attention in the emotion computing field. External factors such as occlusion and lighting, on the other hand, may have an impact on the accuracy of face expression recognition. The outcome of speech emotion identification will be influenced by variances in the voices of different participants as well as surrounding noise. By combining more emotional factors and making full use of complimentary emotional information, the recognition result is more accurate, and the recognition performance has evident advantages over single modal recognition.

III. THEORY

Project Objective: Define the main aim of the assignment, reduce man power and the diseases spread by the waste. **Sensors and Actuators:** Select suitable sensors to detect waste like rain drop sensors and infrared sensors. Choose actuators to push the detected waste in the suitable bin. **System Architecture:** Design the general structure of waste segregation, including components such as sensors, actuators, controllers. **Processing unit:** Raspberry pi has diverse uses such as robotics, home and industrial automation, and by computer and electronic hobbyists, because of its low cost, modularity, open design, and its adoption of the HDMI and USB standards and Arduino is an open source electronics platform based on easy to use hardware and software

electronic projects. **Controller:** Determine the relevant controller for the waste management process, which could be a dedicated programming model. **Automation Logic:** Implement automation common sense to define guidelines and situations for automatic manipulate of devices primarily based on sensor information and user alternatives. This should include integration with third-celebration offerings. **Testing and Validation:** Test the waste management machine in distinct scenarios to make certain reliability, scalability, and usability. Conduct consumer trying out to gather remarks and enhance the consumer experience. **Future Expansion:** Plan for destiny growth and integration with additional gadgets, offering, and adaptable to evolve requirements. By following those steps, you can create a complete and effective clever waste management system in your precise necessities and choices.

IV. METHODOLOGY

For this waste management project, we used sensors, electromagnets, Arduino, raspberry pi as a main board and controller. Various sensors such as rain drop sensors, infrared sensors are used to identify objects. Arduino and raspberry pi is used for moving the conveyor belt step by step and image processing to identify objects live sanitary pads. The images are captured and compared with the images stored in the database. This project aims to storing household waste. The household waste is rolled on the conveyor belt where it is sensed and monitored by various sensing and decision-making element to sort them into plastic, paper, glass, metal, Bio degradable, non-bio degradable. This total automated sorting plant increases efficiency of waste sorted and decreases man power as well as the diseases and skin problems caused to human due to waste. It gives user a totally controlled and achievable sorting of waste collected.

V. IMPLEMENTATION

Implementing waste management system using raspberry pi and Arduino involves integrating various sensors, actuators and communication protocols to create a seamless and efficient waste sorting system. Raspberry pi is programmed to perform image processing and separate different types of waste and thermal images are used to separate sanitary pads from waste. This data is processed and sent to cloud database to compare with the sorted images and identify them. Sensors like rain drop sensor and infrared sensor are used to separate wet, plastic and glass from waste. Based on input from sensing and raspberry pi actuators are used to push out of the conveyor. This project is very useful as it sorts waste at the primary level which can be easily recycled, reducing complications caused due to sorting waste at higher level.



Fig.2 Procedure

VI. RESULTS AND CONCLUSION

Using smart automation systems in waste management is efficient and saves time. The operating system has experience in teaching machine algorithms to improve operational efficiency. Early sensor data can distinguish between wet and dry debris. They can also separate glass, paper and plastic by using different measuring points. Many companies have developed machine learning robots for recycling. Some companies with potential in the technology space for investment and technology divestiture projects include Zen Robotics, Biotech and Intel.



Fig.3 Output

VII. SOCIAL IMPACT & FUTURE

should be approached with a similar approach, but the information should be developed by including local visuals of waste information. In addition to visuals of unhealthy and dirty waste, sensors that will provide sensitive and more accurate readings should be added to training materials. This will help the model predict local waste, which mostly consists

of dirty household products. This can help achieve Studies a better classification with higher accuracy. The data must also contain a large number of images with a large number of residual images; so, the framework can easily learn to predict many objects in a single image without making errors in the search. Further research in this project should consider including different types of other bulk wastes from the literature. By strengthening the list of categories, the framework will be further developed and will help in proper development of the waste management process. We can also add recycling facilities so that waste can be recycled immediately after the initial selection.

Smart Agriculture Monitoring System using IOT

Diksha Patel¹, Suvasi Sheth¹, Trupti Gami¹, Ranjushree Pal²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹ sunshinedik2003@gmail.com, ¹suvasisheth23@gmail.com, ¹truptigami40@gmail.com, ²ranjushree.pal@djsce.ac.in

Abstract— Agriculture can become smart agriculture (IoT) with the use of advanced wireless networks and the Internet of Things. Crop demand rises in tandem with the growth of the human population. Food security will be increased by the smart agriculture system's understanding of environmental temperature, humidity, and soil moisture measurement through real-time monitoring. Furthermore, crop output, water waste, and productivity can all be increased through smart agriculture. This study suggests smart agriculture as a solution, which makes use of real-time, sensor-based monitoring devoid of human intervention. All sensor data is captured and monitored continuously, from any location within the internet's coverage area, and users have a direct access to the real-time data. This study quantifies the effects of temperature, humidity, and soil moisture on agricultural yield. We can gather data from wireless sensor networks by using an Internet of Things (IoT)-based farm monitoring system. The data is transmitted via wireless protocol. The three sensors will provide data to the system upon implementation, which will then be transmitted to the ThingSpeak interface for display of temperature, humidity, and soil moisture content data. A temperature is frequently a set point that is supported by the type of crops that are grown. The farmers can utilize smart gadgets to access the information.

Keywords— Internet of things, Cloud, Wi-Fi, wireless sensor network, ESP32.

I. INTRODUCTION

Every country's cornerstone is its agriculture, which also contributes to the country's GDP. In order to increase crop productivity, it is crucial to fortify the agricultural sector by improving technology and system efficiency. Stated differently, the nation's growth and the impact it has on the average citizen's level of living are both facilitated by the modern agriculture sector. One major difficulty facing this industry is providing people's food demands while increasing crop output, quality, and quantity without the need for manual monitoring. The Internet of Things is a crucial part of a smart system. The idea of the internet of things (IoT) allows a device to communicate data via a network without the need for human interaction. The sensors that are affixed to the chosen object produce the data. Furthermore, real-time crop monitoring is made possible by embedded systems, like those found in smart agricultural systems, which leads to more productive crop growth

A farmer using smart agriculture can maximize yield and maintain the availability of food. Increasing food security can also be achieved through the use of precision agriculture in intelligent agriculture. This is because the crop's quality and yield will increase due to the high accuracy and real-time control. Additionally, because of the movement control

order, food security is a crucial component of the COVID-19 pandemic. Furthermore, physical parameters like temperature, measurements of soil moisture and relative humidity are necessary in the agriculture. This is due to the fact that these factors both favorably and unfavorably impact crop growth. It is perhaps advisable to take into account additional factors like the level of the pH of soil as well as the quantity of fertilizer. However, for this project, these parameters are not measured. In order to boost agricultural yields and enhance crop management, smart agriculture, also known as smart farming, is utilizing a large varieties of the tools and the technologies, including the internet, and the Internet of Things (IoT) devices and cloud computing. Through wireless data exchange, the Internet of Things seeks to close the distance between the real as well as virtual worlds. IoT also makes precision agriculture more effective because it can increase crop quality, productivity, and yields. The monitoring system is made up of multiple sensors that are able to interface with other devices in order to monitor all the physical parameters such as soil moisture, temperature, and humidity. Precision agriculture, often known as smart agriculture, is a technique that maximizes crop productivity by using fertilizers and water efficiently. A technique for modifying agricultural inputs to sthe current environmental circumstances is called precision agriculture. It is controlled by a set of regulations and uses sensors to acquire data about the crops, including soil temperature and humidity, so that the data may be used to make decisions. Because the relay is precisely engaged and deactivated based on data acquired by the sensor, this method uses less water. Farmers can also water crops according to their needs with the help of smart agriculture, provided they receive quick notifications. Thus, the goal of this research is to create an algorithm that will enable user participation while maintaining the ideal level of soil moisture using a real-time monitoring system. This method can help save water usage and boost agricultural productivity. Furthermore, a significant amount of research has been conducted in order to enable better outcomes in terms of both number and quality. Given that it can address the difficulties highlighted, this type of intelligent system is one of the more basic possibilities. This work discusses a smart agriculture system that enables real-time soil moisture measurement monitoring.

II. OBJECTIVE

The goal of an Internet of Things (IoT) based smart agriculture monitoring system project may encompass multiple elements, including project system design, hardware and software utilization, data testing, and validation, among other things. The exact size of the project may vary based on its objectives, requirements, and available resources.

The following could be included in the scope of an IoT-based smart agriculture monitoring system project:

- The labor requirement will go down thanks to sensors.
- The temperature sensor does detect the temperature level more precisely and accurately than a manual process.
- The sensor enables exact assessment of the moisture content of soil. This can entail processing the data gathered by the system and producing insightful analysis using statistical techniques and additional analytical tools.
- This could entail developing an intuitive user interface that enables farmers to quickly access and comprehend all the data acquired by the system.

III. PROPOSED DESIGN

The proposed design for the Smart Agriculture Soil Monitoring System (SASMS) leveraging IoT technology consists of various key components. Firstly, the system will deploy sensor nodes equipped with different sensors to monitor several soil parameters namely moisture level, temperature and humidity. These sensor nodes will be strategically placed across agricultural fields, ensuring comprehensive coverage. After sensing the data from the nodes of the sensor it is sent to ThingSpeak, a cloud platform, enabling real-time monitoring and analysis. The cloud platform will serve as the hub for combining the different data input provided by sensors, storage of the data, and processing, leveraging robust security measures to protect sensitive agricultural data. The data will be analyzed simultaneously to identify when to turn pump on or off the, ensuring efficient water supply to the field.



Fig. 1. Block diagram of proposed monitoring system

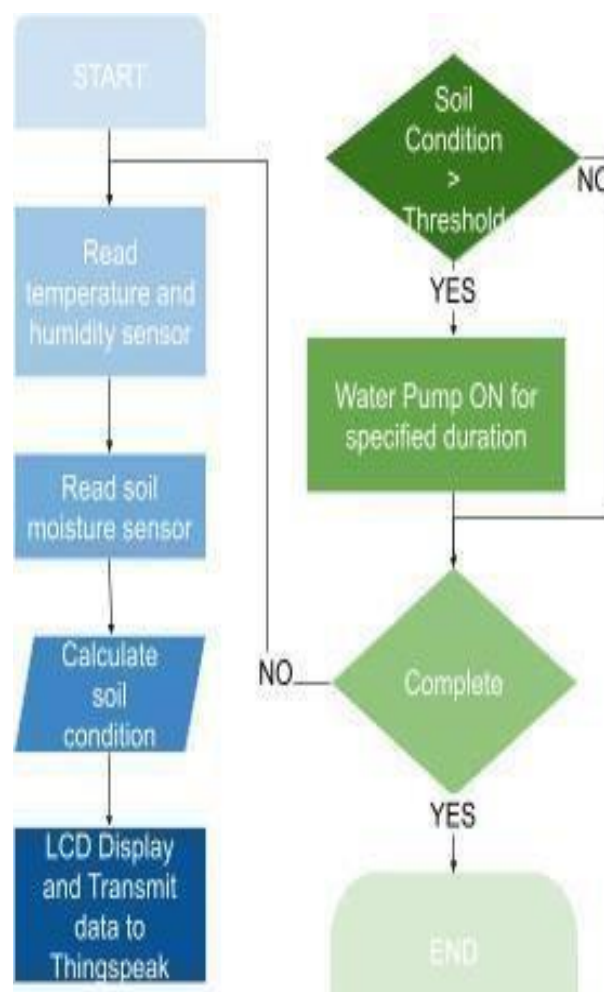


Fig. 2. Flow diagram of proposed monitoring system

IV. IMPLEMENTATION

In this project we plan to build a Smart Agriculture monitoring system using IoT. The Soil sensor is used to detect the soil's moisture level hence take the reading them on the ThingSpeak as well as to the microcontroller in real time. Once the sensor senses the moisture and the humidity level of the plant it is transmitted for cloud computing via wireless connection and compared to the threshold levels given to the microcontroller. If it is observed that the moisture of the soil is lesser than the threshold value, it will display low moisture level on the application and turn on the DC motor which in turn starts the water supply using the water pump. This process of measuring and supplying continues until the moisture level of the soil is greater than or it is equal to the given threshold value. The water pump dispenses the required amount of water and balances the moisture level of the soil. All the processes going on in the system will be alerted to the operator with help of notifications through the web services. We plan on implementing the web service using the ThingSpeak software suite. A simple user interface will be programmed for a hassle-free operation of the entire system. All the sensors and systems are controlled and maintained in

sequence with each other as to get the maximum efficient output by taking the help of the microcontroller. A microcontroller is capable to read the input signal and also convert it into an output signal.

SOFTWARE SPECIFICATION

ThingSpeak serves as a platform for IoT analytics, enabling users to accumulate, display, and examine real-time data streams in the cloud. It offers immediate visualization of data transmitted by devices to ThingSpeak. Additionally, users can run MATLAB code within ThingSpeak to conduct online analysis and data processing in real-time. This platform is commonly utilized for developing prototypes and validating IoT systems that demand analytical capabilities.

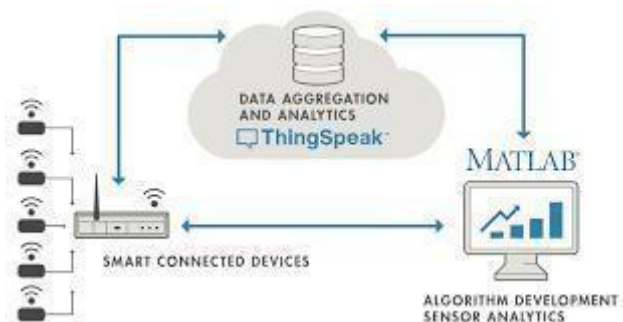


Fig. 3 Software data flow representation

V. RESULTS AND CONCLUSION

The integration of the Smart Agriculture Soil Monitoring System (SASMS) utilizing IoT technology promises significant benefits for agricultural practices. Through real-time monitoring of soil parameters and insights that are data-driven, farmers can make informed decisions to optimize crop yields while conserving resources. The ability of system to accurately assess soil moisture, temperature, humidity, and nutrient concentrations enables precision agriculture techniques, reducing water usage, minimizing chemical inputs, and mitigating environmental impact. By leveraging machine learning algorithms, the SASMS provides predictive models for irrigation scheduling, fertilizer application, and pest management, enhancing productivity and efficiency. The user-friendly visualization interface empowers farmers to remotely monitor soil conditions and crop health, facilitating proactive management strategies. Moreover, the scalability, modularity, and integration with existing farm management systems ensure seamless adoption and compatibility with diverse agricultural settings. Overall, the Smart Agriculture Soil Monitoring System represents a transformative approach to soil management, offering a sustainable solution to meet the evolving challenges of modern agriculture while promoting environmental stewardship and economic prosperity.

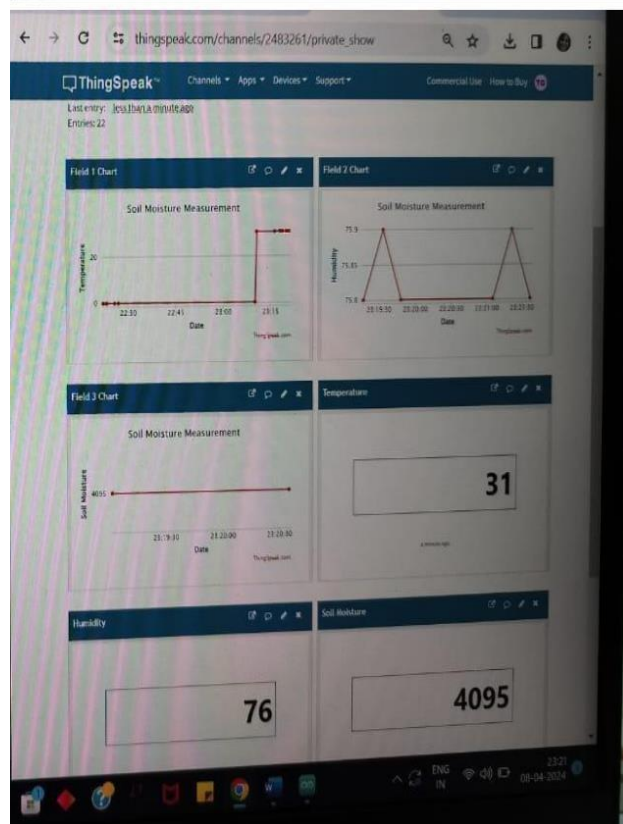
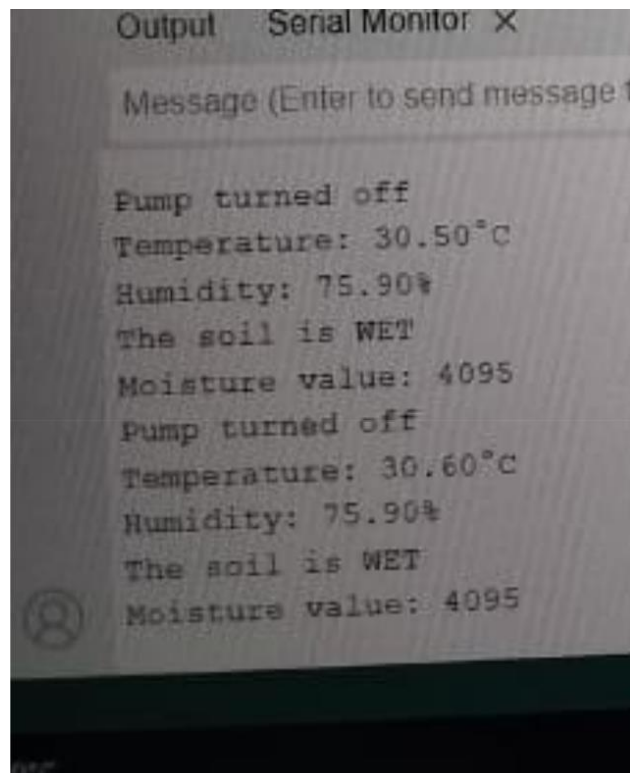


Fig.4 Temperature, humidity and Moisture levels observed

VI. FUTURE SCOPE

A smart agricultural monitoring system project utilizing the Internet of Things might involve multiple areas, such as both software and hardware development, system design, validation, and testing, to name a few. The exact extent of the project will rely on objectives, specifications, and resources on hand.

An Internet of Things (IoT)-Based Smart Agriculture Monitoring System has several possible uses, including:

- Sensors will help to reduce the requirement for labor.
- The sensor makes it possible to monitor the soil's moisture content precisely.
- The temperature sensor is more accurate and precise at detecting the temperature than a manual method.
- To process the data gathered by the system and produce insightful analysis, this may entail utilizing statistical techniques and additional analytical instruments.

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Real-time Speech Recognition and Transcription Smart Glasses

Tanmay Londhe¹, Atharva Akula¹, Mrunalini Pimpale²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056 E-mail: ¹tanmay.londhe.2029@gmail.com, atharvaakula17@gmail.com ³Mrunalini.ingle@djsce.ac.in

Abstract— Speech is the best medium of communication for human beings across the world. For hearing-impaired ones interaction and communication is more difficult. So, converting spoken words into text and interaction with the electronic i.e. computers need more effort & time. This paper presents a new, low-cost, portable, and embedded system for translating spoken language into text for hearing-impaired individuals. The proposed system uses low-cost smart glasses to interact with a microcontroller, record human speech live, and transcribe it into text on an OLED panel. This design provides a more user-friendly interface for accessing communication for hearing-impaired individuals. The research focuses on developing a microcontroller-based speech recognition system to address poor translation in human-electronic-based interaction using open-source tools for low-cost commercial implementation. The proposed wearable system, using smart glasses and MQTT communication, is simple and suitable for the hearing impaired. The paper discusses the methodology of designing, possible scenarios, limitations of the current prototype, elaboration, and recommendations for further research. The paper also provides potential applications of this technology in the public domain to enhance communication between humans and the hearing impaired using the developed system.

Keywords— *Hearing disability assistive technology, Real-time speech recognition, speech-to-text translation, smart glasses, wearable technology, android application*

I. INTRODUCTION

The World Health Organization states that more than 5% of the world's population, around 430 million people, have disabling hearing loss. The methods used for communication with those who are hearing-impaired today can be considered basic at best. For example, medical centres suggest to speak gradually and distinctly, face the person with hearing difficulties directly while talking and reduce unnecessary noises in the surroundings. Not having good methods to communicate with the deaf is a big problem, even in serious situations such as law enforcement or medical practice.

The goal of our project is to change how easily people can communicate, and we are doing this by creating a live text translation system that will be placed in smart glasses. This wearable solution tackles the problems with current methods and helps those who have hearing issues to communicate more clearly.

Advancements in human-computer interaction (HCI) have led to big progress in speech recognition technologies, where modern algorithms and processing methods can convert spoken words into understandable text that appears on the screen. This is what we want to achieve with our project; a system that people with hearing disabilities can use easily for clear communication.

The current speech recognition and translation systems have the ability to process large vocabularies in many different languages. These include English, Spanish, German as well as Chinese and Hindi among others. One important element of these systems is having a speech frequency database for comparison purposes which can be synchronized using universal language resources that are readily accessible from places such as Google Cloud services.

Having described the barriers in current communication techniques for those with hearing difficulties and the possibility of using speech recognition technology, this section now focuses on creating and making our real-time speech-to-text smart glasses system. This wearable answer gives importance to being portable, not expensive, and easy to use for improving communication access in different places.

Our system has four main components that work harmoniously. An Android application using a speech recognition library (Google's speech recognition API) captures the spoken language in live mode. MQTT, which is a lightweight messaging protocol, transmits the text data after it's recognized by the app. A microcontroller called ESP8266-01, which is known for its Wi-Fi connectivity, is used to subscribe to the MQTT broker and get text data that has been sent. This ESP8266-01 talks with an Arduino Nano for more actions. At last, a small I2C OLED display shows the received text in easy-to-read manner on smart glasses because it needs less power and space.

The design process has focused on few important parts to make sure this system is efficient and easy to use. Having real-time function is very important, which means it can quickly convert spoken words into text for smooth communication. Making sure the system works with smart glasses makes it comfortable and convenient for the user. This also promotes ease in carrying around and using the system without hands involved. Using inexpensive components makes the design affordable, increasing the system's availability for more users. Finally, the user interface (UI) shown on the OLED display gives a simple and clear illustration of recognized text that needs little user engagement for easy operation.

II. LITERATURE SURVEY

Speech-to-text (STT) technology, or automatic speech recognition (ASR), has received notable attention in the past few years for its capability to transform communication. The groundwork of STT, its uses and continuous improvements have been widely studied by researchers. Inside the STT systems, there is a complex technical structure that merges machine learning algorithms with neural networks to convert spoken language into text. In the beginning, speech recognition was based on Hidden Markov Models (HMMs)

which were introduced during 1980s. These models worked well in decoding the patterns of speech and it led to great advancements in precision. But, the advent of deep learning methods has really changed STT. Hinton et al.'s studies show how Deep Neural Networks (DNNs) are efficient for making speech recognition tasks more accurate and stronger. In addition, Graves et al. demonstrate that when we combine Recurrent Neural Networks (RNNs) with attention mechanisms, it boosts the overall understanding in context and precision of transcribed text. STT tech isn't just for talking, it has other applications too. The study of Farahat et al. looks into its use in healthcare, making medical dictation possible and improving the way patient records are handled. Likewise, Wang and Smith emphasize the usefulness of STT for meeting transcription and boosting productivity in business situations.

However, the technology of STT is not perfect and has some difficulties. One main problem is with handling different accents, dialects and noise in the background. Audhkhasi et al. examine these concerns and suggest ways to enhance the robustness of STT in demanding situations. Also, study done by Hutchinson and Caliskan-Islam examine the moral aspects about data privacy and probable prejudices in training datasets, highlighting a requirement for ethical structures in STT advancement. Our project contributes to the current research by tackling some of the shortcomings that have been identified. We plan to develop a system that combines with smart glasses and gives real-time speech-to-text function. This will provide an easy, portable solution which overcomes the problems associated with both independent devices and mobile applications. We focus on making it affordable and simple for users to operate by using readily available parts and easy interface design. This method tackles the problem of big, separate devices and the shortcomings found in apps that are based on smartphones. Our concentration on cost-effectiveness and an easy-to-use interface makes this system more reachable to a broader group of users. We take advantage of the good outcomes from smart-glass speech-to-text systems that already exist while also dealing with worries about battery use and how users interact with it. Our project wants to make a live speech-to-text answer using smart-glass technology, which can help people with hearing problems in different places communicate better by providing clear understanding of what is said.

III. PROPOSED DESIGN

Our suggestion is a real-time speech-to-text (STT) translation system that can be used with smart glasses, specifically designed to empower people with hearing loss. This solution focuses on being portable, affordable, and easy to use, making it both useful and reachable as an assistive technology. The functional aspect of this idea hasn't been neglected either. Using advanced STT libraries and fast processing techniques, the system provides speech translation in real-time. This guarantees that users can easily understand ongoing conversations and actively engage with their environment.

The system has a design that focuses on a few important things for it to work well and be easy to use.

Affordability and Accessibility: The system gives importance to components that are easily acquired and not too expensive, so everyone can use them. For example, we use Arduino nano and ESP8266-01 Wi-Fi module because it is cheap and simple for development purposes.

Offline Functionality: The main function is created to work online and it requires STT services from the cloud. But you can think about saving often-used phrases in the cache for future offline use. It would mean keeping commonly used words or groups of words in memory of MCU so they could be recognized without needing an internet connection.

User Interface: The user interface on the smart glasses display is purposely designed to be basic. It puts the most emphasis on showing the identified text in a simple font with big contrast for easy reading, especially under different illumination settings.

Security: For the communication between the app and smart glasses, secure protocols such as TLS/SSL are used to protect user data privacy. The recognized text could have sensitive details, so encryption is important during its transmission.

Real-Time Performance: Optimizations are done in the entire system to achieve real-time performance. This involves using efficient algorithms within the STT library, reducing processing delays found in MCU, and utilizing communication protocols with low latency such as MQTT.

The system prioritizes portability, affordability, and user-friendliness while aiming for high accuracy and real-time performance. The system comprises three main components

Android App: This easy-to-use app records speech through the phone's microphone and utilizes a pre-installed library for Speech-to-Text (STT) to convert it into recognized text.

Wireless Communication: To send the recognized text from the app, a message queuing telemetry transport (MQTT) protocol is used to transmit it through wireless means. This protocol can be very efficient for low-bandwidth situations and is appropriate for devices that rely on batteries. The tiny computer within these smart glasses gets this securely transmitted information via MQTT.

Smart Glasses: Within the smart glasses, there exists a low-power microcontroller unit (MCU) functioning as the translator. It accepts the transmitted text and converts it into a visual display. This MCU is linked to a tiny, low-power screen that shows recognized text in clear and easy-to-read format.

IV. IMPLEMENTATION

The section gives comprehensive knowledge about putting into practice the real-time speech-to-text smart glasses system. It starts with a general view of development surroundings, Android application instruments and lastly the smart glasses firmware. The process of implementation is then detailed, explaining functions in each stage and underlining tactics for getting top performance. This section will explain the key stages for combining and testing, in order to develop a strong system that is easy for users. We'll talk about the environment of development, tools used for creating Android application as well as smart glasses firmware. We will also give detailed explanations about how it was implemented and breakdown of functions at each stage. Plans for reaching top performance will be looked at. When the stage of integration and testing is done, then comes the part where we put in user feedback and make changes for making everything work smoothly and well-organized.

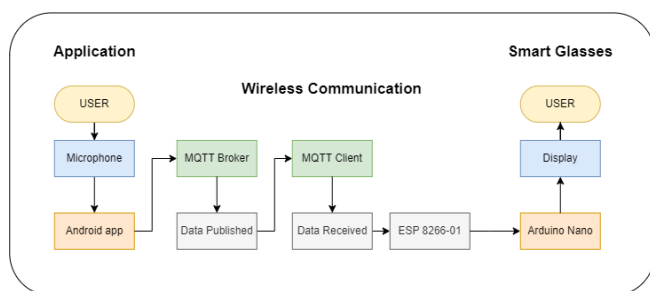


Fig.1 Block Diagram

Android Application

The Android application serves as the bridge between the user and the smart glasses. Here's a detailed breakdown of its functionalities

Capturing Speech Input:

The initial stage needs to use the microphone in user's smartphone. The Android AudioRecord API gives needed functions for accessing and recording audio data from this embedded microphone. For smooth running and low usage of battery, we will look into setup choices in AudioRecord API. This could mean searching for an equilibrium between audio quality and resource effectiveness by modifying the sample rate, which is how many audio samples are gathered in each second, along with the audio format that represents this data digitally. The desired settings will be selected according to what is needed by the STT library you plan to incorporate later on.

Speech-to-Text Processing:

After getting a clear audio stream, the next step is to convert speech into text. This process requires using a strong and precise STT library. Common choices are the Google Speech-to-Text API that works in the cloud, known for its high accuracy and ability to recognize many languages also, Vosk which is an open-source library providing offline recognition option. We use Google Speech-to-Text API. The audio stream we capture is a continuous flow of bytes that will be input into the STT library. This library does real-time speech recognition, employing sophisticated algorithms to examine the audio stream, recognize speech patterns and convert them into acknowledged text. For situations having a lot of background noise or using technical words, the library has language model adaptation. This helps to improve recognition accuracy in these particular circumstances by training the model on a special dataset that includes important keywords or phrases.

Communication

The real-time speech-to-text functionality hinges on efficient communication between the Android application and the ESP8266-01 microcontroller unit (MCU) within the smart glasses. Here, we'll delve into the details of this communication protocol, exploring the chosen messaging format and the security measures implemented to safeguard user privacy.

MQTT utilizes a publish-subscribe architecture. The Android application acts as an MQTT client that publishes the recognized text message to a specific topic on the MQTT broker, a server facilitating message exchange. The ESP8266-01, also acting as an MQTT client, subscribes to the same topic. This way, the app doesn't need to know the exact location of the ESP8266-01; it simply broadcasts the message,

and the broker efficiently delivers it to the subscribed device. Additionally, MQTT minimizes data traffic compared to traditional client-server models. The app only transmits the message once to the broker, and the broker forwards it to all subscribed clients. Finally, MQTT offers features like message queuing and delivery confirmation, ensuring that messages are delivered even in situations with temporary network connectivity issues.

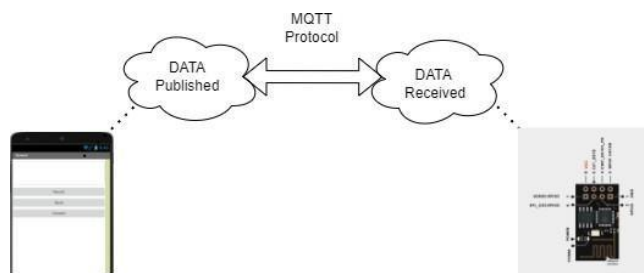


Fig.2 Communication Diagram

For the communication to occur, several crucial elements need to be established. An MQTT broker acts as an intermediary server, facilitating message exchange. This broker can be a cloud-based service or a self-hosted server depending on the desired level of control and security. Topics act as designated channels for communication. The app will publish the recognized text message to a specific topic on the broker. The ESP8266-01 is programmed to subscribe to that same topic, allowing it to receive only the relevant messages from the app.

Since the transmitted text might contain sensitive information, robust security measures are essential. The communication will be encrypted using protocols like TLS/SSL (Transport Layer Security/Secure Sockets Layer). This encrypts data transmission between the app, the broker, and the ESP8266-01, ensuring that only authorized devices can access the information. Libraries like Retrofit on the Android side and established MQTT libraries for ESP8266 will be utilized to implement these security protocols seamlessly.

Smart Glasses Firmware

This configuration leverages two microcontrollers: the ESP8266-01 for data acquisition and the Arduino Nano for interfacing with the I2C OLED display. Let's delve into the functionalities implemented within the firmware for each device to establish seamless communication and data visualization.

The ESP8266-01 firmware prioritizes secure communication with the MQTT broker. To achieve this, a dedicated MQTT client library is integrated, enabling the ESP8266-01 to establish a secure connection using TLS/SSL encryption. The firmware then subscribes to the same topic on the broker that the Android application utilizes for message publishing. This ensures that the ESP8266-01 only receives relevant messages containing the recognized text data. Once subscribed, the ESP8266-01 continuously listens for incoming messages on the designated topic. Upon receiving a message, the firmware extracts the recognized text by parsing the message content. As per our application's requirements, an optional step might involve processing the received data. This could include tasks like data validation to ensure its integrity or basic manipulations for improved presentation on the display. Following potential data processing, the ESP8266-01 transmits the information (processed or raw) to the Arduino

Nano. To facilitate this communication, a software serial library is incorporated into the firmware. This library enables serial communication on designated pins that will be connected to the Arduino Nano's corresponding RX and TX pins. The serial port configuration on the ESP8266-01 is crucial, as it needs to match the baud rate used for communication with the Arduino Nano to avoid data transmission errors.

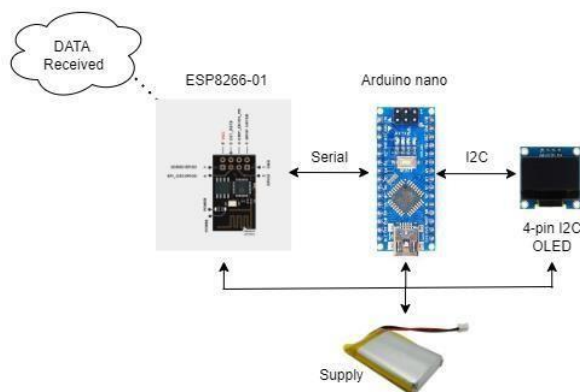


Fig.3 Smart Glasses Firmware Diagram

The Arduino Nano firmware focuses on serial communication with the ESP8266-01 and controlling the I2C OLED display. Similar to the ESP8266-01, the Arduino Nano firmware also integrates a software serial library. This library enables serial communication on the designated pins that will be connected to the ESP8266-01. Just like on the ESP8266-01, the serial port baud rate needs to be configured to match the settings on the ESP8266-01 to ensure consistent communication. Once the serial communication link is established, the Arduino Nano firmware listens for incoming text data from the ESP8266-01. The final step within the Arduino Nano firmware involves controlling the I2C OLED display. To achieve this, an I2C library (Adafruit) is integrated. This library provides functions to interact with the display over the I2C communication protocol. The firmware utilizes these functions to initialize the I2C communication and configure the OLED display settings, such as contrast and brightness, for optimal viewing. Finally, the processed (or raw) text data is transmitted to the I2C OLED display using the I2C library functions, presenting the recognized text to the user.

V. RESULTS AND CONCLUSION

Our research project about real-time speech recognition and transcription for smart glasses with Arduino Nano and ESP8266-01, has reached a successful testing stage. The outcomes are positive! The firmware we created is capable to record the audio data, send it over to a specific module of speech recognition for processing and show transcribed text on I2C OLED display. In the time of testing, people using this prototype shared a big increase in understanding when they combined it with lipreading. This success confirms the main abilities of our prototype: good audio capturing, dependable serial communication with outside module and showing text on display clearly.

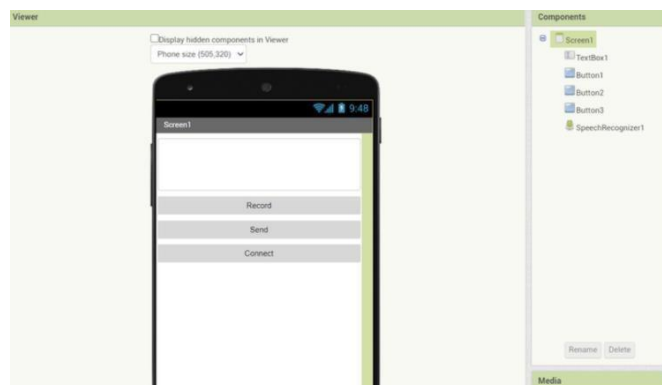


Fig.4 Android Application

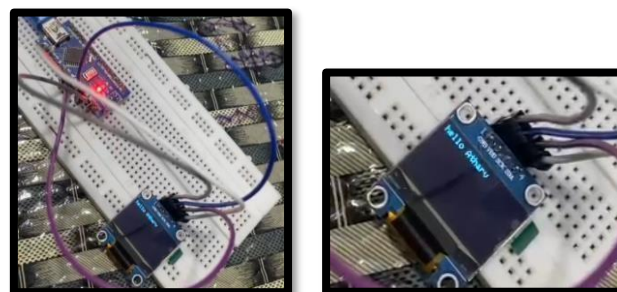


Fig.5 Hardware implementation

Yet, our work is not finished. We are looking into ways to make things even better. In future studies, we aim to improve the process of recognizing speech so that it becomes more accurate especially when there is a lot of noise around. This could include incorporating deep learning models or using cloud-based services. Also, enhancing the code of ESP8266-01 and researching into power-saving microcontrollers can greatly lengthen battery duration, resulting in better user convenience. In future versions, we might also look at improved display technologies such as colour displays or micro-displays for clearer reading and a more stylish appearance. With ongoing improvement of the technology, we hope to make a future where these smart glasses give people with hearing difficulties the ability to communicate easily and clearly.



Fig.6 CAD renders

VI. SOCIAL IMPACT & FUTURE

For those with hearing loss, smart glasses that translate speech to text can be life-changing, promoting social inclusion and inclusive communication. These glasses improve communication accessibility by offering real-time transcription of spoken words, enabling users to actively engage in discussions, meetings, and social events. By lessening reliance on middlemen and lowering the stigma attached to hearing loss, this technology encourages user confidence and independence. Additionally, it promotes greater accessibility in technological design and facilitates linguistic inclusion, opening doors to better education and career prospects. In the end, smart glasses improve social inclusion and overcome communication barriers to create a more just and compassionate society where all perspectives are respected and heard. Smart glasses not only promote inclusivity but also transform communication patterns by enabling people with hearing impairments to participate completely in a range of social and professional contexts. These glasses improve users' freedom and engagement by enabling them to follow discussions in real-time through the smooth conversion of speech to text. This technology argues for accessibility across various domains in addition to language and cultural inclusivity. As smart glasses become more widely used, they help to create a more inclusive society in which people with hearing loss are not only accepted as normal members of society but are actively encouraged to do so, which promotes mutual respect, empathy, and understanding.

The technology of smart glasses is a quickly developing field with many possible uses. The following are some potential advancements and uses for smart glasses in the future:

Enhanced comfort and design: The present limitations of smart glasses include their weight and size, which can make them uncomfortable to wear for long periods of time. It's conceivable that smart glasses will become more comfortable to wear in the future as their designs get more compact.

Increased precision and accuracy: The accuracy of the sensors and other components of smart glasses currently limits their ability to deliver precise and accurate information. It's possible that as time goes on, smart glasses will improve in accuracy and precision, opening up even more uses.

Multi-Language Support: In order to meet the varied linguistic needs of users across many countries and cultures, future smart glasses may support numerous languages and dialects. This would increase their global reach and influence.

Improved Connectivity and Accessibility Features: Upcoming versions of smart glasses might have more sophisticated connectivity features, like easy interaction with smartphones or other assistive technology, and adaptable accessibility features to suit the needs and preferences of specific users.

Artificial Intelligence and Customization: By using artificial intelligence (AI) algorithms, smart glasses may be able to learn from user interactions and adjust over time to each user's unique communication preferences, providing individualized support and improving user experience.

Collaboration with Healthcare professionals: better monitoring, treatment, and rehabilitation of hearing impairments may be made possible by the integration of smart glasses into all-encompassing hearing healthcare solutions

through collaboration between technology developers and healthcare professionals

ACKNOWLEDGMENT

We would like to sincerely thank Professor Mrunalini Pimpale for her essential advice and assistance throughout this project. Her extensive knowledge, unwavering support, and perceptive criticism were invaluable in guiding our research and significantly improving the caliber of our work. We are particularly grateful for her dedication and mentorship, which have greatly enriched our academic progress.

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Smart Road Movable Divider

Diya Shriyan¹, Mahek Pandya¹, Palak Nair¹, Venkata A P Chavali²

¹U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

²Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: ¹diyashriyan2004@gmail.com, ¹mahekpandya952@gmail.com, ¹palaknair08@gmail.com, ²venkata.chavali@djsce.ac.in

Abstract— This paper outlines the design, development, and implementation of a Smart Movable Road Divider system aimed at enhancing road safety, efficiency, and sustainability. The Smart Road Divider integrates advanced technological features into traditional road dividers, transforming them into dynamic elements within the urban transportation infrastructure. The primary objectives of this project revolve around improving road safety, optimizing traffic flow, and incorporating sustainable practices in urban planning. The Smart Road Divider incorporates various sensors, such as cameras, and proximity sensors, to detect and monitor traffic conditions in real-time. This data is processed using artificial intelligence and machine learning algorithms to enable adaptive responses to changing traffic patterns. Additionally, the Smart Road Divider integrates smart lighting systems and LED displays to convey essential information to drivers, pedestrians, and other road users. These features facilitate better navigation, communication of traffic regulations, and warnings about potential hazards or lane closures. The report details the system architecture, the technologies utilized, and the methodologies employed for data collection, processing, and decision-making within the Smart Road Divider system. It also includes a comprehensive analysis of the system's performance based on real-world testing and simulations, demonstrating its effectiveness in improving road safety, traffic management, and overall urban mobility. In conclusion, the Smart Road Divider project showcases an innovative approach to modernizing and enhancing conventional road infrastructure. Its integration of cutting edge technology and sustainable practices offers a promising solution for addressing the challenges of urban transportation, contributing to safer, more efficient, and environmentally conscious cities.

Keywords— road safety, transportation infrastructure, sensors, LED, traffic flow, Machine Learning.

I. INTRODUCTION

One of the most pressing issues of road traffic authorities and citizens of any country is traffic congestion. During peak hours we observe that there is immense traffic on one side of the divider of a road and there is absolutely no traffic on the other side. This crisis can be controlled by moving the divider to that side of the road that has the least amount of traffic. Of all the consequences, the most crucial is the delay in emergency services reaching the scene of an incident. This delay can result in loss of life, injuries, and significant financial damages in situations such as fires, car accidents, or terrorist attacks. This project aims to develop and implement a Smart Road Divider system that prioritizes road traffic by dynamically configuring road dividers. This system aims to enhance response times, improve road safety, and optimize traffic flow in urban areas. Delays caused by congested roads can have critical consequences, potentially resulting in loss of

lives or worsening of medical conditions. This project addresses the following key problems:

Lack of Priority Mechanism: Existing traffic management systems do not provide an efficient mechanism for giving priority to emergency vehicles on the road.

Inefficient Use of Road Infrastructure: Standard Road dividers are passive and do not contribute to the dynamic management of traffic flow, making it difficult to adapt to changing circumstances.

Safety Concerns: Navigating through congested traffic can be hazardous for both vehicle drivers and other road users.

II. LITERATURE SURVEY

Traffic congestion refers to a situation in transportation where vehicles experience slower speeds, extended travel times, and more frequent queues. Over the years, urban road networks have witnessed a significant rise in traffic congestion. When the demand for traffic reaches a point where vehicle interactions impede the flow, congestion occurs. Unfortunately, frustrated drivers may even resort to road rage because of this congestion.

Frequently, drivers and road planning departments prioritize adding extra lanes to roads as a solution to congestion. However, this approach proves ineffective: when road capacity increases, it inadvertently stimulates more driving demand. Traffic congestion arises when the volume of traffic exceeds the available street capacity, a situation commonly referred to as saturation.

Various specific factors can contribute to or exacerbate traffic congestion. Most of these factors either decrease road capacity at specific points or over certain distances or increase the number of vehicles needed to accommodate a given volume of people or goods.

Traffic congestion has several adverse effects:

1. Time wastage for motorists and passengers: Congestion leads to longer travel times, affecting productivity.
2. Economic impact: As a non-productive activity, congestion negatively impacts regional economic health.
3. Delays: Late arrivals for work, meetings, or education can result in lost business opportunities, disciplinary actions, or other personal setbacks. In the proposed system, a module has been developed that includes an infrared (IR) sensor for measuring traffic density. As vehicles pass through these IR sensors, they detect the presence of vehicles and transmit this information to an Arduino. A reference value is set using a

variable resistance to define the desired sensing range. The system counts events where the sensor output transitions from LOW to HIGH, indicating the passage of a vehicle. Based on this, the percentage of traffic density is determined on either side of the divider. If the traffic density is high, the movable divider adjusts accordingly.

III. PROPOSED DESIGN

The smart movable divider will utilize IR sensors to detect obstacles and navigate around them. It will have a microcontroller (Arduino) to process sensor data and control the movement of the motors. It also uses an IC293D to spin the DC motor. Connect the IR sensors to the Arduino board. Typically, IR sensors have three pins: VCC, GND, and OUT. Connect VCC to a 5V pin on the Arduino, GND to GND pin, and OUT to digital pins (e.g., pin 2, 3, and 4). Connect the motor driver to the Arduino board an IC 293D. The motor driver will require connections for control signals (e.g., ENA, IN1, IN2 for one motor and ENB, IN3, IN4 for the other motor), as well as power connections.

(VCC, GND). Power the Arduino and motor driver with an appropriate power source. Write the Arduino code to read data from IR sensors and control the movement of the motors accordingly. Implement logic to interpret sensor readings and make decisions on movement (e.g., turning left or right to avoid obstacles). Ensure smooth and obstacle-free movement of the divider.

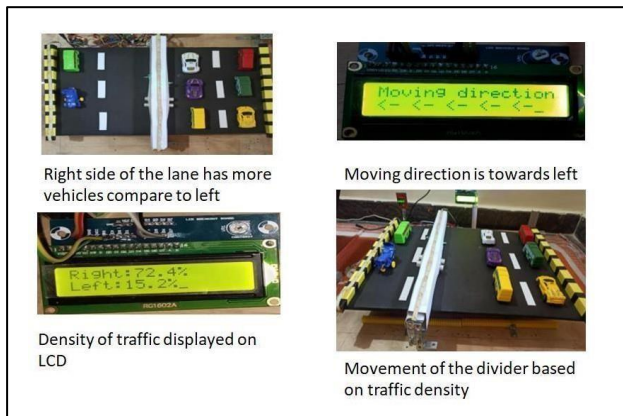


Fig.1 Hardware view of our project

IV. IMPLEMENTATION

The working principle of a smart road divider involves integrating various technologies and sensors into traditional road dividers to enhance their functionality, improve traffic management, and contribute to road safety. Here's an overview of the working principles involved in a smart road divider:

Sensor Integration:

Smart road dividers utilize an IR sensor. This sensor is strategically embedded or mounted within the divider structure to monitor the surrounding traffic conditions including vehicle movements, speeds, distances and lane occupancy.

Data Collection and Processing:

The sensors continuously collect data from their surroundings. This data is then processed in real-time using advanced algorithms. The collected information may include vehicle counts, speed detection, lane changes, and potentially hazardous situations.

Decision-Making and Response Mechanisms: Based on the processed data, the smart road divider system makes adaptive decisions or triggers responses. For instance, in case of detected congestion or an accident, the system may dynamically adjust the lane configurations, display warning messages, or signal nearby traffic lights to optimize traffic flow and alert drivers about potential hazards.

Communication and Information Dissemination: Smart Road dividers often incorporate communication modules and LCD displays. These components are used to communicate important information to drivers and pedestrians. Messages related to lane closures, speed limits, lane changes, or upcoming hazards can be displayed in real-time to ensure safer and more informed navigation.

Energy Efficiency and Sustainability:

To ensure sustainability, some smart road dividers may incorporate renewable energy sources such as solar panels to power the electronic components. This allows the system to operate efficiently while minimizing its environmental impact.

Integration with Traffic Management Systems: The data collected by smart road dividers can be integrated with larger traffic management systems operated by transportation authorities. This integration enables better coordination between various road elements, traffic signals, and control systems, contributing to more effective traffic management strategies.

Continuous Monitoring and Adaptation:

One of the key aspects of smart road dividers is their ability to continuously monitor traffic conditions and adapt in real-time. They can dynamically respond to changing traffic scenarios, optimizing road usage and safety. In essence, the working principle of a smart road divider revolves around sensor-driven data collection, intelligent processing of this data, and responsive actions taken to improve traffic flow, safety, and overall efficiency of urban transportation networks.

V. RESULTS AND CONCLUSION

The implementation of a smart movable road divider using IR sensors and Arduino technology represents a significant advancement in traffic management and road safety. By leveraging real-time data and adaptive algorithms, the divider offers a proactive approach to addressing traffic congestion and enhancing road safety. The integration of infrared (IR) sensors with Arduino technology offers a cost-efficient and adaptable solution that can be seamlessly

incorporated into existing road infrastructure. Its ability to dynamically adjust lane configurations based on traffic conditions helps optimize traffic flow and reduce travel times for commuters. Furthermore, the enhanced safety features provided by IR sensors contribute to minimizing accidents and improving overall road safety. With efficient power consumption and a user-friendly interface, the smart movable road divider offers a sustainable and accessible solution for modern urban environments. In conclusion, the smart movable road divider using IR sensors and Arduino technology offers a comprehensive solution for improving traffic management and road safety. Its adaptive capabilities, efficient power consumption, and user-friendly interface make it a valuable asset for urban infrastructure projects aiming to create smarter and safer cities.

OUR HARDWARE IMPLEMENTATION IS BELOW

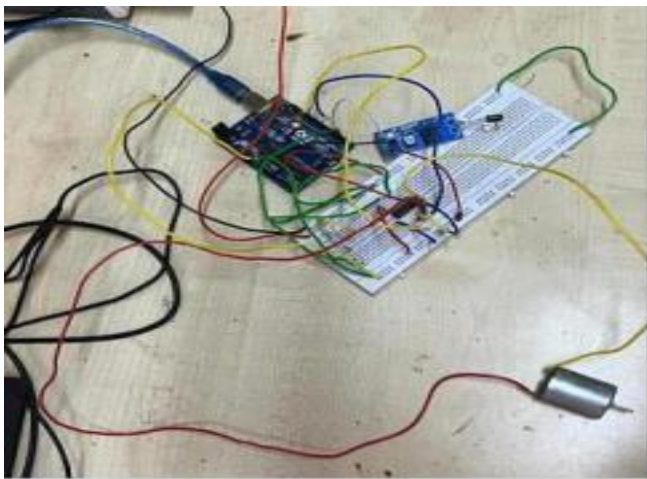


Fig.11 Hardware Implementation

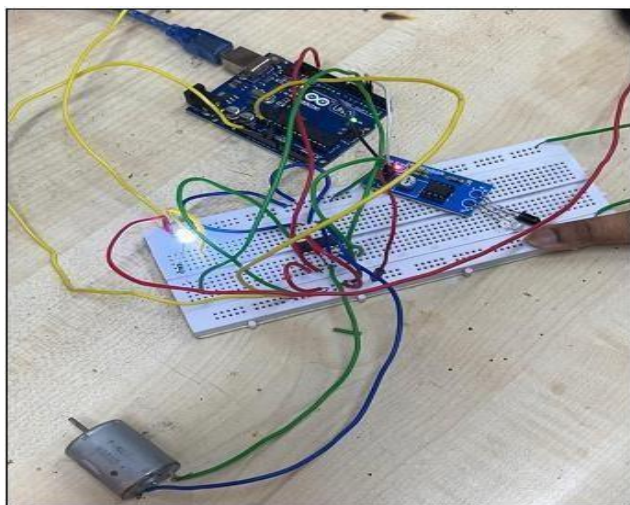


Fig.12 LED glows, DC motor moves

VI. SOCIAL IMPACT & FUTURE

The future scope of smart road dividers holds promising potential in revolutionizing urban transportation and enhancing road infrastructure. Here are several aspects that

represent the future scope of smart road dividers: Advanced Sensor Integration: Continued advancements in sensor technologies, including improved cameras, radar, and IoT devices, will enhance the capabilities of smart road dividers. Integration of more sophisticated sensors will allow for better data collection, accuracy, and real-time monitoring of traffic conditions.

AI and Machine Learning Enhancements:

Further development in artificial intelligence and machine learning algorithms will enable smarter decision-making by smart road dividers. These systems will become more adept at analyzing complex traffic patterns, predicting congestion, and dynamically adjusting traffic flow to optimize efficiency.

Vehicle-to-Infrastructure (V2I) Communication:

Integration of V2I communication will enable direct communication between vehicles and smart road infrastructure. This technology will facilitate real-time exchange of information, allowing vehicles to receive alerts about road conditions, lane changes, or hazards ahead, contributing to improved safety and smoother traffic flow.

Energy Sustainability and Green Technology:

Future smart road dividers may incorporate more sustainable practices, such as advanced energy harvesting techniques, including kinetic energy or piezoelectric systems, to power electronic components. Increased use of renewable energy sources like solar panels could make these systems more self-sufficient and eco-friendly.

Integration with Autonomous Vehicles:

As autonomous vehicle technology advances, smart road dividers will likely play a crucial role in supporting and facilitating the deployment of autonomous vehicles. These dividers can assist in providing necessary information and guidance to autonomous vehicles, ensuring their safe navigation and interaction with the road environment.

In summary, the future scope of smart road dividers involves continuous technological advancements, increased connectivity, sustainability measures, and seamless integration with evolving transportation systems. These innovations aim to create safer, more efficient, and environmentally conscious road infrastructures for the cities of tomorrow.

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VitalSigns+: Advanced ECG Monitoring with Intelligent Alert System

¹Vineet Barot, ²C.K. Beral

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

²Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

E-mail: ¹vineetbarot0405@gmail.com, ¹aaditkhanna@gmail.com, ²chandrashekhar.beral@djsce.ac.in

Abstract— This paper presents the development of a cost-effective Electrocardiogram (ECG) monitoring system utilizing the AD8232 module and Arduino microcontroller platform. The system employs Ag/Cl electrodes placed on the patient's arms and right leg to collect pulse input for analysis. The AD8232 module processes the biological signals, while an Arduino Uno microcontroller manages data transmission and display functions. The system's architecture, hardware components, and software implementation are detailed, along with a discussion of results and future prospects for improvement.

Keywords— *Electrocardiogram (ECG), AD8232, Arduino Uno, Monitoring System, Low-Cost, Bio-signal Processing, Signal Conditioning, GSM Module*

I. INTRODUCTION

The rising prevalence of heart conditions necessitates the development of accessible and affordable monitoring solutions. Electrocardiogram (ECG) technology provides valuable insights into cardiac health by recording electrical activity within the body. Traditional ECG systems can be costly and impractical for widespread use, particularly in resource-limited settings.

This paper addresses the need for a low-cost ECG monitoring system by leveraging off-the-shelf components and open-source hardware platforms. In addition to the economic barriers posed by traditional ECG systems, there are also logistical challenges that hinder their widespread adoption, especially in resource-limited settings. These challenges include the need for specialized training to operate complex equipment, limited availability of healthcare facilities equipped with ECG machines, and constraints related to maintenance and calibration of expensive devices. Furthermore, the portability and scalability of conventional ECG systems are often limited, making them unsuitable for community-based healthcare initiatives and remote patient monitoring programs. By emphasizing the utilization of off-the-shelf components and open-source hardware platforms, this paper seeks to not only address the financial constraints but also to overcome the practical barriers associated with traditional ECG technology. By leveraging accessible and adaptable tools, the proposed low-cost ECG monitoring system has the potential to revolutionize cardiac care delivery, making it more inclusive, scalable, and sustainable in diverse healthcare contexts.

II. LITERATURE SURVEY

Existing ECG Monitoring Systems: The current literature offers an array of ECG monitoring systems, encompassing

both commercial and research-driven solutions. Evaluation of these systems is predicated upon factors such as cost-effectiveness, accessibility, and performance metrics. Scrutiny of these attributes aids in identifying gaps in the extant solutions, thereby substantiating the exigency for a low-cost alternative.

Technological Components: Exploration of scholarly discourse surrounding the AD8232 module, Arduino microcontroller platform, and ancillary hardware components intrinsic to biomedical monitoring systems is imperative. This endeavor entails a comprehensive analysis of their respective features, functionalities, and applicability vis-à-vis low-cost solutions. Comparative assessments of diverse configurations serve to elucidate their efficacy in the context of ECG monitoring applications.

Low-Cost Healthcare Technologies: Delving into scholarly works and projects dedicated to the development of low-cost healthcare technologies, particularly in resource-constrained environments, offers invaluable insights. Deconstruction of design principles, navigational hurdles, and resultant impact on healthcare accessibility informs a nuanced understanding of this evolving landscape.

Signal Processing Techniques: Scholarly discourse surrounding signal processing algorithms and methodologies integral to ECG monitoring systems warrants meticulous examination. Rigorous assessment of their efficacy in noise mitigation, feature extraction, and waveform analysis is imperative. Exploration of innovative paradigms aimed at optimizing signal quality and processing efficiency augments this discourse.

Clinical Validation Studies: Inclusion of clinical validation studies pertaining to low-cost ECG monitoring systems is essential. These studies, encapsulating assessments of accuracy, reliability, and usability in real-world scenarios, provide empirical substantiation. Analysis of user feedback and clinical outcomes enriches comprehension of the pragmatic feasibility and clinical utility of such systems

III. THEORY

Electrocardiogram (ECG) Fundamentals: A theoretical elucidation of ECG fundamentals is indispensable. This encompasses an explication of electrical signal generation within the heart, interpretation of ECG waveforms, and their clinical ramifications in diagnosing cardiac pathologies. A

conceptual overview of the physiological underpinnings of ECG measurement underscores its significance in healthcare. Signal Conditioning and Processing: Discussion surrounding signal conditioning and processing in ECG monitoring systems is imperative. The elucidation of instrumentation amplifiers, filters, and analog-to-digital conversion mechanisms is paramount. Insights into noise reduction and artifact mitigation techniques assume prominence within this discourse.

Microcontroller Programming: An exposition on the rudiments of programming Arduino microcontrollers, facilitated by the Arduino IDE and pertinent programming languages, is warranted. The provision of illustrative code snippets for interfacing with sensors, data processing, and display management augments comprehension within the context of ECG monitoring applications.

Hardware Interfacing: An exposition on hardware interfacing techniques, encompassing electrode connections, signal conditioning module integration, and display unit interfacing with the Arduino microcontroller, is indispensable. Deliberation on electrical connections, sensor configurations, and circuit design considerations contributes to holistic understanding.

IV. METHODOLOGY

Problem Statement: Articulation of the research problem underpinning the development of the low-cost ECG monitoring system is foundational. This entails delineating specific objectives, research inquiries, and pertinent hypotheses for investigation.

System Design: Description of the system design process, inclusive of the selection of hardware components, system architecture, and circuit diagrams, is paramount. A rationale for component selection and system configuration underpins this elucidation.

Prototype Development: A delineation of the steps involved in prototyping the ECG monitoring system, encompassing hardware component assembly, microcontroller programming, and technical specifications, is essential. Detailed instructions facilitate replication of the prototype.

Evaluation and Validation: A discourse on the methodologies employed to evaluate system performance and reliability is essential. Presentation of experimental findings, inclusive of accuracy assessments, signal quality analyses, and user feedback, substantiates the robustness of the developed system.

Discussion and Future Directions: Interpretation of research findings vis-à-vis the research objectives and theoretical framework is imperative. Identification of strengths, limitations, and areas for refinement in the developed system is essential. Proposition of future research trajectories and potential enhancements to system design and functionality provides forward-looking insights.

V.IMPLEMENTATION

A. Software Implementation:

The software underpinning the ECG monitoring system is meticulously crafted using the Arduino Integrated Development Environment (IDE), a robust platform meticulously designed to cater to the diverse needs of

embedded systems development. Leveraging the versatility of the Assembly C language, the ECG measurement algorithm is meticulously implemented to ensure efficient data processing and analysis, thereby enabling real-time visualization of cardiac waveforms.

Figure 1 meticulously elucidates the flowchart outlining the program's operation, offering a comprehensive overview of the software architecture and functionality, thus underscoring the system's efficacy in delivering actionable insights into cardiac health.

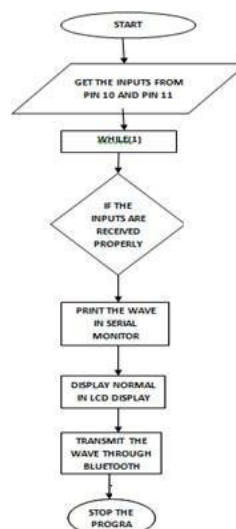


Figure.1 Software Architecture Flowchart

B. Hardware Implementation:

Here we have described briefly the hardware are an implementation of the system. The hardware part depicts briefly about the ECG monitoring circuit system parts such as Ag/Cl electrodes and ECG module.

Figure.2 depicts the circuit diagram of the interfacing between ECG module and Arduino Uno.

Here, The ECG module is getting three inputs from the human body using 3-lead electrodes. The ECG module (AD8232) has Instrumentation Amplifier and High pass filter for the working purpose. After processing the inputs, It produces a single output. This output is given to the Arduino Uno Microcontroller with the help of the Analog pins.

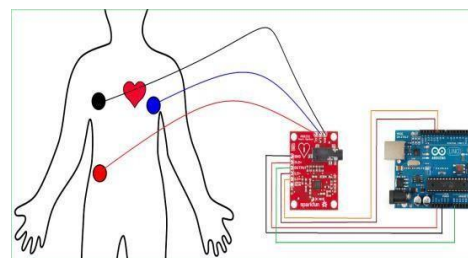


Figure.2 Interfacing of AD8232 and Arduino Uno

VI. RESULTS AND CONCLUSION

The culmination of meticulous design and rigorous implementation efforts culminates in the successful realization of a low-cost ECG monitoring system that delivers on its promise of affordability, accessibility, and clinical utility. The system adeptly displays ECG waveforms

on an LCD monitor, providing healthcare practitioners with invaluable insights into the patient's cardiac health in real-time. By harnessing the power of low-cost components and open-source technology, the system represents a paradigm shift in the provision of cardiac care, offering a viable alternative to traditional ECG monitoring devices. Future enhancements, such as IoT integration for remote monitoring and the development of mobile applications, hold promise for further augmenting the system's capabilities and extending its reach to underserved populations, thus ushering in a new era of inclusive and equitable healthcare delivery.

In conclusion, the development of a low-cost ECG monitoring system utilizing the AD8232 module and Arduino microcontroller platform represents a significant milestone in the quest for accessible and affordable healthcare solutions. By leveraging off-the-shelf components and open-source hardware platforms, the system embodies the ethos of democratizing access to cardiac care, thereby empowering healthcare practitioners and patients alike with actionable insights into cardiac health. As we look towards the future, ongoing efforts to refine the system's functionality and expand its capabilities hold promise for further advancing the frontiers of cardiac care delivery, ultimately ensuring that no individual is left behind in the pursuit of optimal cardiac health.

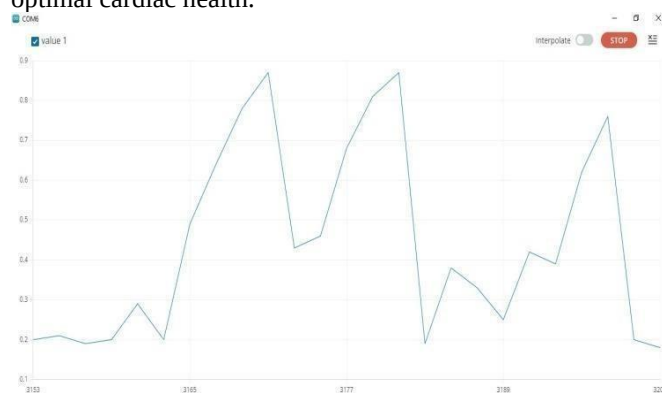


Figure 3 Heart Rate Waveform Output

```

Message (Enter to send message to 'Arduino Uno' on 'COM6')
1.58
Heartbeat detected!
Voltage: 1.60
1.60
Heartbeat detected!
Voltage: 1.48
1.48
Heartbeat detected!
Voltage: 1.
    
```

Figure.4 Input Signals measured by AD8232 Sensor

VII. SOCIAL IMPACT & FUTURE

Looking ahead, the integration of IoT capabilities and mobile applications holds immense potential for further augmenting the efficacy and reach of the low-cost ECG monitoring system. By enabling seamless remote monitoring and data analysis, the enhancements promise to revolutionize the delivery of cardiac care, empowering patients to take proactive steps towards optimal cardiac health. Additionally,

ongoing efforts to optimize hardware design and streamline software algorithms will serve to enhance the system's performance and reliability, thus ensuring its continued relevance and impact in an ever-evolving healthcare landscape.

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IOT BASED COW HEALTH MONITORING SYSTEM

Heet Mistry¹, Akhil Mistry¹, Vaibhav Pagariya¹, Anuja Odhekar²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: ¹heetmistry@gmail.com, ¹akhilmistry@gmail.com, ¹vaibhavpagariya@gmail.com, ¹mihikaa.b202@gmail.com, ²anuja.odhekar@djsce.ac.in

Abstract— With the increased demand for dairy products in the modern world, it is critical to address cow health concerns. Regular monitoring is critical for extending animal life and maintaining dairy output quality. Unfortunately, due to the shortage of time available to personnel, it may be difficult to regularly monitor the well-being of cattle on large grazing operations. This composition addressed IoT biases such as stir detectors, facial heat reporters, and heart rate observers. The aforementioned system will include a specially designed multi-sensor network to record various physiological indicators such as heartbeat, face temperatures, and contemplation in connection with surrounding moisture and temperature, and a camera for processing images to distinguish between colorful behavioral patterns. A portable app or trap runner is designed to monitor data visualization, and monitoring the cattle's real-time health state will alert the stoner if they have a health conclusion. Based on the real-time data from the detector and an engine mastering algorithm, the IoT system is connected with the application to anticipate the health state of cattle. Systems designed to monitor the health of individual cows are intended to show how to recognize and handle sick animals.

Keywords — sleep shadowing, cattle's heart rate, reflection, IoT system, ML algorithm, behavioural patters, trap runner-animals.

I. INTRODUCTION

One of the most important factors influencing dairy cow affairs is animal welfare. The following are some essential components of dairy cattle healthcare: 1. Dietary habits It is vital to dairy cattle's health to feed them a suitable and leveled diet. The diet need to include fresh, clean water coupled with attention and grit. A nutritionist may assist in creating a sensible diet based on the nutritional needs of the cow. 2. encasement Dairy pins ought to be kept in a well-ventilated, dry, and clean space. Overcrowding and inadequate ventilation can cause respiratory infections, even if illness and precipitation can contribute to instances of the udder and bases.

The process of reproduction To preserve dairy cow fertility, good reproductive practices are required. Growers may take proactive steps, such as vaccinations, varying feed and nutrition, and administering essential treatments on time, by monitoring the well-being of their cattle. For several reasons, it's critical to monitor the health of cattle. Initially, it assists in ensuring the welfare of the animals by promptly identifying and addressing any health impacts. Alternatively, it helps prevent diseases and spongers in animals, which may be costly and hazardous for the animals themselves as well as the growers who raise them. A number of benefits result from using IoT technology for cow health monitoring,

including improved animal welfare, decreased healthcare costs, and increased production.

The suggested approach to cow health monitoring provides a number of advantages over conventional methods. It enables continuous health monitoring of the cattle, which can aid in identifying early sickness symptoms and facilitating the dissemination of complaints. Additionally, it lessens the need for routine physical exams, which may save farmers time and money. Additionally, the technology gives producers up-to-date information on the health of their cattle, enabling them to make well-informed decisions about how they operate



Fig.1 Block Diagram

II. RELATED WORK

The most widely used method of laying cow behavior is visual compliance; however, due to labor resource shortages and time restrictions, this method cannot be used intensively or sustainably. It has previously been shown which milk cow farming could profit to the use of IoT technology. By utilizing perfection dairy-monitoring (PDM) technology, it is possible to inspector dairy pins without prying into their typical behavioral conveying as well as cut allegations common and mortal resource. Commercially available IoT technologies were varied with standard optical compliance. The test bias was affixed to the beast's legs and consciousness. Eating, reflecting, and sleeping habits all shown direct compliances with many of the evaluated PDM sensors. Locating cows that are ready for reproduction is still seen as a major challenge in dairy farming. Cow behavior might change dramatically during estrus.

Some behaviours include shellacking, placing a chin on her backside, feeling anxious, waiting to be attached by men, and

sniffing the throat and flehmen of a different cow. Changes in eating and reflecting behaviours occur alongside estrus. An Internet of effects-based monitoring system can support the detection of estrus in advance. Currently, there are several approaches that are being developed and implemented that address cattle health. They are recording colourful physiological indicators, such as facial heart rate, temperature, and reflection in connection with ambient temperature and moisture, using a specifically designed multi-sensor association. Additionally, a camera is trained for image processing in order to recognize bright behavioural patterns.

Data analytics will employ engine literacy ML models to detect unhealthy animals. on gather information for their study, they affix temperatures, heartbeat, and inertial measurement bias on the neck of dairy cows. Engine literacy is used to preserve and codify the collected data, creating work for normal, abnormal, and less normal health groups. Furthermore, continuous health monitoring of cattle is crucial to prolonging their lives and maintaining the caliber of dairy products. And the truth is that it might be difficult to keep an eye on the health of cattle on a daily basis, particularly in large grages where staff members lack the time to personally check on the animals.

The crucial disparity is, they are prognosticating whether any cow is suffering 3 from any complaint or not grounded on cow's geste , but we're prognosticating conditions grounded on their behavioural changes as well as non identical symptoms. We're shadowing the health of cows in real time. The former work only prognosticated one complaint; now, in order to ameliorate the delicacy grievance of our models, we're prognosticating multitudinous conditions at once. This is the primary driving manpower for this paper's dissection of the numerous exploration approaches to cow health monitoring and its donation of a result that would exercise IOT, ML, pall- grounded technologies, and real- time monitoring of the cattle along with some special features.

Visual observation is the most popular method of assessing cow conduct; however, time constraints and a shortage of personnel limit the ability to detect behaviour intensively and sustainably. By using precision dairy-monitoring (PDM) technology, it is possible to monitor dairy calves without interfering with their normal behavioural expression and to cut expenses overall and human resource requirements. It has already been demonstrated that dairy cattle ranching may profit from the use of IoT technology. IoT technologies that are commercially available were contrasted with conventional ocular observation. The animal had the test devices fastened to its ears and legs. Direct observations of eating, rumination, and laying practices showed a strong association with a number of the assessed PDM sensors. ..In the milk-producing farming sector, finding cows ready for fertilization is still seen as a major challenge. Cow behaviour might change dramatically during estrus. Some of her behaviours include licking, placing her chin on her back, sniffing another cow's vulva or flehmen, becoming restless, and waiting to be mounted by males. Changes in eating and ruminating habits coincide with estrus. An Internet of Things-based monitoring system can help identify estrus early. Many researched and implemented strategies are now being used to monitor the health of cattle. They are utilizing their study to monitor a variety of physiological markers, like

skin body temperature, pulse, and rumination in connection to the surrounding temperature and humidity.

A camera is also utilized for image processing in order to recognize different patterns of behaviour. Data analytics will make use of machine learning (ML) models to detect unwell animals. To collect data for their investigation, they affix inertial measuring devices, temperature, and heart rate sensors to the neck of dairy cows. Machine learning is used to maintain and classify the collected data, producing output for typical, less typical, and abnormal health categories.

Furthermore, continuous health monitoring of cattle is crucial to extending their lifespan and maintaining the standard of dairy products.

And the problem is, unfortunately, day-to-day monitoring of cattle's health is difficult, specifically in large farms where workers do not have sufficient time to observe the animals ' health physically. The key difference is, they are predicting whether any cow is suffering from any disease or not based on cow's behaviour, but we are predicting diseases based on their behavioural changes as well as different symptoms. We are tracking the health of cows in real time. The previous work only predicted one disease; now, in order to improve the accuracy score of our models, we are predicting numerous diseases at once. This is the primary driving force for this paper's analysis of the many research approaches to cow health monitoring and its presentation of a solution that would use IOT, ML, cloud-based technologies, and real-time monitoring of the cattle along with some unique features.

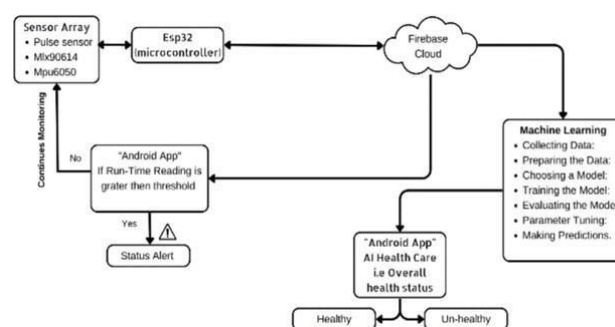


Fig.2 Cycle Diagram

III. METHODOLOGY

The approach employed in a cattle health tracking system is as follows: Hardware configuration: The accelerometer, body temperature, heart rate, and heart rate are the five parameters that Internet of Things (IoT) devices may use to track a cow's health. The first five factors are heart rate, activity level, stress due to heat, the surrounding temperature, and sleep monitoring. Monitor Heartbeats: A pulse sensors, which delivers digital information in the "BPM" format, is used to measure heart rate. The normal heartbeat of a healthy cow is between 48 and 84 beats per minute

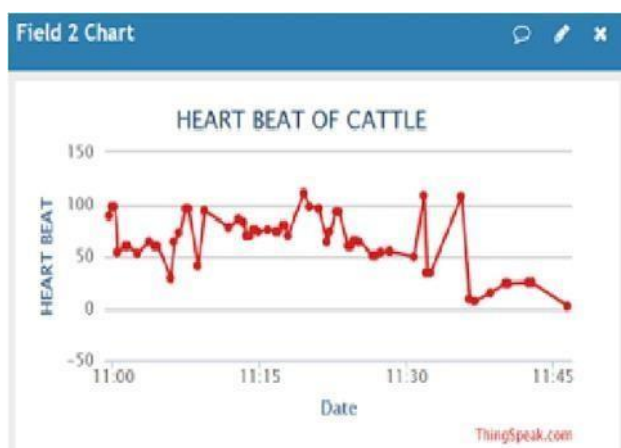


Fig.3 Heart Beat of Cattle

Monitor Activity Level: An Mpu6050 or ADXL345 sensor measures activity level. The data from a Mpu6050 sensor is given as digital data in the “X”, “Y”, and “Z” axes. Based on these three axes, provide status information like as Standing or Laying.

Monitor Heat Stress: A (Mlx90614) sensor is used to detect heat stress, and the sensor's reading is given as digital data in degrees Celsius. Additionally, this sensor provides humidity for animals in the area.

Track sleep: A pulse sensor is used to monitor sleep quality in addition to activity level.

Mobile app and Firebase Cloud: The end-user is the focus of the second portion. The end-user can access the mobile app to visualise data. IoT (Internet of Things) devices frequently employ mobile apps since they provide a straightforward user interface for managing and interacting with IoT devices. Data from the real-time Firebase cloud was obtained by the mobile app. IoT applications that need real-time data synchronisation can be easily created and managed with a real-time database.

Machine learning: This is covered in the third section. It is utilised in "AI healthcare," which refers to the general health of cattle, and "air healthcare," which forecasts the general health condition of cattle. The smartphone application shows the current condition. The random forest approach is used to train the model in order to predict "air healthcare," or the general health of cattle.

IV. IMPLEMENTATION

The present prototype consists of custom hardware designed to integrate many commercial products and sensor into one system. Using Internet of Things Sensors to Monitor Rumination A cloud, a cow device attached to the animal's collar, and an end-user application make up the cow monitoring system's components. The information obtained through the device's sensors is transferred via opportunistic data transmission to ensure optimal power efficiency. To compensate for the inaccuracy of measurements, the data supplied within a payload of Bluetooth low energy (BLE) signals is updated every 10s. After obtaining the BLE packets, the Hub forwards them to the server. Through the internet, the server interacts with the hub and controls input from the Cow Device.

Data may be tracked for each cow via an end-user app that shows the entire set of information. A tripartite framework is utilized to identify behaviors like daydreaming. Level '0' use statistical measures to discern behaviors, Level '1' projects the cow's present state, and Level '2' employs a reference framework that considers the particular characteristics of the particular cow. determining the most precise forecast for the cows' present conduct is the primary goal. The head motion sensor is a waterproof casing-enclosed three-axis accelerometer that is fastened to a halter that is placed atop the cow. At the moment, the cow's raw accelerometer data are gathered and sent straight to the base stations for additional processing. Upon the development of an effective algorithm for the onboard processing of accelerometer data, it will be incorporated into either the core processor or a processor specifically designated for that purpose. This will significantly lower the amount of memory needed for data storage and the amount of power needed for wireless data transfer. The viewing web is called ThingSpeak. The main goal of the program is to enable users to get to the database via the Internet so they may conduct state-of-health assessments from different places. This program provides a user interface with graphics to assist in the interpretation of the data obtained from the health tracking system. The application's features will provide Internet-based animal monitoring. For example, a temperature graph may display an animal's core body temperature across a variety of time periods, and a GPS unit can display a cattle's movements within a herd. Because of its plug-and-play architecture, analytical modules can be added to the programme with ease.

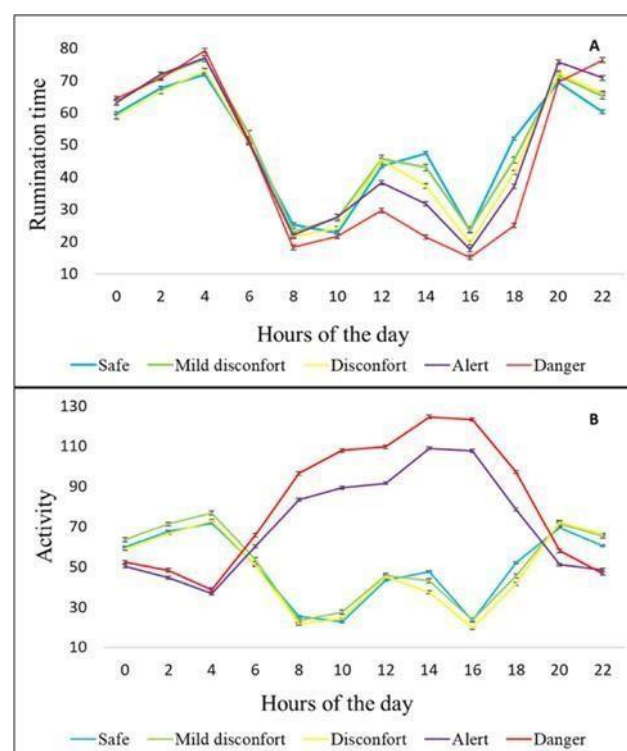


Fig.4 Heart Activity of Cattle

V. RESULTS AND CONCLUSION

The system used the GPS to record the cattle's position, level of activity, surrounding humidity and temperature, breathing, heartbeat, and body temperature. The information was gathered and kept on a centralized server. Algorithms analyzed the data to search for any anomalies related to the cattle's health. Notifications were delivered on the farmer's smartphone if any anomalies were found. The system's test subjects were ten cattle. Data was collected over a three-month period to show that the method was accurate in spotting early signs of sickness or disease. The system recognized this as a case when the cattle's body temperature and respiration rose. The animals were taken to the veterinarian for care when the farmer was notified.

Though the system is currently in its early stages of development, components such as methods for parameter health evaluation and data aggregating in a system of local/regional databases have the potential to completely transform the cow farming sector.

VI. FUTURE SCOPE

The cow health monitoring system has a wide range of potential applications in the future, such as:

Precision Livestock Farming (PLF): To offer a more comprehensive approach to livestock management, the automated feeding systems and the cow health monitoring system can be connected.

Tailored health plans: Depending on each bovine's unique health history and conditions, the next generation of cattle health monitoring systems might offer personalised health programmes.

Integration with precision medicine: Individualised treatment programmes for cattle can be created by integrating the health of the animals with precision medicine approaches.

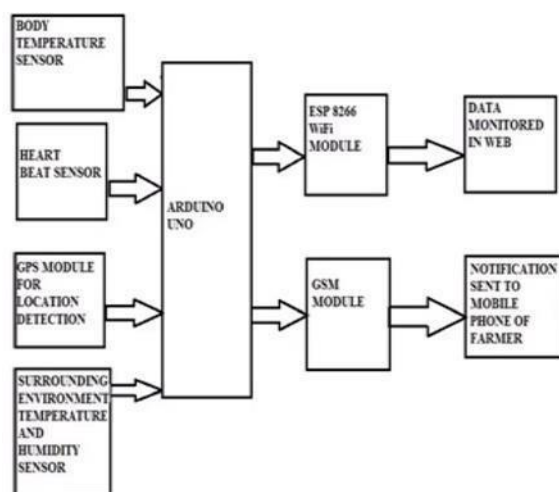


Fig.5 Working Diagram

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HAND BASED GESTURE CONTROLLED ROBOT

Dhruvi Shah¹, Het Shah¹, Sheel Rana¹, Tushar Sawant²

¹U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai-400056

²Assistant Professor, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: dhruvi245@gmail.com, hetushah2708@gmail.com, sheelrana609@gmail.com

Abstract—In today's industrial world, the use of robotics has become an essential part of manufacturing and production processes. This project aims to develop an industrial robotic crane with a robotic arm that can identify and manipulate objects using Arduino and object detection technology. The system will be equipped with a variety of sensors, including cameras, that will detect objects and provide real-time feedback to the Arduino. The Arduino will then use this data to send commands to the robotic arm, allowing it to manipulate objects as needed. The project will demonstrate the potential of using robotics in the manufacturing industry and highlight the benefits of automation.

Keywords- Autonomous robot, Arduino UNO, robotic arm, HC-05

I. INTRODUCTION

An industrial robot is a type of robot that is designed specifically for manufacturing or industrial applications. These robots are often used in tasks such as welding, painting, assembling, material handling and packaging. They are typically programmed to perform a specific set of tasks and can be reprogrammed as needed to adapt to changes in production processes. Industrial robots have been in use since the 1960s, and they have become increasingly advanced and sophisticated over the years. Today's industrial robots are capable of working alongside human workers in a collaborative manner, making them highly versatile and adaptable to a wide range of production environments. One of the key advantages of industrial robots is their ability to automate tasks that are repetitive, hazardous, or require high precision. By using robots to perform these tasks, manufacturers can reduce the risk of workplace injuries and improve product quality, while also increasing production efficiency and reducing costs. Overall, industrial robots have revolutionized the manufacturing industry and have enabled manufacturers to produce goods more efficiently and effectively than ever before. As technology continues to advance, we can expect to see even more exciting developments in the field of industrial robotics, with robots becoming even more advanced, versatile, and adaptable to a wide range of production environments.

The Arduino microcontroller UNO, Servo motor, HC05, jumper wires.

II. PROPOSED DESIGN

The project involves designing and building a robotic crane with a robotic arm that is capable of detecting and picking up objects

using an Arduino, the robotic arm is designed to pick up and manipulate the objects as needed. The project also involves integrating electronic components that is the Arduino Uno, HC-05, A Robotic Arm operated with 6 servo Motors, developing software, testing and evaluating the system, developing a user interface, and integrating all the components to create a complete and functional robotic system. The goal of the project is to develop an innovative and efficient robotic system that can provide significant benefits to the manufacturing industry, by improving efficiency, reducing labor costs, and increasing productivity.

III. COMPONENT DESCRIPTION

1. Arduino UNO

The Arduino Uno is a versatile microcontroller board that serves as the foundation for countless electronic projects. At its core lies the ATmega328P microcontroller chip, boasting 32 KB of flash memory for program storage, 2 KB of SRAM for data storage, and 1 KB of EEPROM for non-volatile memory storage. With a clock speed of 16 MHz, it's capable of executing instructions swiftly. The Uno offers 14 digital I/O pins, including 6 PWM-capable pins, and 6 analog input pins, facilitating interfacing with a wide array of sensors, actuators, and peripherals. Powering the Uno is simple, with options for USB connection or an external DC power supply through the onboard voltage regulator. A reset button allows for easy program reinitialization. Additionally, it features LEDs for power and pin 13 status indication, while a USB-to-serial converter chip enables seamless communication with computers. With its user-friendly interface and extensive community support, the Arduino Uno empowers creators to bring their electronic ideas to life efficiently and effectively.



Fig 1-Arduino UNO

2. SG 90

The SG90 servo motor is a compact and lightweight component widely utilized in hobbyist electronics and robotics projects due to

its affordability and versatility. With dimensions typically around 22 mm × 12 mm × 29 mm and weighing just 9 grams, it is well-suited for applications with limited space constraints. Despite its small size, the SG90 offers a reasonable torque output of approximately 1.8 kg/cm, making it capable of handling various light-duty tasks. Operating within a voltage range of 4.8V to 6V DC, it can be powered by common sources such as batteries or dedicated power supplies. Its standard three-wire control interface simplifies integration into projects, with connections for power, ground, and control signals. Additionally, the SG90 servo motor delivers responsive and relatively fast movement, with an unloaded speed of about 0.12 seconds per 60 degrees rotation. Overall, the SG90 servo motor is a popular choice for hobbyists and enthusiasts seeking a compact and reliable actuator for their projects.



Fig 2-SG 90 Servo Motor

3. MG 995

The MG995 servo motor is a popular and widely used hightorque servo motor in robotics and electronics projects. It is known for its robust construction, reliability, and affordability. The MG995 features metal gears, which enhance its durability and make it suitable for applications requiring higher torque. With a torque output of around 10 kg-cm at 6V, it is capable of exerting considerable force, making it ideal for tasks such as lifting, pushing, and pulling heavy loads. The motor operates over a wide voltage range, typically between 4.8V to 7.2V, allowing flexibility in power supply options. It utilizes pulse width modulation (PWM) signals for control, with a typical operating frequency of 50 Hz. The MG995 servo motor offers precise positioning and smooth operation, making it well-suited for applications in robotics, remote-controlled vehicles, animatronics, and other mechanical systems where accurate motion control is essential.



Fig 3-MG 995 Servo Motor

4. HC-05

The HC-05 is a widely-used Bluetooth module renowned for its versatility and ease of integration in electronics projects. It operates on Bluetooth version 2.0 and can function as both a master and slave device, offering flexibility in establishing wireless connections between various electronic components. The module typically supports a range of up to 10 meters, making it suitable for short-range communication applications. It features a UART (Universal Asynchronous Receiver Transmitter) interface, allowing seamless communication with microcontrollers such as Arduino, Raspberry Pi, and other embedded systems. The HC-05 module is renowned for its simplicity of use, often requiring minimal configuration to set up a reliable



Fig.4 Fig 4-HC-05 Bluetooth Module

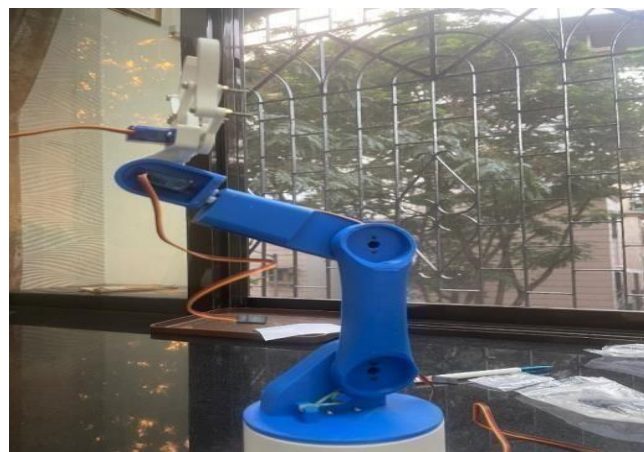


Fig 5- Robotic Arm

V. RESULT

This Arduino code is designed to control a robot arm via Bluetooth using an HC-05 module. It initializes servo motors and sets their initial positions. The main loop continuously checks for incoming data from the Bluetooth module. When data is received, it's read as a string.

The app is made using the MIT App Inventor online application and here's how it works. At the top we have two buttons for connecting the smartphone to the HC-05 Bluetooth module. Then on the left side we have an image of the robot arm, and on the right side we have the six slider for controlling the servos and one slider for the speed control. Each slider have different initial, minimum and maximum value that suits the robot arm joints. At the bottom of the app, we have three button, SAVE, RUN and RESET through which we can program the robot arm to run automatically. There is also a label below which shows the number of steps we have saved.

VI. Circuit Diagram:

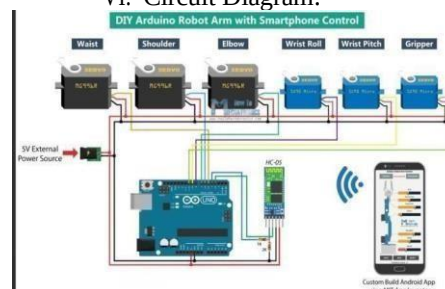


Fig 6- Circuit Diagram

VII. CONCLUSION

We aim to replicate a warehouse type environment where various sizes of objects such as boxes or containers are meant to be identified, picked up and moved around the warehouse. The main aim of our project is picking and dropping the object. The integration of the HC-05 module enables wireless communication, allowing for remote control and operation of the crane. The combination of SG90 and MG9950 servo motors provides a balance between size, power, and torque, allowing for the manipulation of various crane components with different requirements. The SG90 motors can handle lighter loads and provide agility for swift movements, while the MG9950 motors offer higher torque capabilities, suitable for lifting heavier loads and providing stability.

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Smart Energy Meter for Theft Detection

¹Shreya Pathak, ¹Sakshi Mane, ¹Shubham Bhimawat, ²Rahul Taware

¹U. G. Student, Department of Electronics and Telecommunication, D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

– ²Assistant Professor, Electronics and Telecommunication Department D.J. Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: ¹pathakshreya03@gmail.com, ¹sakshimane2404@gmail.com, ¹shubhambhimawat123@gmail.com, ²rahul.taware@djsce.ac.in

Abstract—Globally, electricity distribution systems face significant challenges that hamper their capacity to distribute electricity efficiently, with electricity theft becoming a pervasive issue within the electrical distribution systems because of the problems of power distribution. It is common for the perpetrators of this illicit activity to tamper with the meters within the homes of consumers and to establish unauthorized connections with a distribution pole grid by hooking up with the lines. A surge in electricity theft has caused power utilities to reassess their customer engagement strategies, putting an emphasis on customer feedback mechanisms and implementing loss detection systems into their distribution networks in response to rising levels of electricity theft. This paper examines the multifaceted nature of electricity theft, encompassing meter tampering and unauthorized connections, and explores the socio-economic factors driving this illicit activity. Drawing upon empirical data and case studies, the research identifies the detrimental impacts of electricity theft on utilities and society at large. By harnessing the power of real-time monitoring and predictive analytics, utilities can proactively safeguard their distribution networks against illicit encroachments, thereby preserving revenue streams and enhancing system reliability.

Keywords— *Electricity Theft, Illegal Connection, ESP-32 microcontroller, Firebase Realtime Database, Smart meter APP*

I. INTRODUCTION

In the domain of power systems, operational losses represent a formidable hurdle, categorized broadly into two distinct types: technical and non-technical losses. Technical losses primarily manifest within distribution networks, arising from a variety of factors including cable faults, transformer inefficiencies, overhead line losses, and other deficiencies within substation equipment utilized for the transmission and distribution of electricity. Conversely, non-technical losses predominantly occur within distribution system networks and stem from illicit activities such as unauthorized electrification schemes, cable theft, evasion of electricity tariffs, utilization of counterfeit prepaid vouchers obtained from stolen vending machines, meter manipulation, and the establishment of illegal electricity connections, among others. Among these, meter tampering and illegal connections emerge as the principal contributors to non-technical losses, representing significant challenges for power utilities worldwide. The pervasive issue of electricity theft, encompassing both meter tampering and unauthorized connections, has escalated into a pressing concern for utilities and governments alike, precipitating substantial

financial losses. Illegal connections entail the clandestine tapping into the distribution grid without proper authorization, often through makeshift hook-ups or unauthorized wiring. These unauthorized connections not only siphon off electricity without accountability but also strain the distribution infrastructure, leading to overloading, voltage fluctuations, and safety hazards. The Smart Energy Meter serves as a sophisticated tool capable of continuously monitoring electricity consumption patterns and swiftly identifying anomalies indicative of potential theft. By leveraging advanced sensors and data analytics algorithms, this system can detect irregularities such as unexpected spikes or discrepancies in energy usage, which may signify tampering or illegal connections. By leveraging a network of interconnected devices and leveraging data analytics, utilities can gain deeper insights into consumption patterns and identify potential instances of theft with greater accuracy. Utilizing an ESP32 microcontroller in conjunction with current and voltage sensors presents a robust approach to accurately measure power consumption in real-time. By employing these sensors, the system can precisely capture the electrical parameters necessary to calculate power consumption, providing a reliable basis for monitoring energy usage. The ESP32 microcontroller serves as the central processing unit, gathering data from the sensors and facilitating communication with external systems. Integrating Firebase, a cloud-based platform, into the system offers numerous benefits. Firebase provides a scalable and secure environment for storing, processing, and analysing the collected data. The Smart Meter app serves as the interface through which users interact with the system. Integrated with Firebase, the app provides users with real-time access to their energy consumption data, empowering them to monitor and manage their usage effectively. The combination of an ESP32 microcontroller, current and voltage sensors, Firebase, and the Smart Meter app offers a powerful solution for real-time power consumption monitoring and management. By harnessing the capabilities of these technologies, utilities can enhance their operational efficiency, reduce revenue losses due to power theft, and empower consumers to make informed decisions about their energy usage.

II. LITERATURE SURVEY

The issue of electricity theft (meter tampering and illegal connection) has become a serious concern for most power utilities worldwide. It has resulted in huge financial losses to the power utility and the government. The financial ramifications of electricity theft, driven by illicit activities, have been widely documented, emphasizing its adverse impact on municipal electrical departments and the broader economy. Current monitoring systems, characterized by separate approaches for distribution grids and consumer dwellings, face limitations, necessitating a unified, real-time power theft monitoring and detection system.

The number of power theft cases detected in India varies each year. In 2021, a total of 7,169 power theft cases were detected, amounting to a loss of Rs 87 crore. In 2022, this number increased to 13,370 cases, resulting in a loss of Rs 264 crore. Recent literature advocates for technological innovations, such as smart meters, to enhance detection accuracy, prevent revenue losses, and ensure the integrity of power distribution networks. The smart meters aim to enhance theft detection capabilities and contribute to a more efficient and sustainable energy ecosystem. The literature analysis makes it evident that efforts have been undertaken to address the problem of electricity theft, which includes meter tampering and unauthorized connections. However, one system must be used to handle both electricity theft issues at the same time. Any effort at electricity theft within the power system grid is intended to be recognized, tracked down, and located by the planned real-time power theft monitoring and detection system. Smart meters that are installed on every consumer home and distribution pole grid/node are used in the design of this suggested system. The Smart Energy Meter emerges as a pivotal tool in addressing both technical and non-technical losses. According to survey 2020, smart meters equipped with advanced sensors and data analytics capabilities can effectively monitor electricity consumption patterns and identify anomalies indicative of potential theft or system inefficiencies. The integration of smart meters with cloud-based platforms like Firebase offers a scalable and secure solution for real-time data storage, processing, and analysis. Through this project we not only wanted to build a theft detection system but also a user interface for transparency.

III. PROPOSED DESIGN

The proposed design of the smart meter system is envisioned as a modern solution to enhance the management and monitoring of electricity consumption in homes. At the core of this system is the main electricity supplier, responsible for distributing electricity to households. In this design, each household is equipped with a state-of-the-art smart meter. Unlike traditional meters, these smart meters are equipped with advanced sensors and communication capabilities. They continuously measure and capture real-time data on

power consumption within the home. This real-time data is crucial for providing accurate and up-to-date information on electricity usage. Once the smart meter collects the real-time data, it securely transmits this information to Firebase. Firebase serves as a robust and secure cloud-based database designed to store and manage large volumes of data. In this context, Firebase acts as a centralized repository where the electricity consumption data from each smart meter is stored. The data is organized systematically, making it easier to retrieve, analyse, and manage.

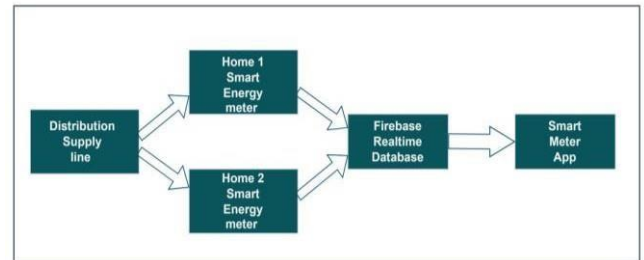


Fig.1 Basic System Design

After the data is stored in Firebase, it is then made accessible through a dedicated application. This application is designed with a user-friendly interface that allows both consumers and utility company representatives to view the electricity consumption data of each household. Consumers can monitor their daily, weekly, or monthly electricity usage, track patterns, and make informed decisions to manage their energy consumption more efficiently. The proposed smart meter system design offers a comprehensive and integrated approach to electricity monitoring and management. By leveraging smart technology, cloud-based storage, and user-friendly applications, this system aims to provide accurate, timely, and actionable information to both consumers and utility companies, ultimately leading to more efficient energy use and better service delivery.

IV. IMPLEMENTATION

The principle of monitoring and analysing the aggregate power consumption of individual households within a distribution network. Consider a scenario where two homes, designated as Home 1 and Home 2, are equipped with smart energy meters denoted as S1 and S2 respectively. Under normal circumstances, the cumulative power consumption of these homes, as recorded by the smart meters, should accurately reflect the total load drawn from the main supply line. However, discrepancies in this aggregate consumption, such as instances where the total indicated on the main supply line exceeds the sum of individual household consumptions, may indicate unauthorized tapping or theft of electricity. For instance, if the collective consumption of Home 1 and Home 2, as recorded by

their respective smart meters, accounts for 200 Watts, yet the total observed on the main supply line registers 250 Watts, a discrepancy of 50 Watts is indicative of potential theft.

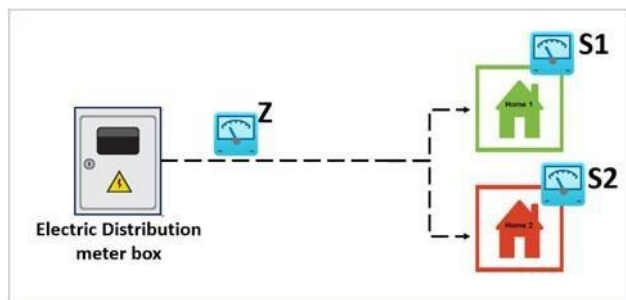


Fig.2 Logical Implementation

In the given fig.2 distribution of electrical supply within buildings often involves a system of individual meters installed in each home, alongside a central meter located in the distribution line. In this configuration, individual meters, denoted as S1 and S2 for respective homes, are employed to measure the consumption of electricity within each household. Additionally, a main meter label as Z, is positioned within the distribution line to monitor the aggregate consumption of electricity for the entire building. This setup facilitates the comparison of the cumulative readings from individual meters with the values recorded by the main meter, providing a means to reconcile discrepancies and ensure accurate calculation based on the total energy consumed.

A. Hardware System

The smart energy meter design depicted in Figure 4 showcases an advanced configuration that integrates multiple components to provide a comprehensive and user-friendly energy monitoring solution. At the core of this system is the ESP32 microcontroller, selected for its robust performance capabilities, including ample General-Purpose Input/Output (GPIO) pins which accommodate the necessary sensors and peripherals. Its ability to connect to Wi-Fi is crucial for the seamless transmission of data to Firebase, a cloud-based platform where the data is stored and managed. This integration ensures that the data collected by the smart meter is not only securely stored but is also accessible in real-time through a dedicated smartphone application, enhancing user interaction and engagement.

The electrical current measurement in the system is facilitated by an ACS712 module sensor, which is connected in series with the household's power supply. This placement is critical as it allows the sensor to measure the flow of electric current passing through it directly, offering precise readings that are essential for accurate consumption tracking. For voltage measurement, the system employs a ZMPT101B sensor module, which is connected in parallel to the power line. This parallel connection is designed to accurately detect voltage levels without interrupting the circuit.

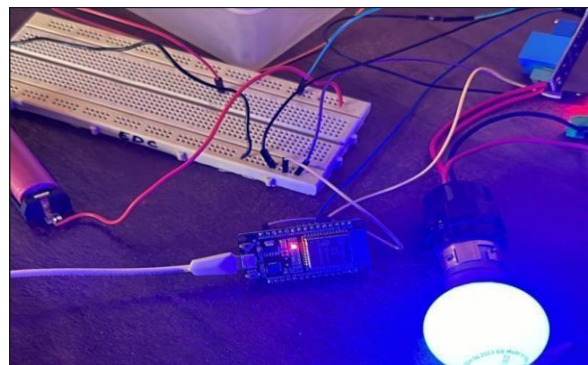


Fig.3 Hardware setup of Smart Meter

Additionally, a 16x2 LCD display is integrated into the system, serving as an immediate visual interface for users. This display shows essential information such as real-time power consumption, allowing users to monitor their electricity usage actively without needing to access the mobile application. This feature is particularly useful for quick checks and helps in raising awareness about energy consumption patterns, prompting more conscious energy usage.

```
COM4
21:46:37.789 -> ID: XYZ789
21:46:38.138 -> PASSED
21:46:38.184 -> PATH: /home2/area2
21:46:38.184 -> TYPE: string
21:46:38.184 -> Area: Vile Parle
21:46:52.039 -> Current: 1.31 mA
21:46:52.068 -> Voltage: 2.44 V
21:46:52.381 -> PASSED
21:46:52.381 -> PATH: /home2/power2
21:46:52.423 -> TYPE: float
21:46:52.423 -> Power: 3.20 Watts
21:46:52.679 -> PASSED
21:46:52.713 -> PATH: /home2/id2
21:46:52.713 -> TYPE: string
21:46:52.754 -> ID: XYZ789
21:46:52.993 -> PASSED
```

Fig 4. Output of ESP32 in Arduino IDE

In Figure 4, the Arduino Integrated Development Environment (IDE) window displays the output readings from the ESP32 microcontroller once the hardware setup of the smart energy meter has been implemented. This output is crucial as it provides real-time feedback on the system's functionality and the accuracy of the connected sensors. In this scenario, the output window likely shows a series of data points that represent the electrical parameters being measured, such as current and voltage. The values displayed are the real data directly from the ACS712 and ZMPT101B sensors, which measure the current and voltage, respectively.

Overall, the selection of the ESP32 microcontroller is justified not only by its technical specifications but also by its compatibility with IoT applications, facilitating a smarter and more interactive energy management

system. The use of ACS712 and ZMPT101B sensors ensures the system provides reliable and accurate measurements of the electric parameters, critical for detecting discrepancies that could indicate electricity theft or other issues. This smart energy meter configuration thus stands as a vital tool in modern energy management, promoting efficiency, transparency, and sustainability.

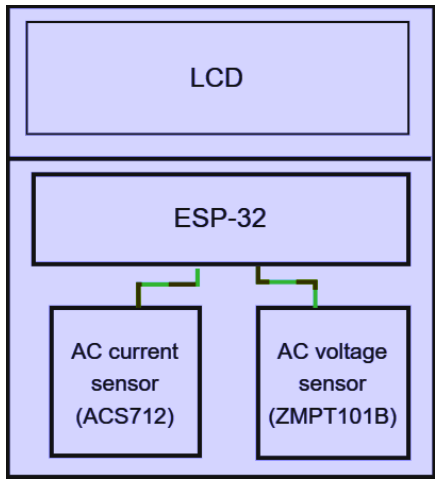


Fig.5 Smart Meter Block Diagram

B. Software System

The Firebase Realtime Database plays a pivotal role in this project by serving as a central repository that not only stores individual power consumption readings from Smart Energy Meters across various households but also aggregates these readings to monitor the total power load on the main supply distribution line. Its ability to provide real-time data synchronization ensures that both consumers and utility providers receive instant updates, facilitating immediate responses to potential issues such as unusual spikes in power usage which may indicate electricity theft. This system enhances the operational efficiency of power distribution networks by allowing for proactive management and detailed analysis of power consumption patterns, thereby improving the reliability and sustainability of electricity supply.

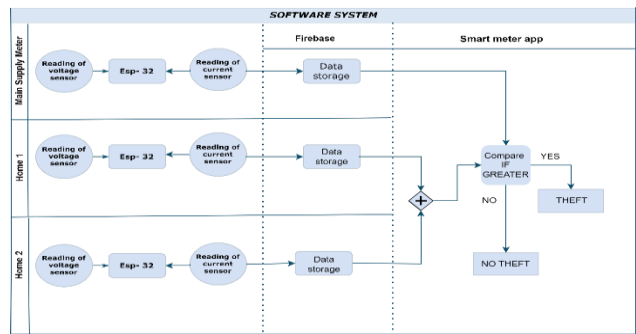


Fig.6 Software System Flowchart

The Smart Meter App, developed using MIT App Inventor, offers tailored interfaces for administrators and consumers to cater to their specific needs. For administrators, the app provides a secure login mechanism using a unique area ID, granting personalized access to their respective areas. The app displays detailed power consumption data, including individual readings from each household and the total consumption. It also monitors the power on the distribution line, enabling administrators to compare it with household consumption to detect any discrepancies or potential theft conditions. Utilizing logical blocks in MIT App Inventor, the app performs comparisons between individual and total power consumption, generating alerts if significant differences are detected, thereby notifying administrators to take immediate action.

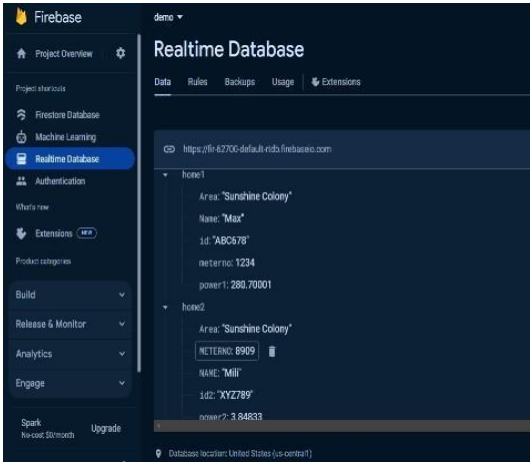


Fig.7 Firebase Real Time Database

On the other hand, the consumer interface of the Smart Meter App allows consumers to log in using a unique login ID assigned to them. Upon login, consumers can view their registered name and meter number, providing transparency and accountability. The app enables consumers to monitor their individual power consumption, helping them manage their electricity usage more efficiently. A clock mechanism is implemented in MIT App Inventor to update the power consumption values at regular intervals, ensuring that consumers and administrators always have access to the latest data. In case of any suspicious activity or potential theft detected by the system, an alert is sent to the administrator via notifier, prompting them to take immediate action.



Fig.8 Smart Meter App Interface

V. RESULT AND CONCLUSION

The implementation of the proposed smart meter system demonstrated promising results in enhancing the monitoring and management of electricity consumption. The system successfully captured real-time data on power consumption from individual households and transmitted this information securely to Firebase. The Firebase database efficiently stored and managed the collected data, providing a centralized repository for easy retrieval and analysis.

The system's ability to detect discrepancies in aggregate power consumption between individual households and the main supply line proved valuable in identifying potential instances of electricity theft. This proactive approach to theft detection enables utilities to safeguard their revenue streams, preserve the integrity of their distribution networks, and promote a more sustainable and efficient energy ecosystem. In conclusion, the integration of smart meters with advanced sensors, data analytics, and cloud-based platforms like Firebase offers a promising solution to address the multifaceted challenges posed by electricity theft. By harnessing the capabilities of these technologies, utilities can enhance their operational efficiency, reduce revenue losses due to power theft, and empower consumers to make informed decisions about their energy usage. Future research and development in this field should focus on further enhancing the system's detection accuracy, expanding its scalability, and exploring additional functionalities to continuously improve its performance and effectiveness.

VI. SOCIAL IMPACT & FUTURE

The implementation of the smart meter system has profound social implications that extend beyond the realm of electricity distribution and consumption. One of the most significant social impacts of this project is the promotion of transparency and accountability in the energy sector. By

providing consumers with real-time access to their electricity consumption data, the system empowers them to make informed decisions about their energy usage, leading to more responsible and sustainable consumption patterns. Furthermore, the detection and mitigation of electricity theft through the smart meter system contribute to the reduction of financial losses incurred by power utilities. This, in turn, can lead to more stable and affordable electricity tariffs for consumers, making electricity more accessible to low-income households and underserved communities.

As we look to the future, there are several avenues for further development and expansion of the smart meter system. One potential direction is the integration of renewable energy sources and energy storage systems to create a more resilient and sustainable energy ecosystem. By incorporating solar panels, wind turbines, or battery storage into the system, households can generate, store, and manage their own energy, reducing dependency on the main power grid and promoting renewable energy adoption.

ACKNOWLEDGMENT

This project and the accompanying technical paper greatly benefited from the expert guidance of Professor Rahul Taware. His extensive knowledge and hands-on approach were crucial in navigating the complexities of our research, providing invaluable insights at every stage. We owe a significant part of our project's success and the depth of our paper to his mentorship.

Additionally, we are thankful to our colleagues who generously shared their expertise and provided constant encouragement throughout the research process. Their contributions not only enriched our work but also enhanced our collaborative experience, making significant impacts on the final outcome of our project.

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Smart Home Automation System

Jenil Shah¹, Om Jethwa¹, Sonia Nadkarni¹, Pavan Borra²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: jenilshah880@gmail.com, omjethwa.10@gmail.com, sonu3n@gmail.com , pavan.borra@djsce.ac.in

Abstract—Internet of Things (IoT) refers to a situation whereby objects are interconnected through the use of software as well as sensors and actuators. These appliances can then send data between them via network and other devices. In our house, this technique is employed for smartness and ease in operation of gadgets that would enable one to connect with things as they go by. Smart homes lay a foundation of comfort and convenience using IoT technology. Automation and security remain the major concerns experienced in most modern smart homes. The internet's access to all the house gadgets makes it easier for hackers to know much about someone's personal life; such as when one was away from home on a vacation or in business trip. This project has been tailored towards implementing a home security system that has wireless capabilities. AES encryption achieves security over networks. More so, if there is no alarm notification systems like sirens or any way of letting an intruder know that he has been caught will make this device not fulfil its requirement completely since burglars may get away with whatever they had come for before being captured. Home automation uses various sensors located throughout the premises. Therefore, utmost attention is given to ensuring privacy, non-repudiation and integrity of data sensed by smart objects within smart homes. Moreover, computation overhead presents itself as another obstacle related with Smart Home solutions. Comfortable living environment according to user requirements depending on the scenario is primary requirement for automation. There is also major concern on automation with learning human behavior in the smart home concept. In this paper, a secure IOT based approach has been presented to design a smart home architecture which reduces computational overhead.

Keywords— Internet of Things (IoT), Home automation, Smart devices, Wireless communication protocols, Sensor networks, User interface design, Data security and privacy, Home safety and security, Firmware updates and maintenance, User behavior analysis, Home entertainment integration, Smart lighting and environmental control.

I. INTRODUCTION

Modern homes are undergoing a revolution driven by technological advancements. Smart home automation systems are rapidly transforming living spaces, integrating networked devices to enhance comfort, security, and efficiency. This paper delves into the core concepts of smart home automation, exploring the underlying technologies, communication protocols, and the diverse range of applications that are reshaping how we interact with our homes. We will examine the benefits of automation, including improved energy management, heightened security measures, and the creation of personalized living environments. Furthermore, we will address the technical challenges associated with smart home systems, such as interoperability, data privacy, and cybersecurity concerns. By

providing a comprehensive overview of this dynamic field, this paper aims to illuminate the potential of smart home automation to transform our domestic lives in the contemporary era where technological advancements have permeated every facet of human life, reshaping the way individuals interact with their surroundings. This burgeoning field amalgamates cutting-edge technologies to redefine the concept of home living. Through an exploration of architecture, functionalities, benefits, challenges, and future prospects, we seek to unveil the potential of smart home automation in enhancing convenience, efficiency, security, and sustainability. Ultimately, our aim is to envisage a future where homes seamlessly adapt to occupants' needs and preferences.



Fig.1 Smart Home

II. LITERATURE SURVEY

Smart home automation systems offer a glimpse into the future of intelligent living spaces. By understanding the underlying technologies, system architectures, and addressing security and privacy concerns, researchers and developers can create more user-friendly, secure, and interoperable smart home solutions for widespread adoption. This literature survey provides a foundation for further research in specific areas like AI integration, enhanced security protocols, and improved interoperability standards. Wireless technology is a method of connection within an IoT machine that consists of sensors, platforms, routers, applications, and other systems. Each option has trade-offs between electricity consumption, bandwidth, and range. At a high level, there are widespread wireless options like mobile (3G, 4G, 5G) and WiFi, and there are long-range alternatives like LoRaWAN and LPWAN. Connected tool businesses need to apprehend the basics of the pinnacle IoT technology to decide the high-quality wireless technology choice for their wishes.

Wireless communication protocols enable seamless connectivity between gadgets, home equipment, and gadgets. Wireless verbal exchange protocols, exemplified by way of technology like Wi-Fi and Bluetooth, enable connectivity with out the need for stressed out connections, letting them communicate with each other. This connectivity has made it convenient to manipulate the devices in our clever domestic.

The emergence of IoT and part computing has led to the proliferation of related gadgets and wireless verbal exchange protocols making the house clever with smart appliances and devices. The center characteristic of IoT is the interconnectivity of devices inside the domestic. Imagine waking up to easily made bread toast and espresso as your mobile alarm triggers your toaster and coffee maker to make your breakfast and so, is the characteristic of a smart domestic where devices speak with every other seamlessly. The interconnectivity of IoT can provide you with such magical reports that can blow up your mind.

III. THEORY

- **Project Objective:** Define the main aim of the assignment, consisting of improving strength efficiency, improving comfort, or growing security.
- **System Architecture:** Design the general structure of the clever home machine, including components such as sensors, actuators, controllers, and person interfaces.
- **Sensors and Actuators:** Select suitable sensors to screen environmental conditions like temperature, humidity, mild, movement, and presence. Choose actuators to govern devices consisting of lighting, HVAC systems, door locks, and appliances.
- **Communication Protocol:** Decide on a commune protocol for the clever domestic devices, including Wi-Fi, Bluetooth, Zigbee, or Z-Wave, ensuring compatibility and reliability.
- **Controller:** Determine the relevant controller for the smart home system, which could be a dedicated hub, a microcontroller ,or a cloud-based totally platform.
- **User Interface:** Develop person interfaces for controlling and monitoring the clever domestic machine, inclusive of mobile apps, internet interfaces, voice assistants ,and physical interfaces
- **Automation Logic:** Implement automation common sense to define guidelines and situations for automatic manipulate of devices primarily based on sensor information and person alternatives. This should include scheduling, occupancy detection, environmental triggers, and integration with third-celebration offerings.
- **Security and Privacy:** Address protection issues with the aid of implementing encryption, authentication, and authorization mechanisms to protect sensitive statistics and save you unauthorized get entry to to the smart home machine.
- **Testing and Validation:** Test the smart domestic machine in distinct scenarios to make certain reliability, scalability, and usability. Conduct

consumer trying out to gather remarks and enhance the consumer experience.

- **Deployment and Maintenance:** Deploy the smart domestic device within the target surroundings, imparting documentation and support for users. Establish tactics for system maintenance, updates, and troubleshooting.
- **Future Expansion:** Plan for destiny growth and integration with additional gadgets, offerings, and technology to preserve the smart home gadget up-to-date and adaptable to evolving wishes and requirements.
- By following those steps, you can create a complete and effective clever home automation venture tailored in your precise necessities and choices

IV. METHODOLOGY

For this Arduino Project, we've got used an Arduino Uno as a improvement board and controller. Various sensors are used for detecting movement of objects and identifying them. These consist of movement sensors can sensors, etc. Also fire and smoke danger detection is feasible with using Smoke sensor MQ2. The complete facts is collected and then transmitted from the controller to the user terminal thru internet, allowing the user to take instant and right control selections hence from a far off region. This helps to offer superior protection and twist of fate manipulate.

Many home equipment are related as peripherals to the controller that may be monitored and managed via the person, making sure the usage of superior functions which are scalable to non-public wishes. The monitoring of those home equipment also help the user to preserve a song and manipulate the strength utilization by way of those appliances. This increases efficiency and comfort and decreases fee, lack of energy and other assets and enables the person to have a totally controlled and achievable operation of the residence

V. IMPLEMENTATION

Implementing smart home automation using ESP32 involves integrating various sensors, actuators, and communication protocols to create a seamless and efficient system. Initially, the ESP32 microcontroller is programmed to connect to the home Wi-Fi network, enabling communication with other devices. Sensors like motion detectors, temperature sensors, and light sensors are interfaced with the ESP32 to collect relevant environmental data. This data is then processed locally or sent to a cloud server for analysis and decision-making. Based on predefined rules or user inputs, the ESP32 controls actuators such as relays, motors, or LEDs to automate tasks like turning lights on/off, adjusting room temperature, or operating appliances. Additionally, mobile applications or web interfaces can be developed to provide remote control and monitoring of the smart home system, offering convenience and flexibility to users. Overall, the ESP32 serves as the central hub for orchestrating the smart

home automation ecosystem, enhancing comfort, energy efficiency, and security in residential spaces.

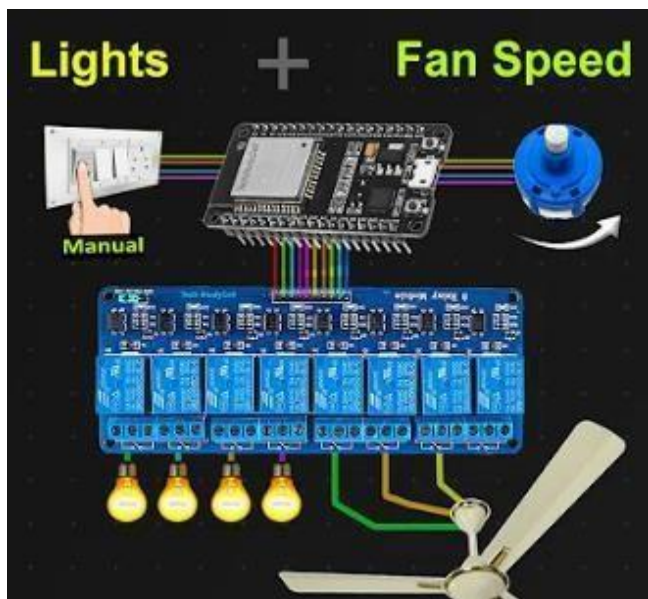


Fig.2 Circuit Diagram

VI. RESULTS AND CONCLUSION

In this review paper the concept of the smart home and the advent of the smart grid had been provided. Smart technology and merchandise available in the marketplace that permit a smart electricity control of homes have been reviewed. It become also discussed a well known machine's structure and the barriers, challenges, blessings and future developments that destiny smart houses and grids will face. Efficient usage of strength outcomes in reducing top load, decreasing strength bills, and minimizing greenhouse gas emissions. In order to comprehend an effective integration of smart homes right into a smart grid, the migration in the direction of bi-directional verbal exchange networks needs to be fostered, and nicely-tuned home automation system needs to be designed. Currently one of the current issues which are related to smart home automation are the fact that in a home with all varieties of computerized utility, there could be too many remote controls or tracking terminal, if the consumer set up a range of proprietary packages from one-of-a-kind providers are also been studied.



Fig.3 Smart Home

VII. SOCIAL IMPACT & FUTURE

Smart home concept brings comfort and convenience in our lives with the aid of IoT. Smart home automation using IoT (Internet of Things) technology offers numerous benefits, both in terms of convenience and efficiency. IoT devices can automate routine tasks like turning on/off lights, adjusting thermostats, locking doors, and more, saving time and effort for homeowners. This technology can help optimize energy usage by automatically adjusting heating, cooling, and lighting based on occupancy or preferences. This not only reduces energy bills but also contributes to environmental sustainability.

Major issues in current smart home scenario are automation and security. IoT-enabled security cameras, motion sensors, and smart locks provide homeowners with enhanced security features. They can monitor the home remotely, receive alerts about suspicious activities, and control access to their property from anywhere around the world. It also allows homeowners to monitor and control their home devices remotely using smartphones or tablets. This enables them to check in on their homes, adjust settings, and receive notifications even when they are away.

Smart home automation can enhance safety by providing early warnings of potential hazards such as smoke, carbon monoxide leaks, or water leaks. IoT sensors can detect these issues and alert homeowners immediately, helping to prevent accidents and minimize damage.

IoT devices offer a high level of customization and personalization, allowing homeowners to tailor their smart home systems to meet their specific needs and preferences. These additional features are very scalable with the use of controllers like Arduino boards as they allow multiple peripherals to be added and interconnected.

Overall, the scope of smart home automation using IoT is vast and continues to expand as new technologies and devices are developed. From improving convenience and energy efficiency to enhancing security and safety, IoT-enabled smart home systems offer numerous benefits for homeowners.

Automated Irrigation System using Soil Moisture Sensor and Android App

Girishkumar Lohar¹, Aarchi Panchal¹, Manasi Bhosale¹, Girishkumar Lohar²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Associate Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: ¹girishlohar@gmail.com, ¹aarchipanchal@gmail.com, ¹manasibhosale@gmail.com, ²archana.chaudhary@djsce.ac.in

Abstract— The assembled system consisted of a submersible water pump, an Arduino, moisture sensors, and a relay mechanism. The two moisture sensors on the field identify the two different regions where the soil is dry. The Arduino system receives a signal from them and uses the information it receives from both sensors to calculate the appropriate amount of water to apply. When the soil reaches a certain moisture level, the system will continue to receive sensor readings and will then automatically turn off the pump. With this irrigation method, farmers will save time, suffer less, and increase accuracy and productivity at a relatively low cost.

Keywords— Soil Moisture Sensor, GSM module Arduino Controller and other hardware.

I. INTRODUCTION

A water famine occurs when there is not enough rain or water available. Farmers and the impoverished suffer the most because they frequently rely solely on these bodies of water for their necessities. The economy and growth of a nation are significantly impacted by the employment of appropriate irrigation techniques in the sector of agriculture. The primary goal of this review is to suggest a technique for conserving farm water resources, since crops are frequently given more water than they require. Thus, it results in both water waste and a reduction in soil quality.[1] Agriculture is the backbone of the economy and a significant sector. For all nations, agriculture automation is a growing area of concern. The need for food is rising along with the world's population, which is growing quickly. It is very difficult for the agriculture business to establish procedures and practices that will allow them to fully satisfy the expanding needs and requirements due to the growing need for food and the shifting demands of consumers [1], [2], and [3]. Agriculture is one of the most important societal areas since it promotes advancements. Therefore, it is vital to guarantee that improvements are implemented in this sector to enhance overall outcomes and performance. Technology used in food production should promote significant advancements in. Since the majority of nations depend on the agricultural sector, it is imperative to utilize these resources [5]. A new field of science called "smart irrigation" is developing. It uses data-intensive techniques to boost agricultural output while lessening its environmental impact. A greater understanding of the operation environment and the operation activities is made possible by the data generated by a variety of sensors in modern agricultural operations [6, 7, 8, 9, 10]. Making decisions becomes more precise and effective as a result. This also makes it possible to maximize resources and accomplish the sector's goals. When these technologies are

used in irrigation systems, water is conserved, which helps to fulfill one of the Sustainable Development Goals (SDGs) of the United Nations, namely Goal 6 and Target.

II. LITERATURE SURVEY

This can be achieved through a range of methods, according to numerous studies, and agricultural experts have been attempting to reduce the quantity of water wasted during plant irrigation. Below is a summary of a few of these agricultural research papers [1]. By examining market growth, the author demonstrated the advantages of employing wireless sensor technologies and standards for wireless communications applied on wireless sensors in the agriculture domain over conventional irrigation methods. The usage of solar-powered wireless stations in a wireless sensor network implementation for agricultural applications with low data rates is described by the author. Moisture is detected via a dual-probe heat-pulse technique. The author has created a site-specific irrigation system in which the watering apparatus is electrically controlled by a programme. examined remote monitoring systems that make use of several wireless protocols created by different scholars. Because of the field programmable gate array that is used in its construction, the system may be modified and reprogrammed to accommodate shifting environmental circumstances.

III. SCOPE OF THE PROJECT

The technology improves agricultural fields' water usage efficiency (WUE) and is a sustainable option. It hydrates plants in accordance with their water requirements and treats their roots in accordance with the moisture content of the soil. This lessens the undue strain on farmers who incur additional water costs. Additionally, using a pump for irrigation saves you money on additional water pumping expenses. Farmers can also administer the appropriate amount of water at the appropriate time with an automated irrigation system [2]. Efficient water distribution that takes into account the water requirements of the system can lower the energy consumption of water pumps. Building an automated plant-watering system that uses sensors to identify soil moisture is the goal of the project.

The article explains how an automated irrigation system's functionality can be increased by including a soil moisture sensor. an Android program. By precisely managing water and improving user accessibility, this novel technique seeks to transform irrigation practices through the harmonic

integration of hardware and software solutions. Hardware Components: This system's primary hardware component, the soil moisture sensor, is in charge of continuously monitoring the moisture content of the soil [3]. When the soil moisture content drops below predetermined levels, this sensor triggers the water supply. This keeps the plants at the ideal moisture level without overwatering them. Software Development: Using smartphones or tablets, users may remotely monitor and control their irrigation system with the help of Android app development, which enhances the hardware configuration. With user-friendly interfaces

IV. IMPLEMENTATION

An needs analysis is the first step in the development process of an automated irrigation system that uses soil moisture sensor technologies and an Android application to identify system goals, features, and user preferences [2]. In hardware setup, the right soil moisture sensors are chosen, irrigation valves and microcontrollers are installed, and the sensors are calibrated to yield precise data. In the interim,

The creation of an Android application with an easy-to-use interface, communication protocols, and functionalities like irrigation scheduling and user identification are all included in software development. Field testing gathers input for optimization and confirms system performance in actual agricultural settings.

These updates, which were made in response to user input and data analysis, resulted in system implementation and documentation along with user manuals and assistance. This all-inclusive approach guarantees the methodical creation and execution of an effective and intuitive automated irrigation system tailored to farming requirements. Since the machine can only communicate in terms of voltage, the controller will take this voltage and output as follows: If (Voltage level = high) { Less Moisture; } Else { More Moisture; } Additionally, it lets the user know if the water supply has been turned on or not. This enables the user to control the water supply even when they are not there.

```

controller and it will produce output as: If (Voltage level
= high)
{
Less Moisture;
}
Else
{
More Moisture;
}

```

It also informs the user whether the water supply has actually been activated or not. This allows the user to manage the water supply when not physically present.

V. SCHEMATIC/BLOCK DIAGRAM

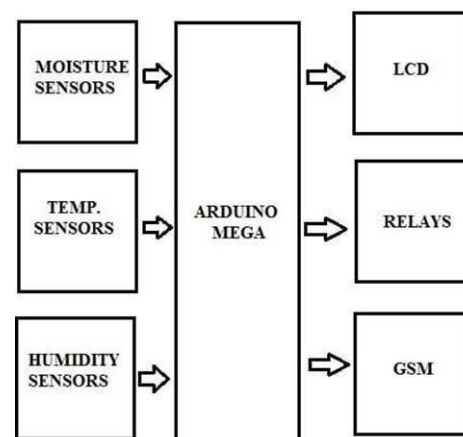


Fig 1. Block Diagram

VI. DESCRIPTION OF THE PROJECT

The soil moisture sensor is a main component of automated

Soil Moisture Sensor:

irrigation systems and is revolutionizing agricultural water management by making precise water planning and real-time soil moisture level monitoring possible. These sensors monitor changes in soil moisture and alert the irrigation controller when moisture levels drop below a predetermined threshold. They are carefully positioned into the root zones of plants.

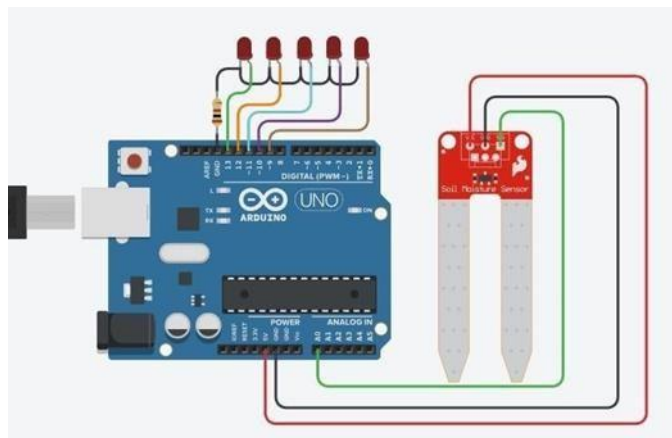


Fig 2. Soil Moisture Sensor

Arduino Uno Micro Controller:

Often used in DIY projects and electronics prototyping, the Arduino Uno is a well-known microcontroller board. The Arduino Integrated Development Environment (IDE), with its huge library of pre-written functions and user-friendly interface, makes programming the Uno easier.

ElectromagneticRelay:

An iron core is encircled by a coil of wire (an electromagnetic relay), which generates a magnetic field when current passes through it. An iron armature or lever attached to one or more contacts is drawn to this magnetic field. The armature is drawn toward the core when the coil is activated, closing the contacts and concluding the circuit. There are several configuration options for electromagnetic relays, such as single pole, single pole (SPST), single pole

LED Indicators:

Automated irrigation systems are not complete without LED indicators, which provide users with a visual representation of the system's state and functionality. Additionally, LED indications show the irrigation system's current status, including whether it is actively irrigating, in standby, or experiencing difficulties.

Relay:

Switch An electrical main voltage switch is called a relay. This implies that it has the ability to be turned on or off, allowing current to flow or not. With Arduino, controlling a relay is as easy as controlling an output, such as a motor (Senpinar, 2018). There are numerous kinds of modules, including four, eight, double, and single channels (Souza et al., 2017). a particular kind of relay known as a contractor that can manage the high power needed to directly control an electric motor or other loads. Electrical circuit protection is achieved by using relays with calibrated operating characteristics and occasionally with several operating coils to guard against overloads and failures. There are three alternative connections for the relays in regard to the main voltage. A common pin (COM) is present; often, a normally closed pin (NC) and a usually open pin (NO). The normally open (NO) pin and the common pin are not in contact with one another. In order to connect the COM pin and supply electricity to a load, we activate the relay. The NC pin and the COM pin are in touch with one another. Even when the relay is turned off, there must always be a connection between the COM and NC pins. Reche et al. (2015) state that when the relay is activated, the circuit opens and no power source is available for a load. Each and every forwarding pin. The relay module and the Arduino have a very straightforward connection. The relay's GND is connected to ground. Arduino digital board is attached to the IN1 relay port.

An Automated Irrigation Hardware Implementation:

A Hardware Implementation for Automatic Irrigation: When examining the automated watering methods from earlier studies, it is evident that automated irrigation systems and plant watering systems were implemented using Arduino-based sensors. The Arduino microcontroller, which is used to control and enable the operation of all hardware attached to it, will be the recipient of all built hardware. The Arduino board and any required associated components are part of the proposed system

VII. WORKING

Acquisition of sensor data: The DHT11 and the soil moisture sensors are both connected to the Arduino Uno. While the DHT11 sensor monitors temperature and humidity, the soil moisture sensor measures the moisture content of the soil [1][2][3]. Via each interface, the Arduino Uno reads the sensor values. Data processing: The sensor data is examined by the ArduinoUno. to ascertain if irrigation is required. The temperature and humidity data from the DHT11 sensor represent the external circumstances, while the moisture level from the soil moisture sensor gives information on the water content of the soil. Making Decisions About Watering: The Arduino Uno makes decisions about watering based on the

evaluated sensor data. The amount of soil moisture is compared to a predetermined threshold. The irrigation mechanism will activate if the moisture level drops below the threshold and the surrounding conditions (temperature and humidity) satisfy the system's specifications. The rain sensor is essential for detecting rainfall and influencing the system's watering decisions. When combined with additional sensors, such as soil moisture and temperature/humidity sensors, its primary function is to detect the presence and intensity of rain. When raindrops contact the sensor, its surface conductivity changes, allowing electricity to flow between its conductive pads.

The Arduino Uno turns on the irrigation system when it determines that it is necessary. Pumps, valves, and other machinery that provides water to the plants may need to be regulated. The apparatus guarantees that the plants obtain the appropriate quantity of water to sustain ideal moisture content.

Monitoring and feedback: The system keeps an eye on the surrounding circumstances and the humidity levels of the soil while it is watering. In order to avoid overwatering, the Arduino Uno turns off the irrigation system when the moisture level reaches the required threshold or when the weather is adverse. Data analysis and logging: For additional study, the Arduino Uno may record sensor readings and irrigation events. Monitoring and feedback: The system keeps an eye on the surrounding circumstances and the humidity levels of the soil while it is watering. In order to avoid overwatering, the Arduino Uno turns off the irrigation system when the moisture level reaches the required threshold or when the weather is adverse. Data analysis and logging: For additional study, the Arduino Uno may record sensor readings and irrigation events. This data can be used to evaluate the system's effectiveness, spot trends,

and make changes that will enhance plant health and water efficiency. Repeat Process: At predetermined intervals or in accordance with the watering schedule, the smart irrigation system repeatedly repeats the phases of data collection, processing, decision-making, and control. The three primary functions that are called in the loop function are `water_motor_start`, `moisture_level_detected`, and `readDTH11_Sensor`.

These operations are in charge of monitoring the temperature and humidity, figuring out the moisture content, and managing the water motor in accordance with the sensor data.

The `readDTH11_Sensor` function retrieves the DHT sensor's temperature and humidity readings, verifies that there are no reading errors, and outputs the data to the LCD and serial monitor.

The function `moisture_level_detected` reads the moisture sensor's analog value and shows it on the LCD and serial monitor.

The `water_motor_start` function reads the analog value from the rain sensor and operates the relay to start or stop the water motor depending on the amount of rain and moisture present.

VIII. RESULT

A garden setting served as the testing and implementation site for the planned smart watering system. The method efficiently kept the soil moisture levels within the intended range by modifying the irrigation schedule based on the weather. When compared to manual watering methods, the gadget showed a considerable reduction in water use by promoting healthy plant development. Efficient Utilization of Water: Powered by a DHT11, an Arduino Uno, and a soil moisture sensor, the smart irrigation system optimizes water usage by only applying water when necessary [4][5]. By ensuring that plants receive the proper irrigation based on their unique moisture requirements, it helps to avoid water waste and overwatering. By using the sensors' real-time data to make precise and timely watering decisions, the device encourages water saving.

Enhanced Plant Health and Growth: The intelligent irrigation system helps to enhance plant health and growth by maintaining the right levels of soil moisture. The system promotes root development, nutrient uptake, and general plant vigor by making sure that plants receive the appropriate amount of water at the appropriate time. Plants are therefore less vulnerable to diseases, stress, and water-related problems like root rot. **Personalized Watering Schedule:** Watering regimens may now be customized to meet the unique needs of plants and the surrounding environment, all thanks to technology. The technology takes into account several factors such as temperature, humidity, and soil moisture content while modifying watering schedules. This adaptability guarantees that irrigation can be changed to suit different plant growth requirements.

Real-time Monitoring and Control: Using the sensors, the intelligent irrigation system enables continuous monitoring of the soil's temperature, humidity, and moisture content. Users are therefore better able to comprehend the plant's surroundings and make wise decisions. Users can remotely modify irrigation settings depending on sensor data and unique needs thanks to the system's management over the irrigation process. **Logging and data analysis:** Because the Arduino Uno can record sensor readings and irrigation events, researchers have access to an invaluable dataset. Users can identify trends, learn more about the plant's water consumption habits, and improve watering techniques by examining the data gathered over time. This data-driven strategy facilitates the ongoing development of the irrigation system

IX. FUTURE SCOPE AND CONCLUSION

Our long-term goal is to simplify farming for farmers by integrating the Internet of Things (IOT) idea into our endeavor. Through the use of an interactive smartphone application, farmers will be able to monitor soil moisture and humidity levels and irrigate plants using a smart irrigation system. The autonomous irrigation system built on the Arduino platform is a simple and precise irrigation technique. since a result, this technology is very beneficial since it reduces the amount of human labor required by farmers and facilitates the effective use of resources. The manual ON/OFF irrigation system switching method used by farmers

is eliminated. Expanding this concept to greenhouses, which require less manual supervision, is possible.

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ESTIMATION OF OBESITY USING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Vaibhavi Gandhi¹, Deepesh Modi¹, Suhani Sawalka¹, Ranjushree Pal²

¹ U. G. Student, Department of Electronics and Telecommunication, D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

² Assistant Professor, Electronics and Telecommunication Department D.J.Sanghvi College of Engineering, Vile Parle (W), Mumbai- 400056

E-mail: ¹vaibhavisvg10@gmail.com, ¹studentdeepesh@gmail.com, ¹suhanirahulsawalka3@gmail.com, ²ranjushree.pal@djsce.ac.in

Abstract— Obesity has become a significant public health concern worldwide, contributing to numerous chronic diseases and reducing overall quality of life. Addressing this issue requires accurate methods of assessment and intervention. In recent years, Artificial Intelligence (AI) and Machine Learning (ML) have emerged as promising tools for various healthcare applications, including obesity estimation and management. Excessive fat accumulation in various parts of the body presents a risk to the normal development of health and affects indistinctly people of all ages and genders. According to the World Health Organization (WHO), many persons aged over 18 years suffer from weight alteration problems, caused by several factors associated with food intake with high caloric content and, sedentary nature. Authors mention other determining factors for obesity: “being an only child, familiar conflicts such as the divorce of parents, depression or anxiety” obesity is a disease with multiple factors; its main feature is the uncontrolled increase of weight due to an excessive proportion of fat, high caloric intake, and low energy consumption.

This abstract focuses on the application of AI and ML techniques for the estimation of obesity. The utilization of these technologies enables the development of predictive models that can analyse vast datasets comprising demographic, clinical, and lifestyle factors associated with obesity.

Key aspects of this research include data preprocessing, feature selection, model training, validation, and evaluation. Data preprocessing involves cleaning, normalization, and transformation of raw data to ensure its quality and consistency. Feature selection techniques help identify the most relevant variables that contribute to obesity prediction, enhancing model accuracy and interpretability.

Model training involves the optimization of algorithm parameters and the selection of appropriate performance metrics. Cross-validation techniques help assess the generalization ability of models and mitigate overfitting. Furthermore, model evaluation involves the comparison of different algorithms and the interpretation of results to derive meaningful insights.

Keywords— Machine Learning; Obesity Estimation; Artificial Intelligence; Linear Regression; Random Forest.

I. INTRODUCTION

Obesity, a complex and multifaceted health issue, has emerged as a global epidemic, posing significant challenges to individuals and societies alike. With its detrimental impact on physical health, mental well-being, and overall quality of life, obesity has become a major concern in public health. The

World Health Organization (WHO) estimates that over 650 million adults worldwide are affected by obesity, and this number continues to rise at an alarming rate. Obesity is associated with a higher risk of developing various chronic conditions, including cardiovascular disease, type 2 diabetes, certain cancers, and musculoskeletal disorders [1]. Moreover, it places a substantial economic burden on healthcare systems, leading to increased healthcare costs and reduced productivity. Accurate and timely classification of obesity levels is crucial for effective interventions, personalized healthcare strategies, and targeted public health initiatives. However, traditional approaches to obesity classification based solely on body mass index (BMI) or simple anthropometric measurements often lack the precision and granularity needed to capture the complexity of this condition. This is where the potential of AIML techniques comes into play

Previous approaches to obesity classification have predominantly relied on traditional methods that often oversimplify the complexity of this multifaceted condition. The widely used body mass index (BMI) has been a common metric for classifying obesity levels, but it fails to capture variations in body composition, distribution of fat, and other important factors. While BMI provides a useful initial screening tool, it lacks the precision and granularity required to accurately classify obesity and its associated health risks. Other traditional approaches based on simple anthropometric measurements, such as waist circumference or waist-to-hip ratio, offer slightly improved insights but still have limitations in terms of their discriminatory power. These approaches often categorize individuals into broad weight categories, ignoring the nuanced differences in obesity subtypes and failing to account for individual variations in factors such as muscle mass, metabolic health, and lifestyle choices. As a result, there is a growing recognition of the need for more sophisticated and data-driven approaches that leverage machine learning (AI) techniques to enable accurate and personalized obesity classification. By exploring the potential of AI algorithms and incorporating comprehensive datasets comprising various biological, lifestyle, and demographic factors, we can overcome the limitations of previous approaches and unlock new insights into obesity classification, paving the way for more targeted interventions and improved public health outcomes.

The research questions and hypotheses guiding this study revolve around the development and evaluation of a data-driven approach for obesity classification using AI&ML techniques. Our primary research question is: Can AI&ML

algorithms effectively classify obesity levels based on comprehensive datasets comprising anthropometric measurements, lifestyle factors, and demographic information? To address this question, we hypothesize that the incorporation of diverse features and the utilization of AI&ML algorithms will significantly improve the accuracy and precision of obesity classification compared to traditional approaches. Additionally, we aim to investigate which AI&ML algorithm(s) exhibit the highest performance in classifying obesity levels and whether feature selection and preprocessing techniques can further enhance the models' predictive capabilities. We hypothesize that a combination of carefully selected features and sophisticated AI&ML algorithms will result in improved accuracy, sensitivity, and specificity in obesity classification.

II. METHODOLOGY

In everyday life, emotion is important. People can communicate and comprehend each other more easily when they express their emotions. Emotion recognition is a technology that allows machines to understand human emotions and has a wide range of applications. It is not necessary that these interpersonal skills are well developed in individuals. Autistic children usually face the issue of interaction and communication.

The methodology section provides a detailed description of the approach and techniques employed in this study to accomplish the objectives of obesity classification using ML. This section outlines the step-by-step procedures involved in data collection, preprocessing, feature selection, model development, and evaluation. Additionally, it highlights the rationale behind the chosen methodologies and their alignment with the research goals. By elucidating the methodology, this section ensures transparency, replicability, and a solid foundation for drawing valid conclusions from the study's findings.

For this research the data used was the data collected from various countries including people with different age groups, heights, weights, etc are mentioned below:

FACTORS TAKEN INTO CONSIDERATION:

Gender

Age

Height

Weight

Family history with overweight

Frequent consumption of caloric food,

Frequent consumption of vegetables

Number of main meals,

Consumption of food between meals,

Smoke

Consumption of water daily

Physical activity frequency

Time-consuming technology devices

Consumption of alcohol

Obesity level.

DATASET:

One of the major causes for the development of obesity refers to high caloric intake, a decrease in energy expenditure due to the lack of physical activity, alimentary disorders, genetics, socioeconomic factors, and/or anxiety and depression.

According to Ref. [Estimation of obesity levels based on eating habits and physical condition. (2019). UCI Machine Learning Repository. <https://doi.org/10.24432/C5H31Z>.]

For creating their dataset, the authors searched in literature for the key factors or habits that are associated with obesity. The dataset has 16 variables that can determine if a person presents obesity. This dataset includes data for the estimation of obesity levels in individuals from the countries of Mexico, Peru, and Colombia, based on their eating habits and physical condition. The data contains 17 attributes and 2111 records, the records are labeled with the class variable NO obesity (Obesity Level), which allows classification of the data using the values of Insufficient Weight, Normal Weight, Overweight Level I, Overweight Level II, Obesity Type I, Obesity Type II and Obesity Type III. 77% of the data was generated synthetically using the Weka tool and the SMOTE filter, and 23% of the data was collected directly from users through a web platform.

Gender: (1=Female or 0=Male).

-Age (years).

-Height: (Numeric).

-Weight: (Numeric).

-Family history of overweight: (1=Yes, 0=No).

-Caloric_food:(0=Yes, 1=No). Frequent consumption of high-caloric food.

-Frequency of consumption of vegetables (1, 2, or 3).

-Number of main meals (1, 2, 3, or 4).

-Consumption of food between meals: (1=No, 2=Sometimes, 3=Frequently, 4=Always).

-Smoke (0=Yes, 1=No).

-Consumption of water daily.

-Physical activity frequency (0, 1, 2, or 3).

-Time using technology devices (0, 1, or 2).

-Consumption of alcohol (1=No, 2=Sometimes, 3=Frequently or 4=Always).

-Obesity level: (1=Insufficient Weight, 2=Normal Weight, 3=Overweight Level I, 4=Overweight Level II, 5=Obesity Type I, 6=Obesity Type_II, 7=Obesity Type III)

IMPLEMENTATION:

DJS STRIKE

Load Data

<pre>[] import pandas as pd df = pd.read_csv('https://docs.google.com/spreadsheets/d/e/ 2PACX-1vRXPVIWuO- LfCqKQPhjcwPU4eSMB2sySjiV1u- c_rUorbsWmQ4UQDZGLQH6dXetYyIVgJ4FA_ARiOx/pu b?output=csv') df account_circle</pre>	<pre>from sklearn.model_selection import train_test_split x_train, x_test, y_train, y_test = train_test_split(x, y, test_si ze=0.2, random_state=100) x_train account_circle</pre>
<pre>keyboard_arrow_down Data Preparation</pre>	<pre>[] x_test account_circle</pre>
<pre>keyboard_arrow_down Data Separation as X and Y</pre>	<pre>keyboard_arrow_down Model Building</pre>
<pre>[] y = df['Obesity Level'] y account_circle 0 2 1 2 2 2 3 3 4 4 .. 2106 7 2107 7 2108 7 2109 7 2110 7 Name: Obesity Level, Length: 2111, type: int64</pre>	<pre>keyboard_arrow_down Linear Regression keyboard_arrow_down Training the Model</pre>
<pre>[] x = df.drop('Obesity Level', axis=1) x account_circle</pre>	<pre>[] from sklearn.linear_model import LinearRegression lr = LinearRegression() lr.fit(x_train, y_train) account_circle</pre>
<pre>keyboard_arrow_down Data Splitting</pre>	<pre>keyboard_arrow_down Applying the model to make a prediction</pre>
<pre>[]</pre>	<pre>[] y_lr_train_pred = lr.predict(x_train) y_lr_test_pred = lr.predict(x_test) y_lr_train_pred account_circle array([6.79363745, 1.50127515, 3.30576702, ..., 2.54771086, 6.22810319, 5.83175708])</pre>
<pre>keyboard_arrow_down Data Splitting []</pre>	<pre>[] y_lr_test_pred account_circle array([3.08436117, 8.67547153, 6.61834538, 4.02139051, 4.87802113,</pre>

1.982355, 5.84378088,	6.50420639,	1.67427216,	0.53706139,	4.19098403, 5.75674556,	6.71878224,	7.47734634,	6.69694182,
3.94937152, 1.47189489,	1.40206216,	4.02260406,	6.12601603,	8.18662963, 3.22453463,	5.58439091,	3.30712622,	3.79756268,
4.58915206, 4.0076266,	1.01393599,	3.08616733,	5.12550741,	3.51442239, 6.56907182,	5.76941918,	6.55206021,	5.689603,
4.47911309, 4.56867213,	3.64275049,	1.48192332,	1.54000873,	3.59800708, 3.87660067,	5.27933546,	4.77875399,	7.31634885,
5.65036916, 6.39482521,	3.55585511,	2.61739519,	2.58424921,	1.30274077, 4.6819316,	3.94848107,	6.71878224,	2.9075225,
3.15161906, 1.45013634,	5.28728042,	5.20338159,	6.69424606,	8.64450807, 4.81517909,	0.72413138,	2.67281262,	3.85774125,
6.91785625, 5.72559885,	2.91964679,	6.14093883,	3.92196439,	1.9167345, 2.37035777,	1.98388618,	4.97838528,	6.12601603,
4.5173326, 4.7623317,	6.00346706,	7.44840905,	1.16804523,	6.79363745, 5.88945093,	3.22954673,	8.4286799,	6.58323459,
1.10773017, 8.16979516,	4.633697,	4.36438856,	5.34155004,	5.13363224, 3.18634294,	0.77159012,	6.12601603,	3.1663856,
5.13679081, 3.12070146,	4.3198047,	4.72807254,	2.88393299,	3.192947, 3.62144008,	6.02983139,	3.81307787,	5.96276093,
6.15146426, 3.97222256,	6.48223756,	6.71339071,	1.85602489,	0.67835154, 5.41180013,	3.52155547,	5.93288086,	3.71040601,
2.98339475, 2.23888393,	6.25078062,	2.55366637,	4.93417681,	4.94721803, 4.31698879,	5.92139857,	1.96636562,	3.06818433,
4.90864102, 6.71608647,	5.79270743,	5.48665534,	2.73658963,	6.09774748, 6.00707034,	4.54915295,	2.24406899,	2.99817973,
3.51909173, 2.80084984,	3.86131445,	3.58467301,	6.29327869,	5.43939843, 4.62976776,	4.82948845,	6.79363745,	1.21944666,
4.56925146, 6.79094168,	5.03659053,	8.42664402,	6.71878224,	0.87057505, 4.17271185,	3.39821357,	4.7017241,	3.2425139,
5.12116789, 6.49226899,	1.02345362,	3.12354332,	4.75678171,	5.57191087, 3.01238195,	6.99540722,	3.25536695,	1.63591655,
4.58347755, 2.22597443,	4.90955182,	3.8916971,	0.86829119,	4.7921391, 4.33034675,	5.73453516,	8.7187034,	6.64392703,
3.65547029, 1.67124983,	3.69619177,	6.02883721,	3.92504092,	6.12601603, 4.97632374,	3.05569533,	7.31349721,	0.77727563,
3.84589039, 4.34928359,	0.81926655,	1.38215255,	1.7629991,	7.27194219, 2.98029734,	0.96693424,	3.416474,	1.0201811,
3.30711878, 1.77463958,	2.54180724,	4.2509084,	6.01180802,	1.0564405, 5.93325418,	1.29896645,	2.5956035,	3.34798937,
3.03366975, 3.90002574,	5.91521912,	2.87015067,	4.57342541,	5.91845295, 6.35058166,	8.16104799,	3.67278993,	2.87924415,
1.8292251, 6.18239435,	3.9097191,	2.15990441,	3.92324591,	2.96664331, 5.50815134,	3.59847755,	7.22801482,	1.20581884,
3.44618816, 5.93963725,	4.52925674,	4.34693506,	4.84737054,	6.17239263, 3.30937377,	1.52850649,	4.55411975,	6.18424056,
5.75539537, 7.4151354,	1.19433702,	6.45346956,	5.26906848,	2.84669007, 6.22810319,	6.4642889,	1.17691335,	6.71878224,
2.27466184, 4.93717051,	1.25476693,	4.53316083,	5.57401162,	3.74994051, 6.32563583,	8.44012284,	2.21254339,	4.63635728,

3.38975869, 5.95695674, 2.7727704, 7.565496, 0.91215781,	4.17432615, 3.86264606, 6.1287118, 1.75849268, 3.99709036,
4.45428693, 5.04389597, 6.71878224, 3.08397599, 4.38966434,	6.22597014, 1.73495441, 3.59674019, 3.24100053, 4.41815626,
2.95723424, 4.39502631, 4.80695262, 7.39830093, 4.70245813,	7.09036252, 1.08858552, 4.04847132, 3.69101082, 1.35141435,
0.15209437, 3.30711878, 3.32156494, 4.60798923, 2.9924291,	1.15573324, 1.76461501, 2.8743862, 1.27324294, 4.49566325,
3.83210762, 3.61560423, 5.78534607, 1.28164298, 6.71878224,	1.21084819, 4.83207302, 3.07256645, 3.87860366, 1.39403936,
4.10250462, 5.60952589, 3.35620694, 5.85382713, 3.74380877,	4.17919929, 4.50921647, 5.2533745, 6.25078062, 3.04355586,
4.23063654, 3.04108111, 0.94770909, 8.67277577, 2.33579605,	5.90953769, 4.32911193, 7.43762599, 3.42388662, 3.68588553,
6.48700004, 6.06172835, 1.39879565, 1.42223888, 4.32690283,	3.18679275, 1.02556036, 5.98088566, 2.92145979, 3.05588197,
1.26028736, 1.37368474, 5.33597967, 5.89539899, 4.28618298,	7.36277078, 4.23209245, 7.01550731))

Evaluate Model performance

```
[ ]
y_train
account_circle
2031 7
97 1
864 3
1955 7
561 1
..
350 2
1930 7
79 2
1859 7
1544 6
Name: Obesity Level, Length: 1688, dtype: int64
```

```
[ ]
y_lr_train_pred
account_circle
array([6.79363745, 1.50127515, 3.30576702, ...,
2.54771086, 6.22810319,
5.83175708])
```

```
[ ]
```

```
from sklearn.metrics import mean_squared_error, r2_score
lr_train_mse = mean_squared_error(y_train, y_lr_train_pred)
lr_train_r2 = r2_score(y_train, y_lr_train_pred)

lr_test_mse = mean_squared_error(y_test, y_lr_test_pred)
lr_test_r2 = r2_score(y_test, y_lr_test_pred)
```

```
[ ]

print('LR MSE (Train): ', lr_train_mse)
print('LR R2 (Train): ', lr_train_r2)
print('LR MSE (Test): ', lr_test_mse)
print('LR R2 (Test): ', lr_test_r2)

account_circle

LR MSE (Train): 0.18810015369984434
LR R2 (Train): 0.9524862030158567
LR MSE (Test): 0.2226510704720314
LR R2 (Test): 0.9420775211931333
```

```
[ ]

lr_results = pd.DataFrame(['Linear Regression', lr_train_mse,
lr_train_r2, lr_test_mse, lr_test_r2]).transpose()
lr_results.columns = ['Method', 'Training MSE', 'Training R
2', 'Test MSE', 'Test R2']
lr_results

account_circle
```

```
[ ]

import matplotlib.pyplot as plt
import numpy as np

plt.figure(figsize=(5,5))
plt.scatter(x=y_train, y=y_lr_train_pred, c="#7CAE00", alp
ha=0.3)

z = np.polyfit(y_train, y_lr_train_pred, 1)
p = np.poly1d(z)

plt.plot(y_train, p(y_train), '#F8766D')
plt.ylabel('Predicted Obesity Level')
plt.xlabel('Experimental Obesity Level')

account_circle
```

RESULTS:

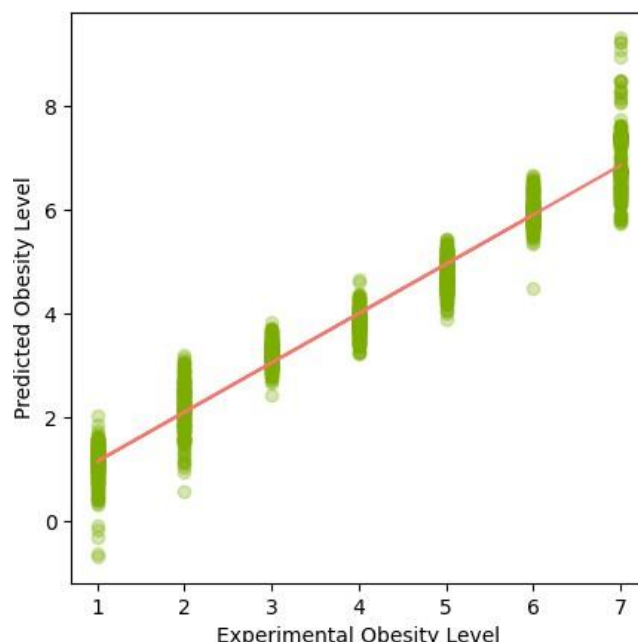
```
[ ]

print('LR MSE (Train): ', lr_train_mse)
print('LR R2 (Train): ', lr_train_r2)
```

```
print('LR MSE (Test): ', lr_test_mse)
print('LR R2 (Test): ', lr_test_r2)

account_circle

LR MSE (Train): 0.18810015369984434
LR R2 (Train): 0.9524862030158567
LR MSE (Test): 0.2226510704720314
LR R2 (Test): 0.9420775211931333
```



RANDOM FOREST:

```
import numpy as np
import pandas as pd
import matplotlib as mpl
import matplotlib.pyplot as plt
```

IMPORTING DATASET

```
train =
pd.read_csv("https://docs.google.com/spreadsheets/d/e/2PA
CX-1vRXPVIWewO-LfCqKQPhjcwPU4eSMB2sySjiV1u-
c_rUorbsWmQ4UQDZGLQH6dXetYyIVgJ4FA_ARiOx/pu
b?output=csv")

print(train.shape)

(2111, 15)

train.head(5)
```

```
https://colab.research.google.com/drive/1n1Cb85d0qq2VFS
S6BaQWeOdmBqcuu5M5#scrollTo=zXUtcQlbmqgc&line=
1&uniqifier=1
```

CHECKING FOR MISSING DATA

```
[ ]
```

```
NAs = pd.concat([train.isnull().sum()], axis = 1, keys = ["Train"])
NAs[NAs.sum(axis = 1) > 0]
labels = train.pop('Obesity Level')
MODEL TRAINING
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split( train, labels,
test_size=0.25)
from sklearn.ensemble import RandomForestClassifier
rf = RandomForestClassifier()
rf.fit(x_train, y_train)
y_rf_test_pred = rf.predict(x_test)
y_rf_train_pred = rf.predict(x_train)
y_rf_train_pred
array([2, 6, 3, ..., 1, 4, 1])
y_rf_test_pred
y_rf_test_pred
array([4, 5, 7, 4, 1, 4, 2, 3, 1, 1, 4, 2, 4, 5, 4, 1, 5, 4, 2, 4, 7, 1,
      4, 7, 4, 4, 1, 4, 1, 2, 5, 7, 7, 5, 7, 5, 5, 4, 3, 4, 2, 1, 7, 3,
      5, 2, 2, 5, 5, 5, 6, 2, 7, 5, 1, 6, 6, 4, 6, 3, 5, 4, 7, 3, 6, 6,
      7, 6, 2, 7, 2, 3, 7, 6, 2, 4, 1, 7, 5, 1, 6, 3, 1, 6, 1, 7, 6, 2,
      3, 1, 5, 2, 7, 1, 3, 4, 5, 6, 6, 5, 3, 1, 4, 7, 1, 7, 6, 3, 1, 2,
      3, 6, 5, 7, 2, 7, 5, 6, 2, 1, 6, 7, 7, 3, 7, 2, 7, 7, 2, 4, 3,
      3, 7, 4, 6, 4, 1, 6, 7, 2, 5, 4, 6, 6, 3, 1, 4, 4, 4, 4, 7, 3, 7,
      3, 5, 6, 3, 5, 1, 2, 4, 6, 6, 2, 1, 2, 7, 3, 4, 1, 6, 1, 1, 4, 6,
      5, 5, 4, 3, 2, 5, 4, 1, 1, 4, 4, 5, 6, 5, 5, 5, 2, 5, 3, 4, 2, 7,
      2, 2, 1, 5, 7, 1, 7, 2, 4, 3, 7, 5, 5, 6, 2, 6, 2, 2, 2, 1, 7, 5,
      2, 7, 6, 2, 5, 3, 7, 2, 2, 2, 3, 3, 5, 2, 2, 2, 2, 5, 5, 7, 7, 3,
      4, 7, 6, 3, 7, 4, 4, 1, 4, 1, 3, 3, 5, 1, 6, 6, 3, 6, 4, 7, 3, 3,
      2, 3, 7, 1, 7, 2, 7, 7, 4, 1, 3, 1, 3, 6, 1, 1, 7, 5, 1, 3, 1, 5,
      5, 7, 5, 5, 4, 2, 5, 7, 7, 6, 1, 1, 5, 2, 7, 3, 3, 6, 2, 7, 7, 4,
      6, 3, 1, 1, 6, 2, 7, 6, 1, 5, 2, 7, 7, 4, 2, 1, 7, 5, 6, 1, 5, 4,
      3, 7, 4, 6, 7, 2, 4, 1, 1, 7, 5, 7, 5, 1, 2, 2, 7, 5, 3, 1, 6, 6,
      2, 1, 6, 3, 7, 7, 5, 6, 4, 4, 3, 4, 4, 2, 2, 5, 1, 7, 3, 1, 4, 2,
      5, 3, 5, 1, 2, 6, 7, 2, 4, 7, 4, 5, 6, 4, 5, 6, 7, 1, 5, 3, 2, 3,
      6, 1, 7, 2, 6, 5, 5, 7, 7, 2, 5, 3, 6, 2, 4, 6, 6, 4, 4, 2, 1, 1,
      5, 7, 4, 3, 4, 5, 1, 2, 2, 3, 5, 6, 4, 7, 5, 3, 5, 7, 3, 7, 7, 3,
      4, 3, 7, 4, 6, 7, 4, 1, 1, 2, 1, 1, 2, 3, 3, 2, 1, 4, 2, 4, 5, 5,
      3, 2, 2, 5, 4, 5, 4, 3, 4, 3, 3, 7, 3, 3, 1, 7, 2, 4, 5, 4, 6,
      7, 6, 2, 3, 6, 2, 6, 2, 2, 4, 5, 6, 3, 5, 6, 6, 6, 2, 3, 7, 7, 6,
      6, 1, 7, 2, 6, 5, 7, 4, 1, 5, 4, 5, 3, 5, 2, 3, 7, 3, 4, 4, 1, 1])
y_train
```

```
111 2
1715 6
304 3
987 4
1486 5
..
482 2
641 1
662 1
1097 4
266 1
Name: Obesity Level, Length: 1583, dtype: int64
y_rf_train_pred
array([2, 6, 3, ..., 1, 4, 1])
```

CHECKING FOR ACCURACY

```
from sklearn.metrics import mean_squared_error, r2_score
print('RF MSE (Train): ', rf_train_mse)
print('RF R2 (Train): ', rf_train_r2)
print('RF MSE (Test): ', rf_test_mse)
print('RF R2 (Test): ', rf_test_r2)
RF MSE (Train): 0.0
RF R2 (Train): 1.0
RF MSE (Test): 0.06439393939393939
RF R2 (Test): 0.9840406096785808
```

```
[ ]
rf_results = pd.DataFrame(['Random Forest',rf_train_mse, rf_train_r2, rf_test_mse, rf_test_r2]).transpose()
rf_results.columns = ['Method', 'Training MSE', 'Training R2', 'Test MSE', 'Test R2']
rf_results
rf_results = pd.DataFrame(['Random Forest',rf_train_mse, rf_train_r2, rf_test_mse, rf_test_r2]).transpose()
rf_results.columns = ['Method', 'Training MSE', 'Training R2', 'Test MSE', 'Test R2']
rf_results
Method Training MSE Training R2 Test MSE Test R2
Random Forest 0.01 0.00 0.064394 0.984041
```

```
import matplotlib.pyplot as plt
import numpy as np

plt.figure(figsize=(5,5))
```

```
plt.scatter(x=y_train, y=y_rf_train_pred, c="#7CAE00", alpha=0.3)
```

```
z = np.polyfit(y_train, y_rf_train_pred, 1)
```

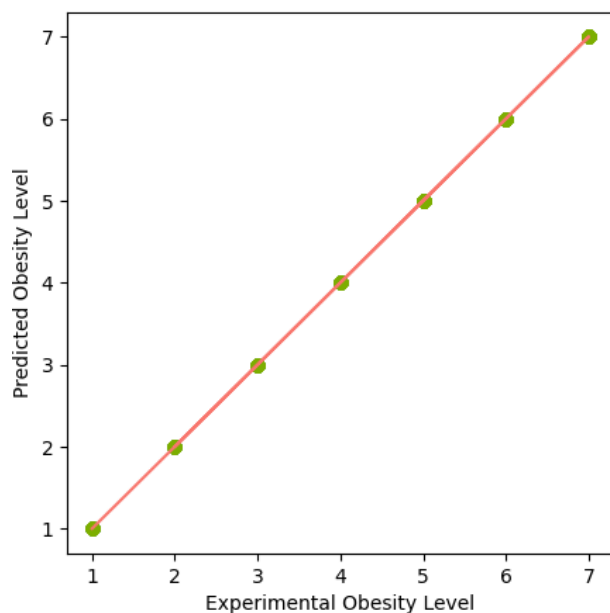
```
p = np.poly1d(z)
```

```
plt.plot(y_train, p(y_train), '#F8766D')
```

```
plt.ylabel('Predicted Obesity Level')
```

```
plt.xlabel('Experimental Obesity Level')
```

```
Text(0.5, 0, 'Experimental Obesity Level')
```



III. IMPLEMENTATION

The program demonstrates the implementation of a Linear Regression model to predict obesity levels based on a dataset. Here's a summary of the key points and findings:

1. **Data Preparation:** The dataset was loaded using pandas from a CSV file. It contains features related to obesity levels.
2. **Model Building:** A Linear Regression model was chosen for its simplicity and interpretability. The model was trained on the training dataset and evaluated using the test dataset.
3. **Evaluation Metrics:** The model's performance was evaluated using Mean Squared Error (MSE) and R-squared (R²) scores. These metrics help assess the accuracy and goodness of fit of the model.
4. **Model Performance:** The Linear Regression and Random Forest model performed well on both the training and test datasets. The MSE values were low, indicating minimal error between the actual and predicted values. The R² scores were high, suggesting that the model explains a significant portion of the variance in the data. Overall, the Random Forest model appears to be a suitable

choice for predicting obesity levels based on the given features, as it is more accurate as compared to linear regression. However, further analysis and refinement may be necessary to enhance the model's accuracy and generalization capabilities. Additionally, exploring other machine learning algorithms and feature engineering techniques could potentially improve predictive performance.

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