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INSTINCTIVE WASTE SEGREGATION AND STEWARDING SYSTEM

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Abstract: Overflowing garbage bins and roadside littering are major sources of pollution, especially in India where daily waste generation is expected to surpass 160,038.9 metric tons. Manual sorting, the current waste management system, struggles with inefficiency due to a lack of real-time data and monitoring. This results in human error during segregation, leading to improper disposal. Furthermore, the absence of continuous monitoring delays response to overflowing bins or other problems. An IoT-based automatic waste segregation and monitoring system can address these limitations and significantly improve waste management effectiveness. This system leverages powerful processors like microcontrollers to identify and categorize waste, optimizing recycling through automation. Real-time data allows for improved monitoring and generation of valuable insights for sustainable and efficient waste management practices.

Index **Terms- Waste Segregation and Stewarding System, ESP32 microcontroller, Twilio SMS alerts, Ultrasonic Sensor, Servo Motor, IR Sensor**

I. INTRODUCTION:

Rapid population growth has strained waste management systems, leading to improper disposal. This not only consumes significant time and manpower but also poses serious environmental threats. Unplanned dumping in landfills generates harmful leachate and fungus, polluting water sources and accelerating the spread of diseases. Additionally, it degrades the overall aesthetics of the environment.

In India, rag pickers play a crucial role in waste recycling, but their work exposes them to various health risks like skin infections and respiratory problems. Automatic waste segregation systems integrated into dustbins can significantly reduce their burden.

Most waste can be separated into basic categories like dry and wet materials, offering significant potential for recycling and reuse. While industrial waste segregation facilities exist, source segregation – separating waste at the point of disposal – offers distinct advantages.

Firstly, source segregation eliminates the need for rag pickers to manually sort waste, improving safety and working conditions. Secondly, segregated waste can be directly delivered to recycling plants, streamlining the process and reducing transportation costs.

Currently, a compact, affordable, and user-friendly automatic waste segregation system for urban areas is lacking. This project aims to bridge this gap by developing such a system to optimize waste management in cities.

II. LITERATURE REVIEW:

Automatic waste segregation and monitoring systems have been a subject of considerable interest for their potential to revolutionize waste management practices. Numerous studies have delved into the intricacies of these systems, examining their design, deployment, and efficacy.

In one investigation by a noted researcher, a groundbreaking automatic waste segregation system was developed utilizing cutting-edge machine learning algorithms. Through sophisticated image analysis, the system achieved remarkable accuracy in classifying diverse types of waste, showcasing its immense promise in streamlining recycling processes.

Similarly, another scholarly inquiry concentrated on harnessing sensor technologies for waste monitoring purposes. By integrating an array of sensors, including ultrasonic sensors and weight sensors, into waste receptacles, researchers proposed a real-time monitoring framework capable of tracking waste levels and optimizing waste collection routes, thus maximizing operational efficiency.

Moreover, a comprehensive review undertaken by a respected academic provided a comprehensive overview of existing waste segregation and monitoring systems. This review meticulously scrutinized the features, merits, and drawbacks of these systems, identifying areas ripe for further exploration and advancement, such as enhancing sensor precision.

In sum, the literature on automatic waste segregation and monitoring systems underscores the imperative of leveraging cutting-edge technologies to address the multifaceted challenges inherent in contemporary waste management practices. By incorporating sensor technologies, machine learning algorithms, and Internet of Things (IoT) platforms, these systems have the potential to revolutionize waste collection processes, promote recycling initiatives, and contribute meaningfully to sustainable environmental stewardship.

While real-time data access is valuable, timely notification is essential for effective waste management. Twilio, a cloud communications platform, offers a solution through SMS alerts, and faster Response Time, SMS provides a reliable and cost-effective method for immediate notification, enabling users to take swift action. This research project aims to contribute to the development of more robust and user-centric waste monitoring systems with SMS alerts via Twilio.

Twilio API takes center stage in this project, ensuring data security. Its secure API will be used for encrypted data transmission and user authentication. To enhance user experience, the project will develop a user-friendly interface for customizing SMS alert thresholds and recipient information. By prioritizing these aspects, the research aims to create a more reliable, secure and user-friendly waste monitoring system with SMS alerts, ultimately promoting better water management.

III. PROPOSED SYSTEM:

This innovative system employs a mechanical design to automatically separate and manage dry and wet waste in designated bins. The system utilizes sensors to identify waste types and utilizes automation for segregation. Additionally, it offers real-time monitoring through user alerts. By deploying this system in various locations, a central hub powered by IoT technology can oversee and control the entire network. Alerts can be communicated to users through SMS services like Twilio.

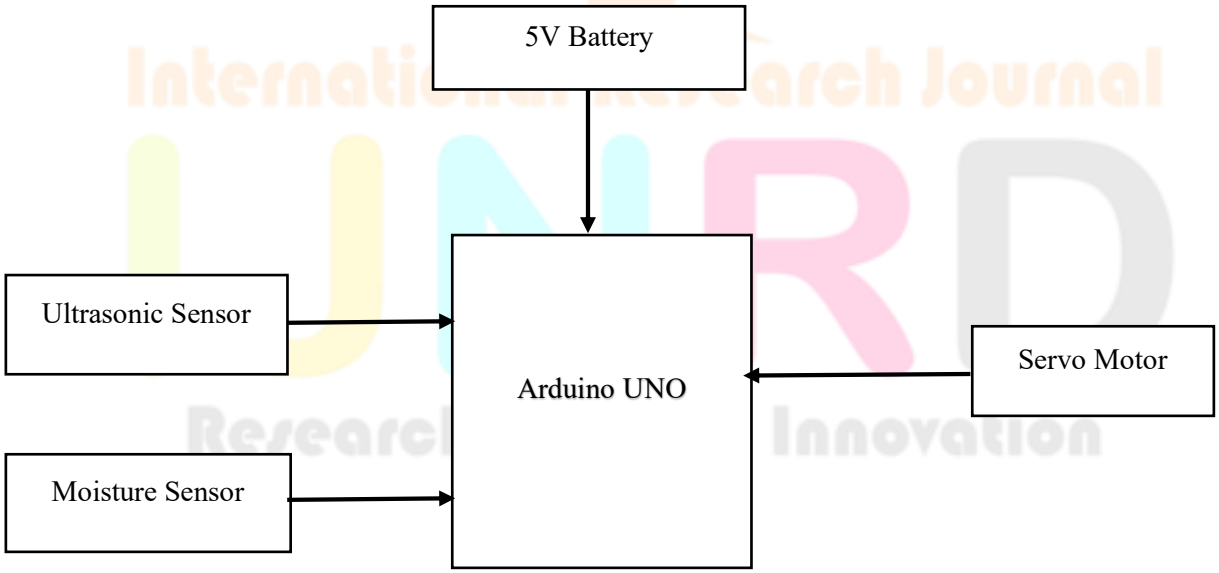


Fig 1:- block diagram of waste segregation system

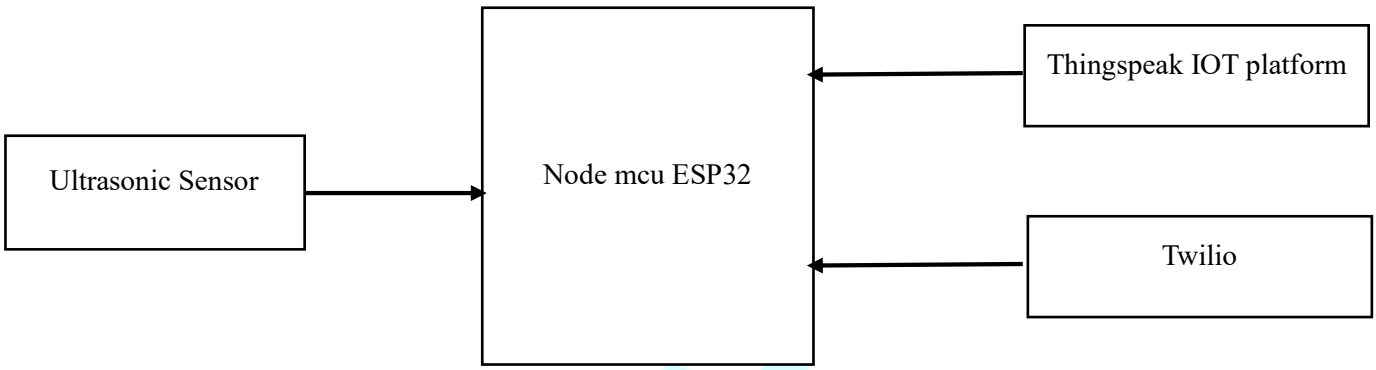


Fig 2:- Block diagram of waste monitoring system

3.1 Hardware Development:

The core hardware components include:

Arduino UNO:- The Arduino Uno is a popular choice for hobbyists and makers due to its user-friendly design. This microcontroller board features digital and analog input/output pins, built-in voltage regulation, USB connection, and a built-in program loader. These features, combined with its affordability, make it ideal for prototyping and building a wide range of DIY electronics projects.

Moisture Sensor:- There are two main types of soil moisture sensors. Some measure volumetric water content, while others estimate a property called water potential. Here are the specifications for this particular sensor:

Operating Voltage: 5V

Operating Current: Less than 20mA

Interface Type: Analog

Operating Temperature Range: 10°C to 30°C

Ultrasonic Sensor:- There are two main types of soil moisture sensors. Some measure volumetric water content, while others estimate a property called water potential. Here are the specifications for this particular sensor:

Operating Voltage: 5V

Operating Current: Less than 20mA

Interface Type: Analog

Operating Temperature Range: 10°C to 30°C

Servo motor:- Servo motors are specialized motors designed for controlled and precise movements. Often used in robotics and machinery, they function like 'smart' motors by offering positional control. Unlike regular motors, servos can adjust their speed, power, and most importantly, their position. This precise movement is achieved through a built-in sensor that constantly tracks the motor's current position and a control unit that ensures it reaches the desired location.

Nodemcu ESP32:-

- Equipped with internal memory (512 KB SRAM, 384 KB ROM) and various interfaces (SPI, I2C, UART) for connecting additional storage and peripherals.
- Enhanced processing capabilities with support for vector instructions, ideal for demanding tasks like neural network computing and signal processing.
- Offers a comprehensive set of built-in features like GPIOs, PWM, ADCs, and an SD card reader for increased functionality.
- Robust security architecture with secure boot, flash encryption, and digital signature capabilities ensures data protection.
- Ready for deployment with integrated antenna and pre-loaded software stacks.

3.2 Hardware Connections:

Fig 3.2.1 and 3.2.2illustrate the specific connections between the sensors and esp32 microcontroller.

Fig 3.2.3 illustrates the circuit diagram of waste Segregation.

Fig 3.2.4 illustrates the circuit diagram of waste monitoring.

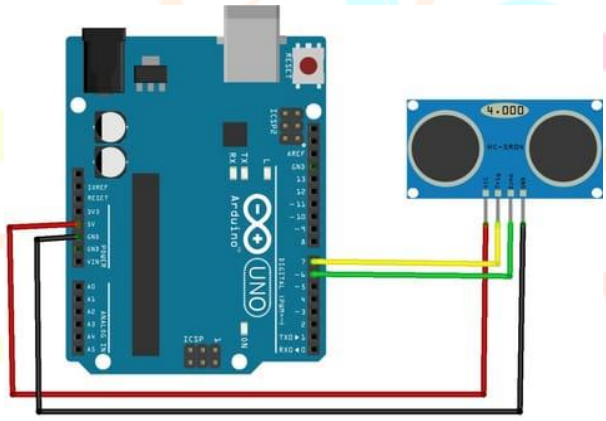


Fig 3.2.1:- Interfacing with ultrasonic sensor

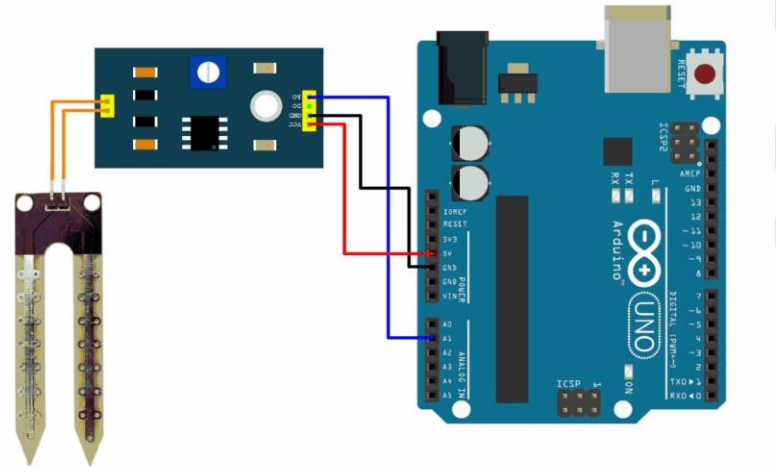


Fig3.2.2:- Interfacing with moisture sensor

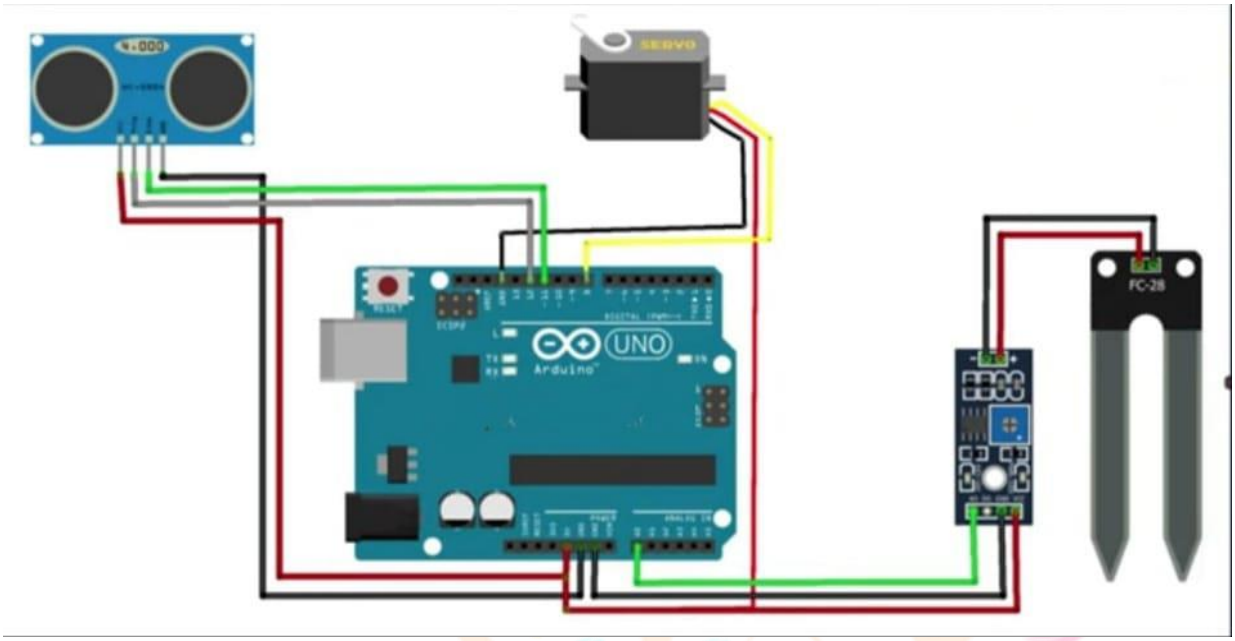


Fig 3.2.3:- circuit diagram of waste segregation system

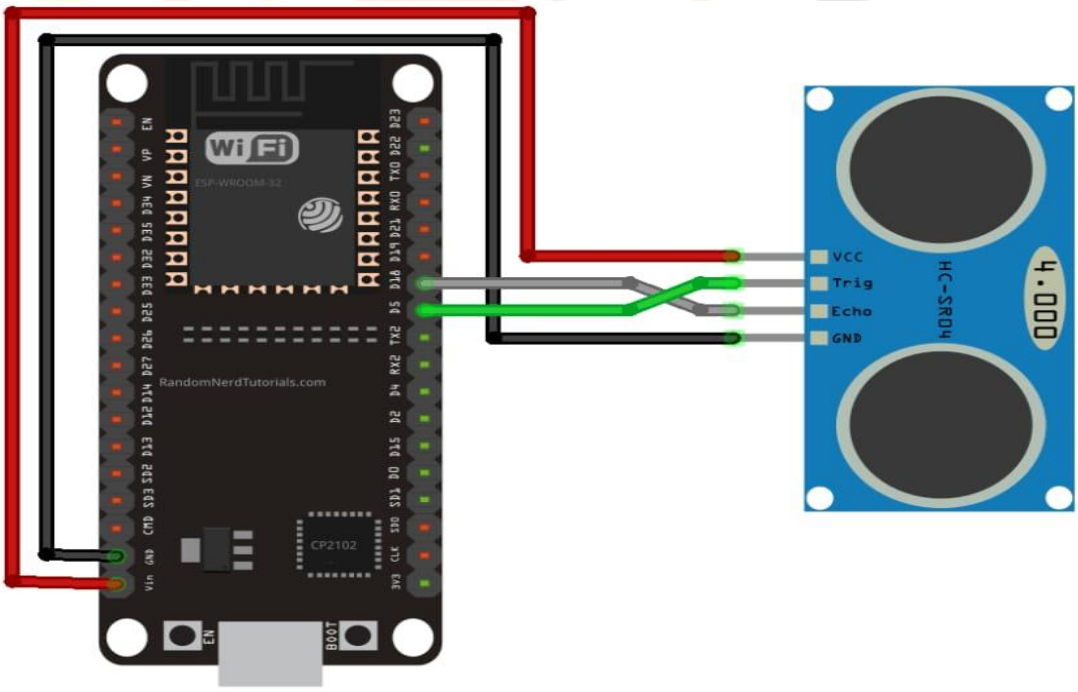
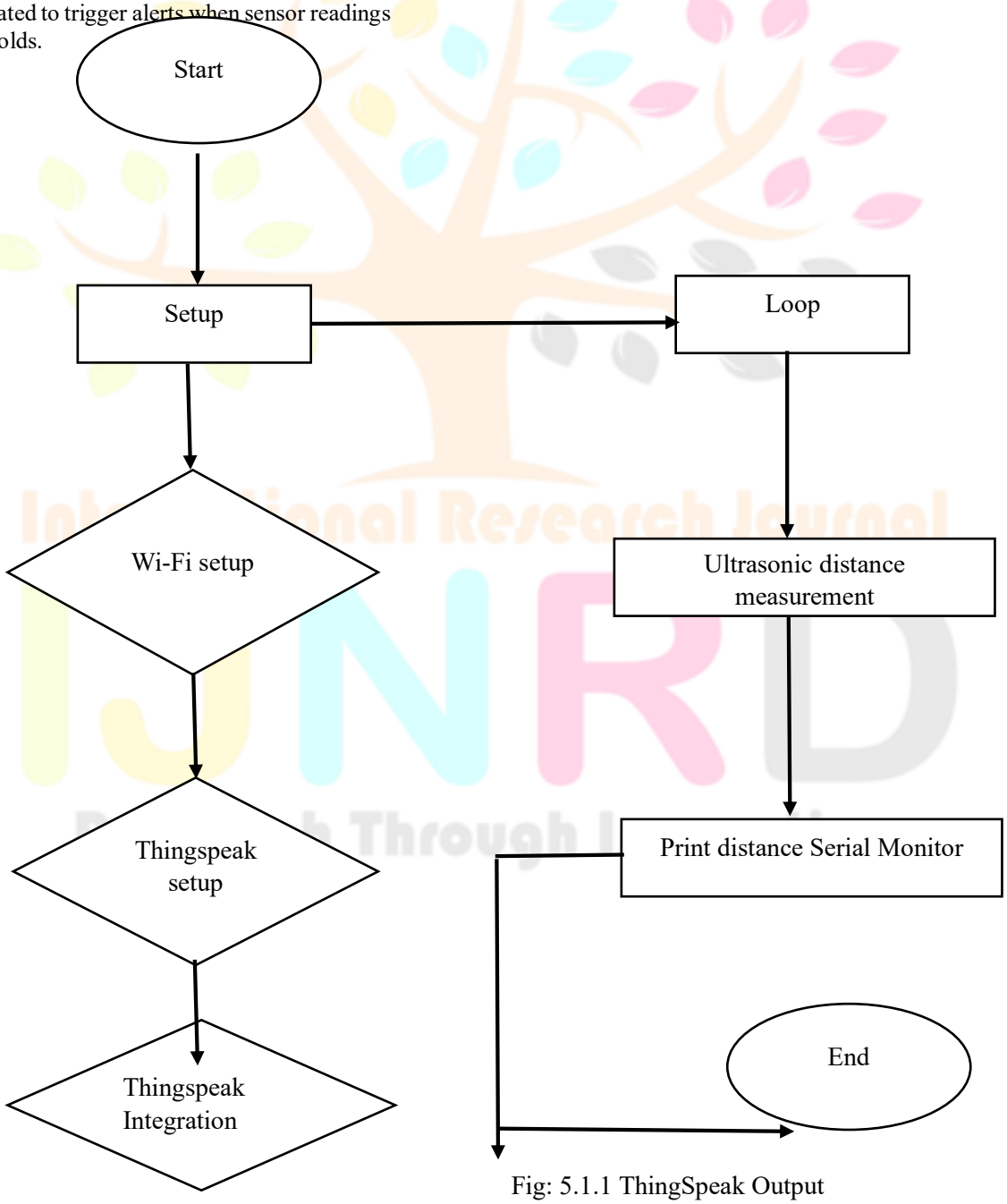


Fig 3.2.4:- circuit diagram of waste monitoring system

IV. SOFTWARE DEVELOPMENT:

The software for this waste monitoring system utilizes Arduino IDE for programming and Thing Speak as the cloud platform. The code manages data collection from ultrasonic sensors and transmits it securely to Thing Speak. During setup, sensor details like address and communication protocol are configured. The system continuously collects sensor data at set intervals using a microcontroller's input pins. A Wi-Fi library within the code facilitates data transmission to Thing Speak via its API, integrating the data with designated channels. Thing Speak acts as a user-friendly online dashboard, allowing for real-time data visualization, analysis, and even data combination.

Following hardware development, the ESP32 microcontroller is programmed using the Arduino IDE. The code is uploaded via a USB connection, and communication protocols within the code enable synchronization with the Thing Speak platform. Once received, sensor readings are displayed on the Thing Speak website for user access and analysis. Additionally, an external application can be integrated to trigger alerts when sensor readings reach pre-defined thresholds.



V. RESULTS AND DISCUSSIONS:

5.1 RESULTS:

The project prototype successfully demonstrates the functionality of the waste segregation and stewarding system. The ESP32 connected to Wi-Fi, and sensor readings were displayed on the Thing Speak platform.

Fig: 5.1.1 ThingSpeak Output

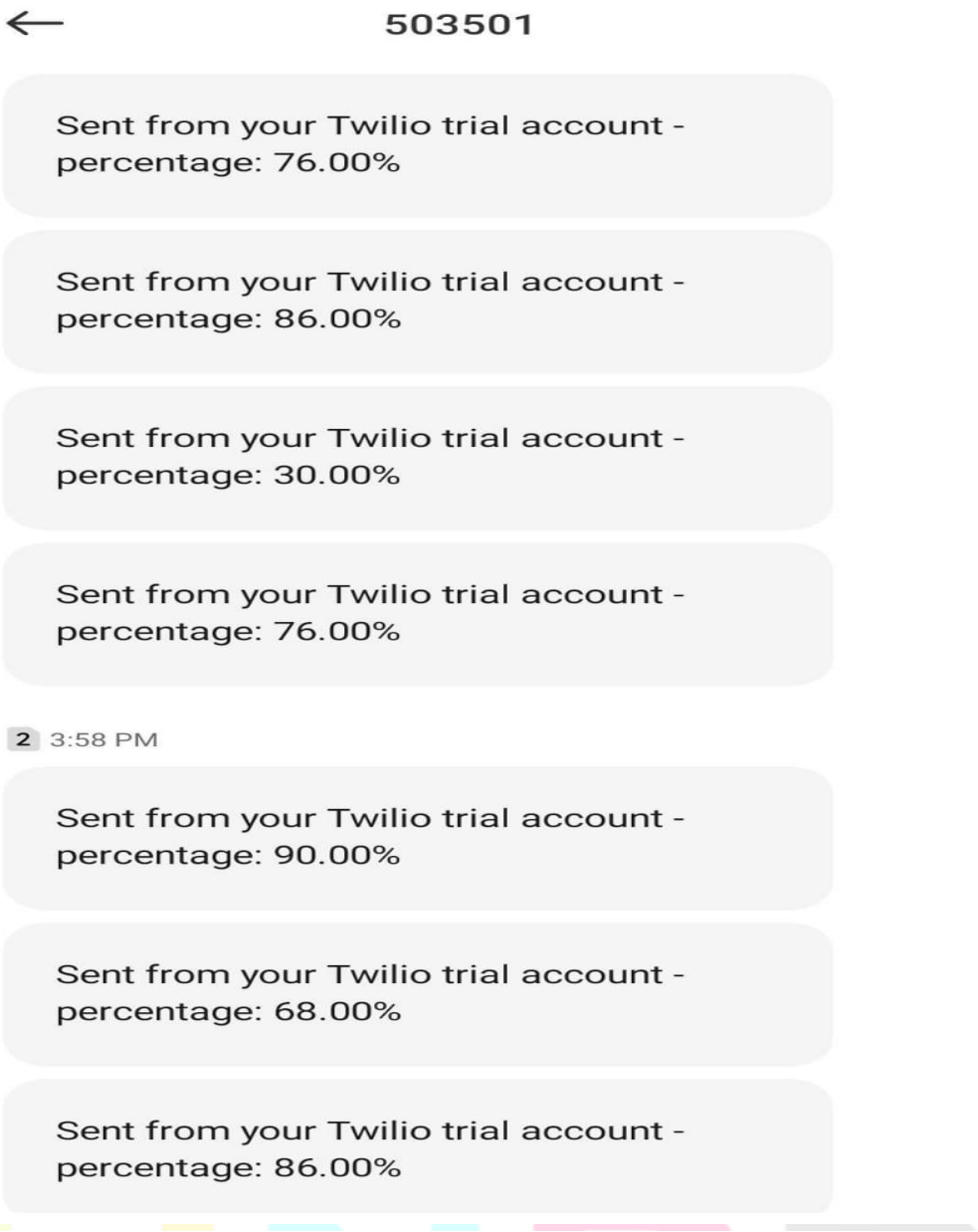
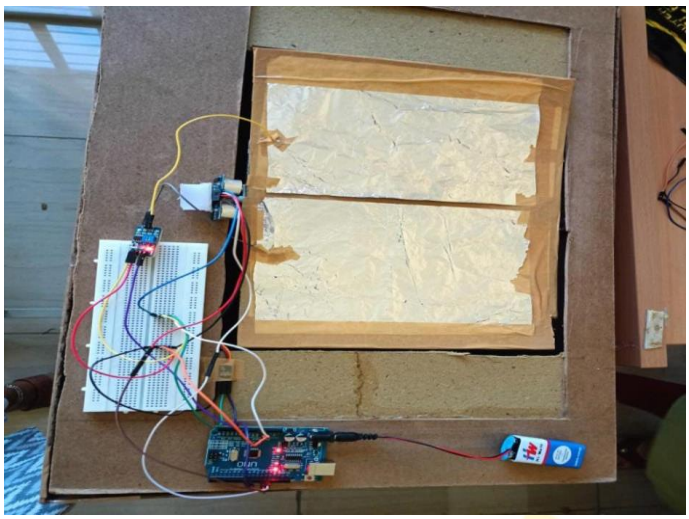
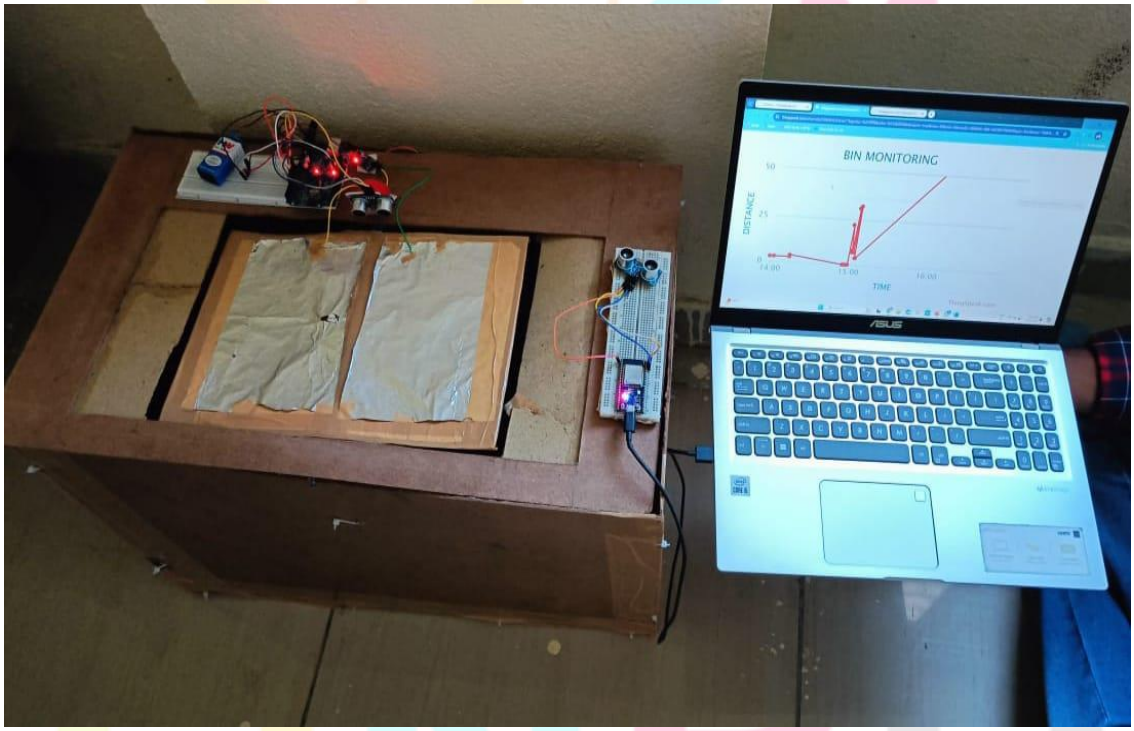


Fig:

5.1.2Alert SMS notifications



igure 5.1.3 – Practical Demonstration of Hardware



5.2 DISCUSSIONS:

We successfully segregated and monitored the waste by using Arduino UNO board and ESP32 and when the readings were out of the range then we got an SMS alert through the Twilio app.

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