IOT BASED GARBAGE MONITORING SYSTEM

A PROJECT REPORT

Submitted by

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Project report titled **"IOT BASED GARBAGE MONITORING SYSTEM"** is the bonafide work of **" SUBASH S (710021106035) , SAKTHIVEL G (710021106032) , VINOTH P G (710021106311) "** who carried out the project work under mysupervision

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ABSTRACT

This project presents an innovative Internet of Things (IoT) solution for efficient garbage management. The system utilizes ultrasonic sensors embedded in waste bins to detect and measure garbage levels. These sensor readings are transmitted wirelessly to a central server through a microcontroller, typically an ESP-32 Microcontroller, connected to the Internet. Users, including waste management authorities, can access real-time data via a web or mobile application.

The system enhances waste collection efficiency by providing timely alerts for bin optimization and reduces operational costs. It exemplifies a smart city application, showcasing the potential of IoT in creating sustainable and technologically advanced urban environments.

LIST OF FIGURES

LIST OF ABBREVATIONS

IOT	INTERNET OF THINGS
GSM	GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS
LCD	LIQUID CRYSTAL DISPLAY
UART	UNIVERSAL ASYNCHRONOUS RECEIVER-TRANSMITTER
SPI	SERIAL PERIPHERAL INTERFACE
I2C	INTER-INTEGRATED CIRCUIT
RAM	(RANDOM ACCESS MEMORY
GPRS	GENERAL PACKET RADIO SERVICE
GPIO	GENERAL-PURPOSE INPUT/OUTPUT
SMS	SHORT MESSAGE SERVICE

1 INTRODUCTION

In response to the escalating challenges in traditional waste management, the advent of technology has ushered in a paradigm shift. The Garbage Monitoring System, based on innovative Internet of Things (IoT) principles, emerges as a groundbreaking solution. This system leverages smart sensors and connectivity to revolutionize the way we monitor and manage waste. Real-time data on garbage levels facilitates efficient collection, optimizing routes and minimizing environmental impact. As we delve into the intricacies of this technology-driven approach, it becomes evident that the Garbage Monitoring System is a key player in the evolution towards smarter and more sustainable urban environments.

1.1 BLOCK DIAGRAM

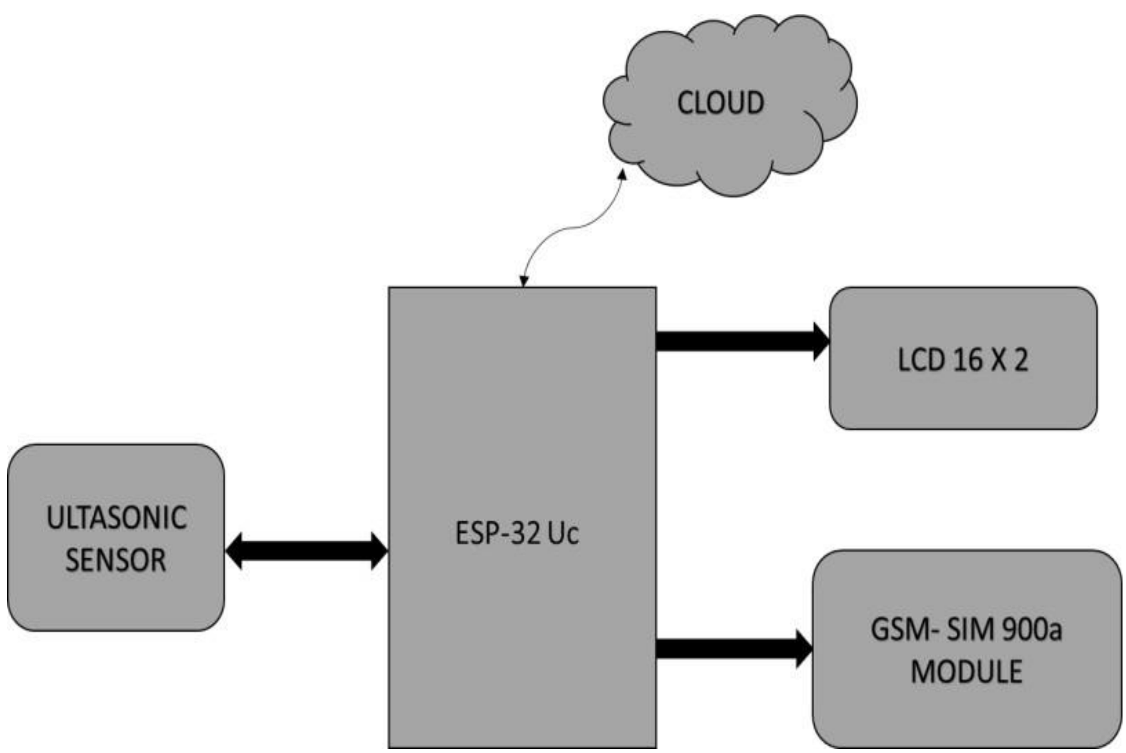
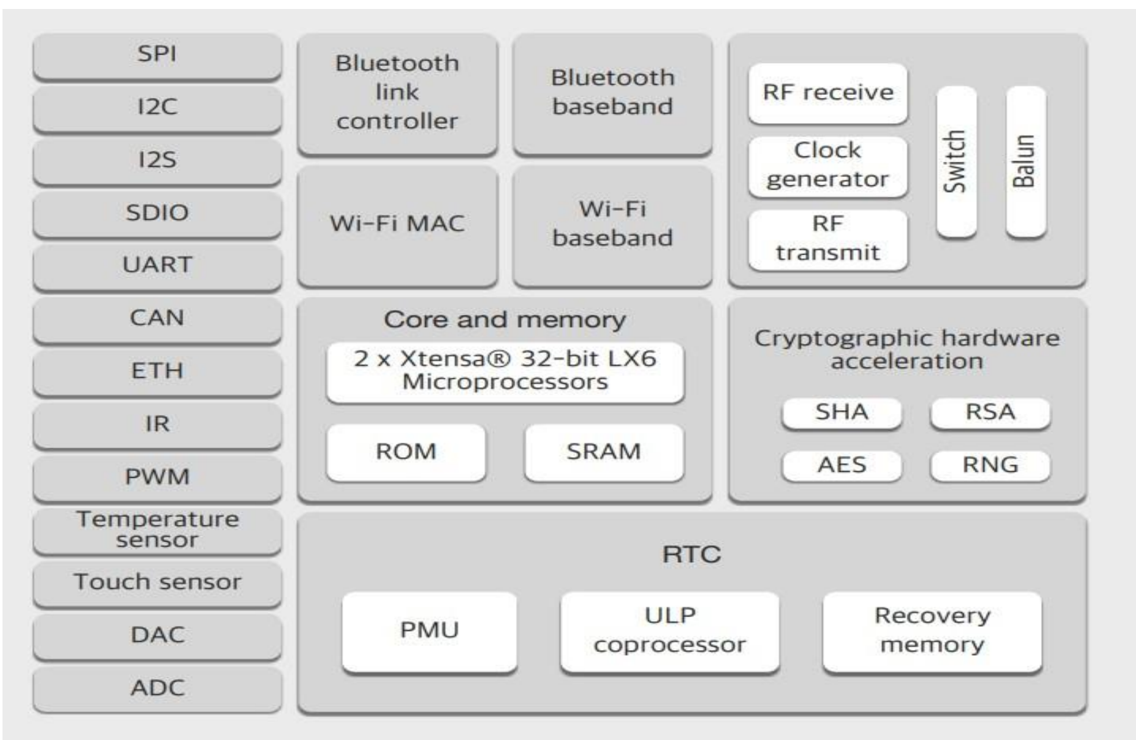


Fig 1.1.1: BLOCK DIAGRAM

In our IoT-based Garbage Monitoring System project, we employ an ESP-32 microcontroller as the central processing unit. The system utilizes Ultrasonic Sensors for real-time garbage level monitoring, ensuring accurate measurements. GSM technology is incorporated for timely alerts, notifying relevant stakeholders of critical garbage levels. To facilitate efficient data storage and remote monitoring, a Cloud platform is employed, enhancing accessibility and analysis. Additionally, an LCD display is integrated into the system, providing on-site users with instant access to current information. The ESP-32's versatile features make it a robust choice, orchestrating seamless communication between sensors, GSM, Cloud, and the LCD display for effective waste management.

1.2 BLOCK DIAGRAM OF ESP-32

Fig 1.2.1 : BLOCK DIAGRAM FOR ESP-32



The ESP32 microcontroller's block diagram showcases its versatile architecture. At its core are two powerful Xtensa LX6 processors, complemented by integrated **Wi-Fi and Bluetooth** modules for seamless connectivity. The system includes memory components, such as Flash and RAM, for program storage and data handling. GPIO pins provide extensive peripheral interfacing, while various communication interfaces, including **UART, SPI, and I2C**, enhance connectivity options. A real-time clock and timers contribute to precise timing functions.

1.3 CONCLUSION

By embracing Internet of Things (IoT) technologies, this system offers real-time monitoring, efficient data collection, and optimized waste collection strategies. The integration of smart sensors and connectivity not only enhances the accuracy of waste management but also paves the way for a more sustainable and environmentally conscious approach. As cities move towards smart urban planning, the IoT-based garbage monitoring system emerges as a crucial innovation, showcasing the power of technology in revolutionizing conventional processes for the benefit of society and the environment.

2. LITERATURE SURVEY

2.1 INTRODUCTION

The literature survey for an IoT-based garbage monitoring system delves into existing research and developments in the field. It explores the technological landscape, methodologies, and innovations in waste management leveraging IoT. This survey provides a comprehensive overview of the strengths and limitations of current solutions, guiding the design and implementation of a novel garbage monitoring system. By reviewing scholarly articles, reports, and advancements, the literature survey lays the foundation for understanding the state-of-the-art in IoT-based waste management, informing researchers and practitioners about key insights, challenges, and opportunities in this dynamic and evolving domain.

2.2 PREVIOUS WORKS

Implementation of a Smart Garbage Monitoring System using GSM . Proceedings of the Fifth International Conference on Computing Methodologies and Communication (ICCMC 2021) IEEE Xplore Part Number: CFP21K25-ART . Dr.T.M.N.Vamsi et.al, They have proposed

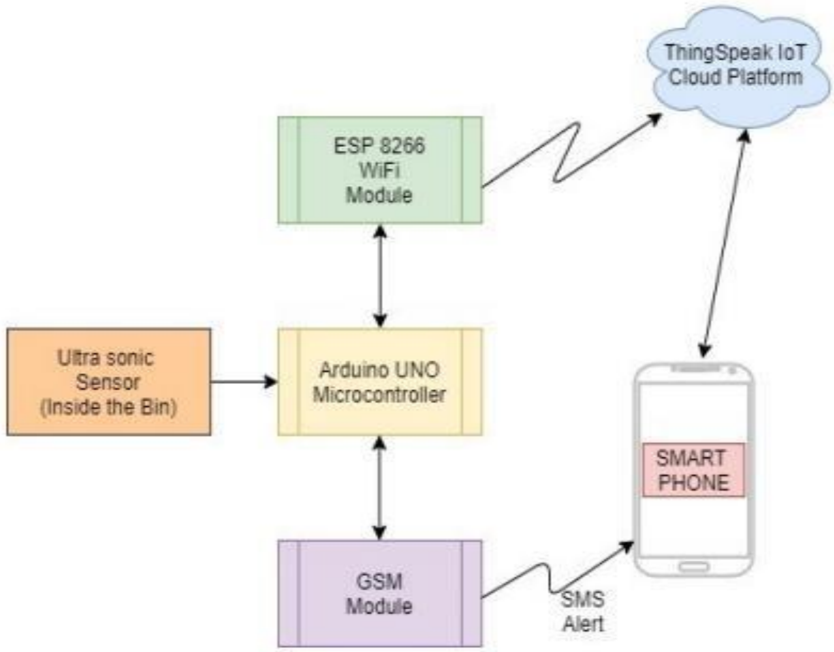


Fig 2.2.1: PERVIOUS WORK METHODOLOGY

The proposed system is designed with integrating different modules like ESP8266 Wi-Fi modem, Ultrasonic Sensor, Arduino board, and a GSM module, which is a cost-efficient and economic smart garbage collection system. The major advantage of this system is, it is implemented with the help of the cloud ThingSpeak database which is an open-source for collecting waste levels at each location and serves back to the mobile application for garbage collection without any delay. By implementing this system, the problem can be minimized for excess accumulation of garbage from the dustbins in streets, residential houses, organizations, etc. which are loaded manually or by using loaders in traditional garbage vans. The improved feature of any other similar systems already existing is, this proposed system can monitor the garbage level automatically with the help of sensors and transfer that information to the cleaning workers through an android application and also provides the shortest route to reach the location of the garbage bin. The process and methodology used in this SGMDSS are more than enough to ensure the practical application and is a seamless system for garbage collection processing, monitoring, and disposal management for a better clean and green environment.

2.3 PROPOSED WORK

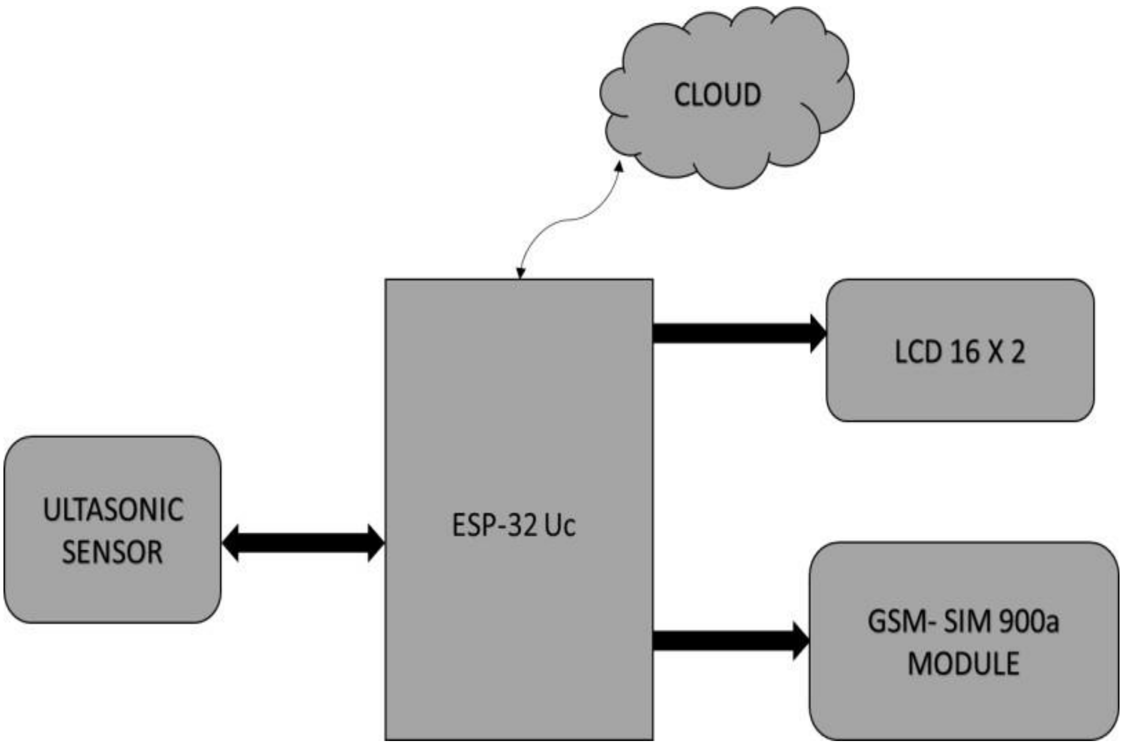


Fig 2.3.1: PROPOSED WORK METHODOLOGY

The ESP32 microcontroller serves as the brain of our IoT-based garbage monitoring system, providing wireless connectivity and efficient data processing. Ultrasonic sensors, strategically placed in waste bins, play a pivotal role in the system, accurately measuring garbage levels through the emission and reception of ultrasonic waves. The GSM module acts as the communication hub, ensuring seamless transmission of real-time data from the garbage sensors to the central server, facilitating remote monitoring and management. An LCD (Liquid Crystal Display) enhances the system's user interface, providing a visual representation of garbage levels and system status, making it accessible and user-friendly for monitoring and control purposes.

2.4 CONCLUSION

In conclusion, both systems offer innovative solutions to modernize garbage collection processes. The choice between them could depend on specific project requirements, such as the need for cloud integration and mobile application features. Each system presents a step towards efficient waste management, contributing to a cleaner and more sustainable environment.

3. HARWARE COMPONENT

3.2 ULTRASONIC SENSOR

An ultrasonic sensor is a device that measures distance or detects objects by emitting ultrasonic waves and calculating the time it takes for the waves to bounce back. Comprising a transmitter and receiver, it operates on the principle of echolocation, similar to how bats navigate. The transmitter e

mits ultrasonic pulses, and the receiver calculates the time delay between emission and reception, converting it into distance. Ultrasonic sensors find applications in robotics, proximity detection, and automation. They are widely used for obstacle avoidance, level sensing, and in burglar alarms. Ultrasonic sensors offer non-contact, accurate distance measurements, making them integral in various technological domains.

Fig 3.2.1 : ULTRA SONIC SENSOR

3.2.2 SPECIFICATIONS

- Power Supply: DC 5V
- Working Current: 15mA
- Working Frequency: 40Hz
- Ranging Distance : 2cm – 400cm/4m
- Resolution : 0.3 cm
- Measuring Angle: 15 degree
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm

3.2.3 WORKING PRINCIPLE OF ULTRASONIC SENSOR

In an IoT-based garbage monitoring system utilizing ultrasonic sensors, the working principle revolves around distance measurement through ultrasonic waves. The sensor emits ultrasonic pulses towards the garbage level, and upon striking the surface, the waves reflect back to the sensor. The time taken for this round trip is used to calculate the distance. As the garbage level rises, the distance decreases, enabling real-time monitoring. This data is then transmitted to a central server through IoT connectivity, facilitating efficient waste management. By integrating ultrasonic sensors into this system, it ensures accurate, non-contact garbage level measurements, enhancing the precision and effectiveness of waste collection strategies.

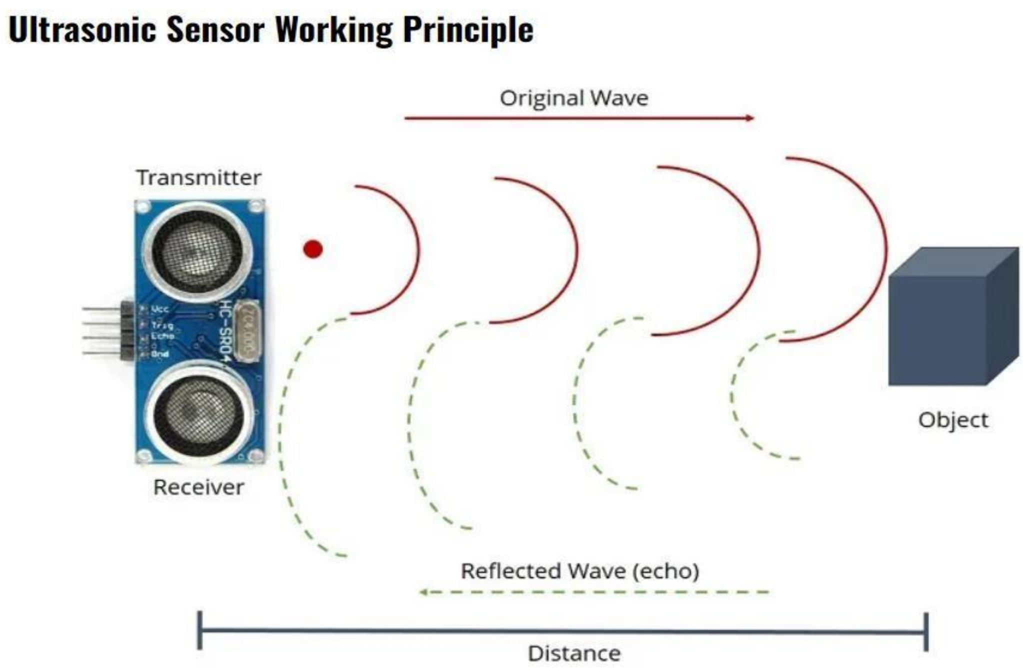


Fig 3.2.4 : WORKING PRINCIPLE OF ULTRASONIC SENSOR

3.3 GSM SIM 900a MODULE

SIM900A GSM Module is the smallest and cheapest module for GPRS/GSM communication. It is common with Arduino and microcontroller in most of embedded application. The module offers GPRS/GSM technology for communication with the uses of a mobile sim. It uses a 900 and 1800MHz frequency band and allows users to receive/send mobile calls and SMS. The keypad and display interface allows the developers to make the customize application with it. Furthermore, it also has modes, command mode and data mode. In every country the GPRS/GSM and different protocols/frequencies to operate. Command mode helps the developers to change the default setting according to their requirements.

Fig 3.3.1: GSM SIM 900a MODULE

3.3.2 FEATURES OF GSM SIM 900A MODULE

FEATURES	DETAIL
Power Input	3.4V to 4.5V
Operating Frequency	EGSM900 and DCS1800
Transmitting Power Range	2V for EGSM900 and 1W for DCS1800
Data Transfer Link	Download: 85.6kbps, Upload:42.8kbps
SMS	MT, MO, CB, Text and PDU mode.

Antenna Support	Available
Audio Input/output	Available
Serial Port	I2C and UART
Serial Debug Port	Available

3.4 LCD Display

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. But the most used one is the 16*2 LCD, hence we are using it here.

All the above mentioned LCD display will have 16 Pins and the programming approach is also the same and hence the choice is left to you. Below is the Pinout and Pin Description of 16x2 LCD

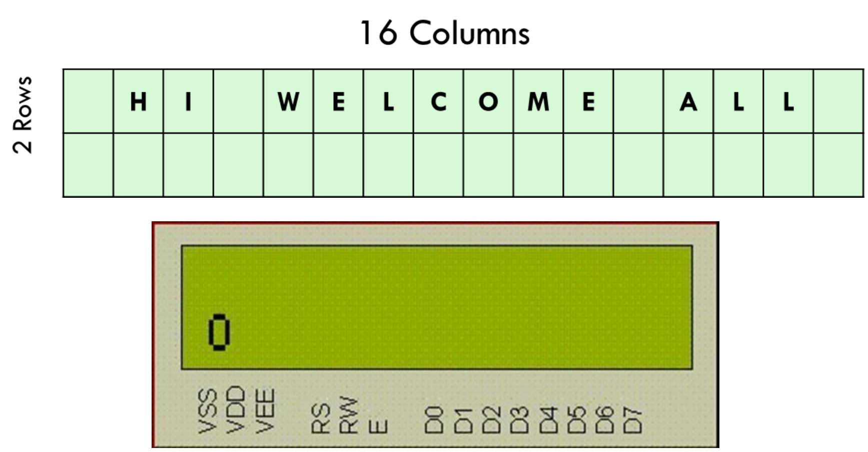


Fig 3.4.1: LCD DISPLAY

4 ESP-32 OVERVIEW

The ESP32 is a powerful and versatile microcontroller developed by Espressif Systems. It features a dual-core processor, Wi-Fi and Bluetooth connectivity, a variety of GPIO pins, and numerous built-in peripherals. The ESP32 is widely used in Internet of Things (IoT) applications due to its low power consumption, cost-effectiveness, and capability to handle complex tasks. Its dual-core architecture allows for multitasking, making it suitable for a range of projects from simple sensor nodes to more advanced applications like home automation and industrial IoT. With an active developer community and support for multiple programming languages, the ESP32 has become a popular choice in the embedded systems and IoT development community.

4.1 PIN DIAGRAM

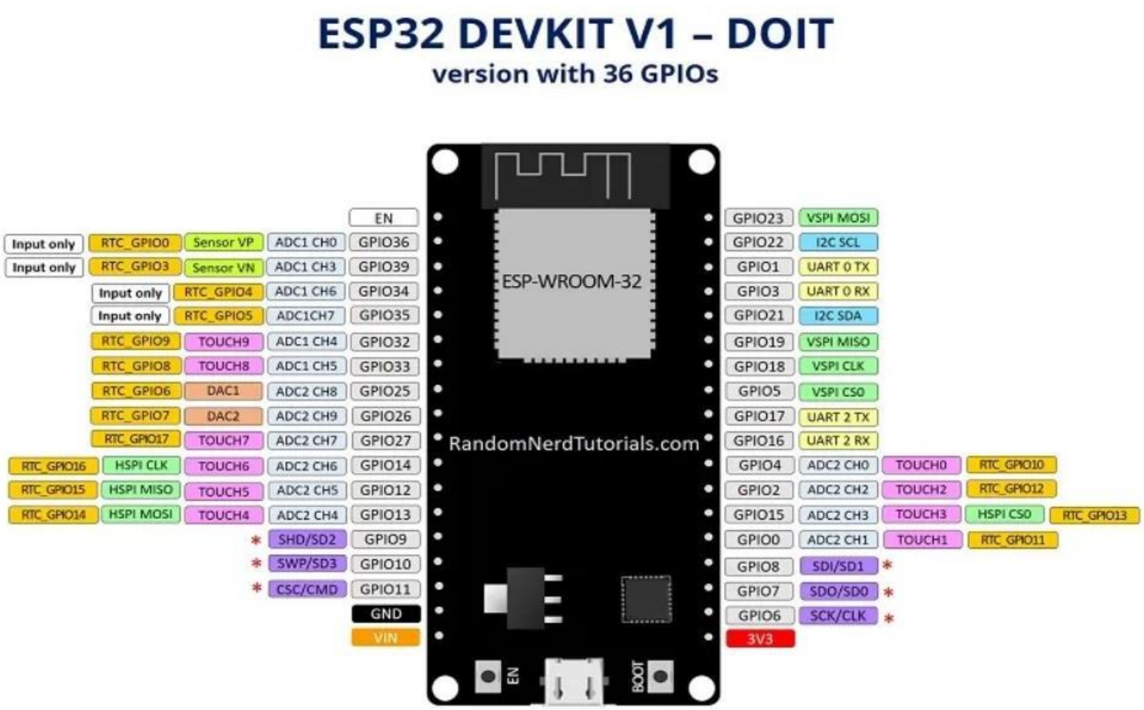


Fig 4.2.1 : PIN DIAGRAM OF ESP-32 DEV MODULE

4.2 ESP-32 INTERFACING WITH ULTRASONIC SENSOR

The ESP32 microcontroller, coupled with an ultrasonic sensor, creates a robust system for level monitoring in various applications. The ESP32's dual-core processor and integrated Wi-Fi enable seamless connectivity. The ultrasonic sensor, employing echolocation principles, measures distances accurately without physical contact. When integrated, the ESP32 processes data from the ultrasonic sensor, providing real-time level monitoring information. This combination is invaluable for applications such as tank level monitoring, water level measurement, or **smart waste management**. The ESP32's versatility, low power consumption, and wireless capabilities make it an ideal choice for IoT-based level monitoring systems.

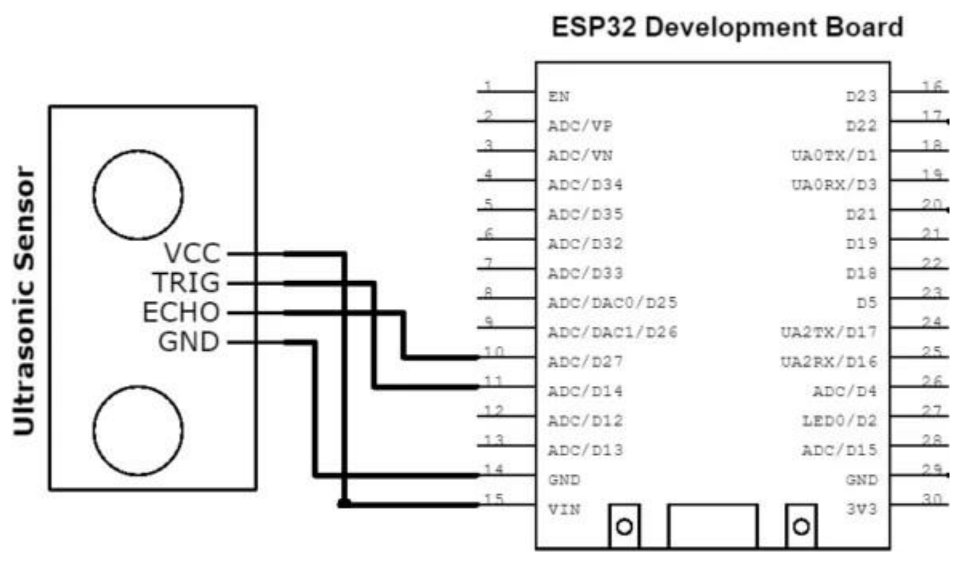


Fig 4.3.1: CIRCUIT FOR ESP-32 INTERFACING WITH ULTRASONIC SENSOR

4.4 ESP-32 INTERFACING WITH GSM SIM 900a MODULE

The ESP32 microcontroller, when connected with a GSM module, forms a potent combination for SMS alerts in various applications. This integration enables the ESP32 to send SMS notifications based on specific events or sensor readings. The GSM module facilitates mobile network communication, allowing the ESP32 to transmit messages in real-time. This setup finds applications in security systems, environmental monitoring, and remote automation. By harnessing the ESP32's capabilities for data processing and the GSM module's connectivity, this solution provides an efficient means of receiving timely alerts via SMS, enhancing the remote monitoring and control aspects of IoT and embedded systems.

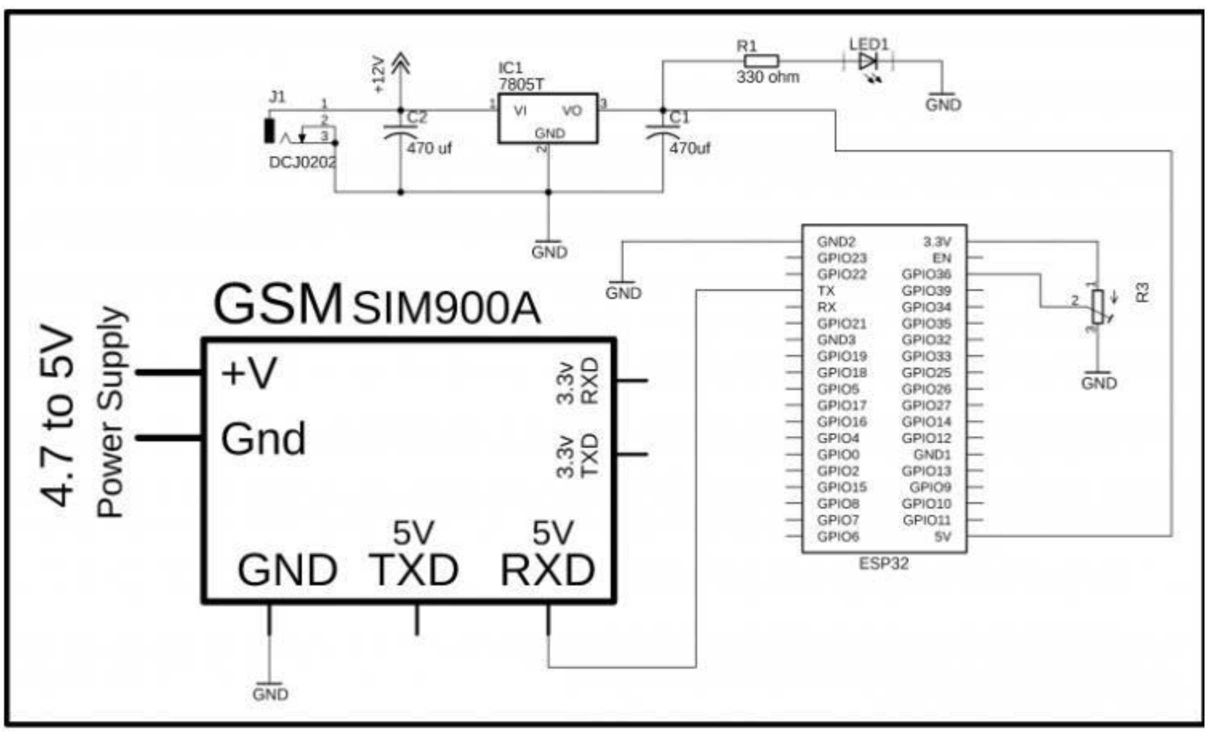


Fig 4.4.1: CIRCUIT DIAGRAM FOR INTERFACING ESP-32 WITH GSM SIM 900a MODULE

5 SOFTWARE DESIGN

5.1 ARDUINO IDE

The Arduino Integrated Development Environment (IDE) is a user-friendly software platform designed for programming and uploading code to Arduino microcontrollers. It provides a simplified interface for writing, compiling, and uploading code to Arduino boards, making it accessible to beginners and experienced developers alike. The IDE supports the Arduino programming language, which is based on Wiring, and includes a vast library of pre-written code to facilitate project development. With features like a serial monitor for debugging and a straightforward interface, the Arduino IDE has become a staple tool in the maker and electronics communities, fostering creativity and innovation in the real of microcontroller programming.

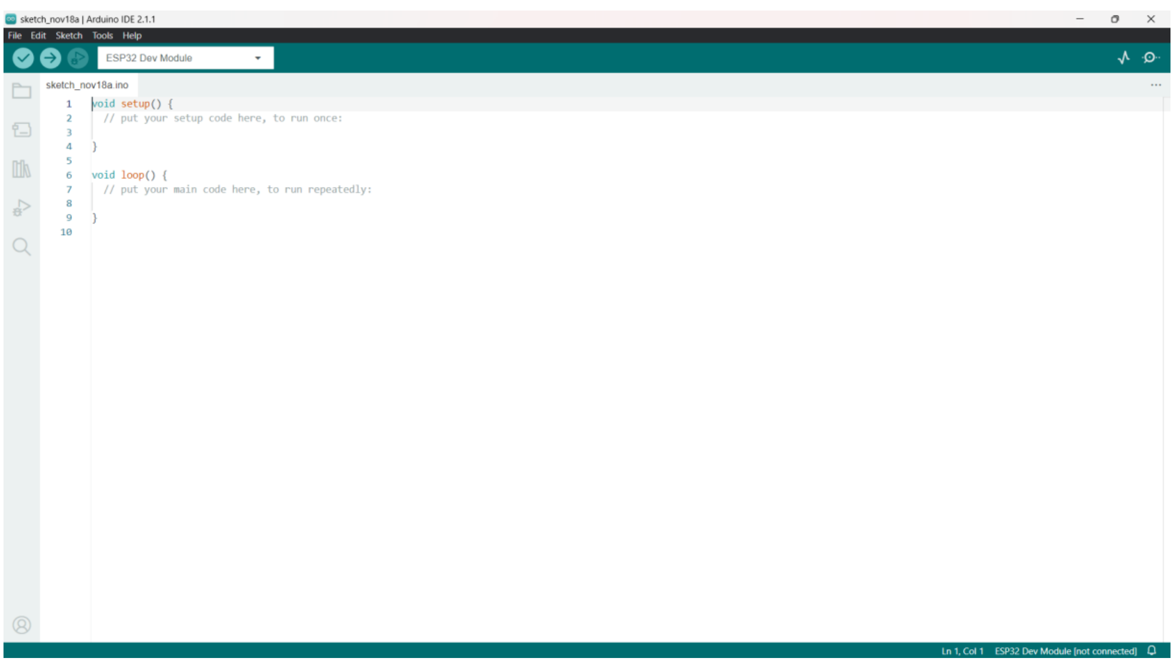


Fig 5.1.1 : ARDUINO IDE

5.2 EMBEDDED C

Embedded C is a specialized programming language tailored for embedded systems, where software interacts closely with hardware to perform specific functions. It is a variant of the C programming language but adapted to the constraints and requirements of embedded systems. Embedded C emphasizes efficiency, low-level control, and direct hardware interaction, making it well-suited for microcontroller-based applications, real-time systems, and other resource-constrained environments. Programmers use Embedded C to develop firmware for devices like microcontrollers, ensuring precise control over hardware features. Mastery of Embedded C is crucial for professionals working on embedded systems, IoT devices, and other embedded applications.

6 EXPRIMENT RESULT AND ANALYISIS

6.1 INTRODUCTION

In examining the experiment results and analysis of the IoT-based garbage monitoring system, a comprehensive overview of the system's performance and impact emerges. This investigation delves into the efficacy of real-time garbage level monitoring, waste collection optimization, and resource efficiency. By scrutinizing the collected data, we gain insights into the system's responsiveness and its ability to streamline waste management processes. The analysis considers factors such as route optimization, cost reduction, and environmental benefits. This examination of results aims to provide a thorough understanding of the system's practical implications, underscoring its potential to revolutionize traditional waste management paradigms through IoT technology.

6.2 RESULT AND DISCUSSION

6.2.1 INITIALLY TAKING LEVEL FROM ULTRASONIC SENSOR

In an IoT-based garbage monitoring system employing ultrasonic sensors, the process involves capturing garbage levels with precision. Ultrasonic waves emitted by the sensor bounce off the garbage surface, and the time taken for the waves to return is calculated to determine the distance. As garbage accumulates, this distance decreases, enabling accurate level measurements. The collected data is seamlessly transmitted through IoT connectivity, allowing real-time monitoring. This technology-driven approach ensures efficient waste management by providing timely information for optimized collection routes and resource utilization. The integration of ultrasonic sensors plays a pivotal role in enhancing the effectiveness and reliability of the garbage monitoring system.

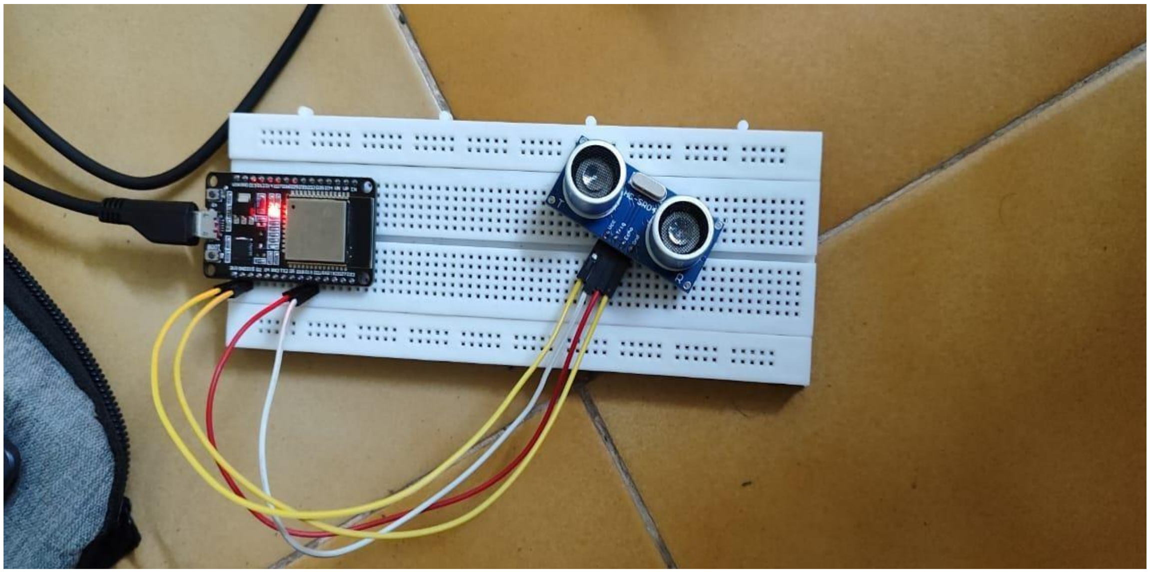


Fig 6.2.1.1 : CIRCUIT CONNECTION FOR INITIAL LEVEL MONITORING

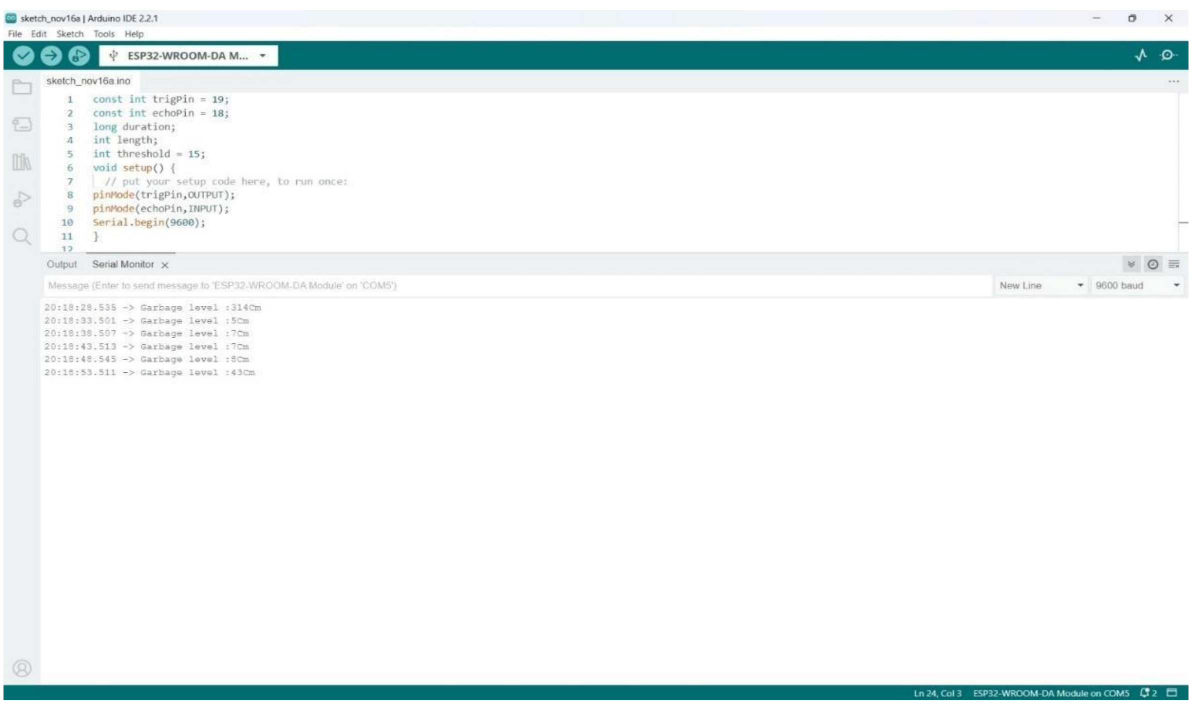


Fig 6.2.1.2 : OUTPUT FOR INITIAL LEVEL MONITORING

6.2.2 SENDING ALEART SMS Via GSM

In an IoT-based garbage monitoring system, the GSM module serves as a crucial component for alerting authorities. When the sensor detects a critical garbage level, the system triggers the GSM module to send an alert SMS. This ensures real-time communication, allowing swift response to overflowing bins or maintenance needs. The integration of GSM technology adds a layer of proactive management to the system, enabling timely actions and preventing potential issues. This feature enhances the overall efficiency of waste management, making the system not only intelligent in monitoring but also responsive to the dynamic needs of urban environments.

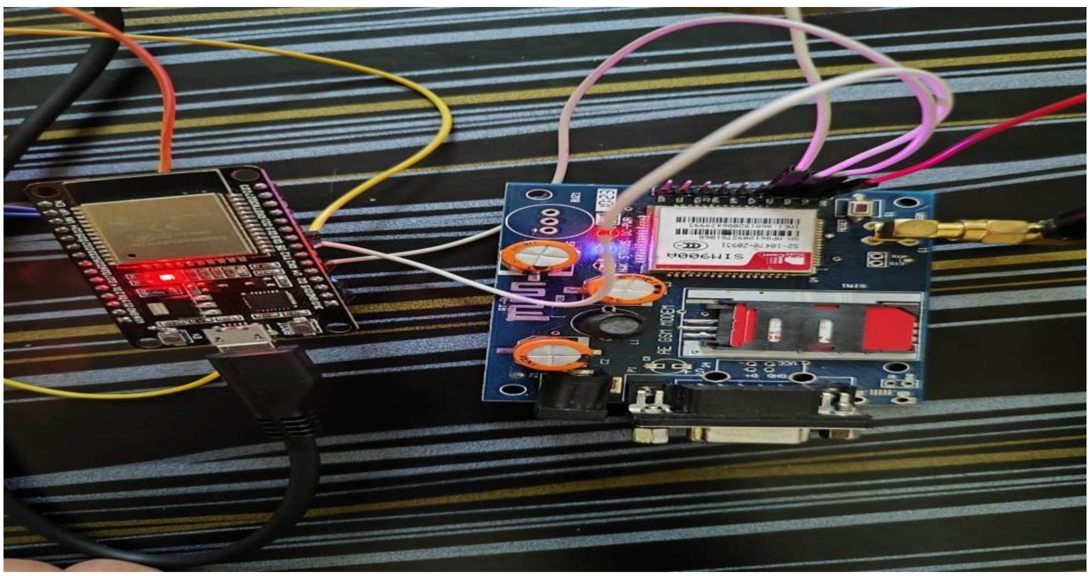


Fig 6.2.2.1 : CIRCUIT CONNECTION FOR SENDING ALERT SMS Via GSM

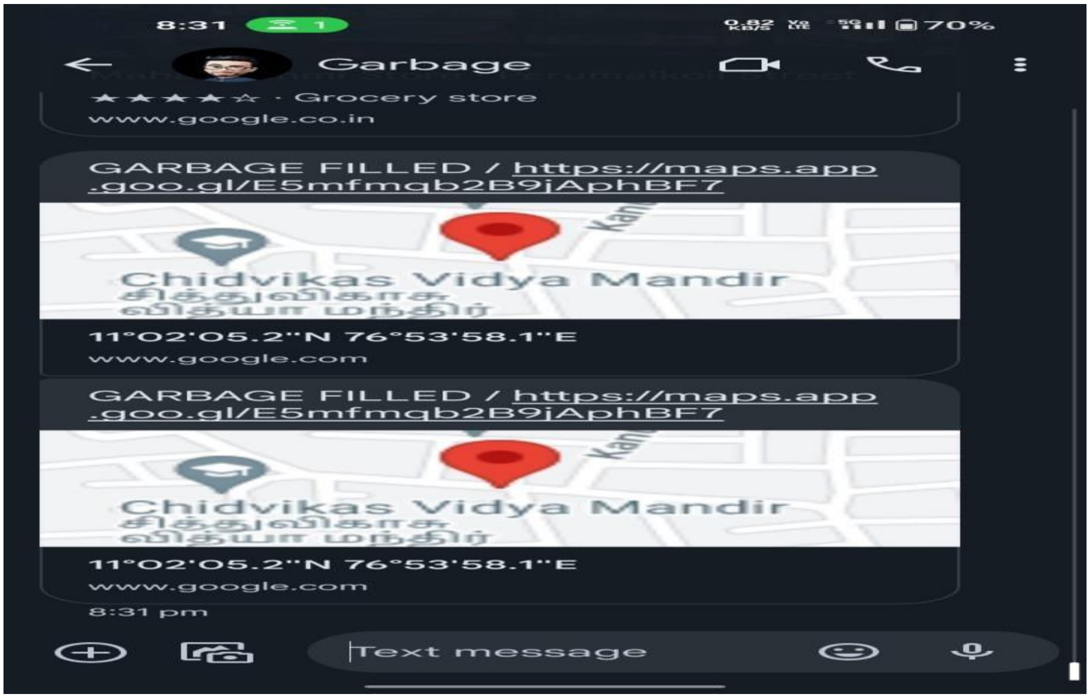


Fig 6.2.2.2 OUTPUT FOR SENDING ALEART SMS Via GSM

6.2.3 MONITORING GARBAGE LEVEL IN CLOUD PLATFORM

The IoT-based garbage monitoring system integrates cloud platforms to revolutionize waste management. Smart sensors measure garbage levels, transmitting real-time data to the cloud. This seamless connection enables centralized monitoring and analysis, empowering authorities to optimize collection routes and schedules. Leveraging cloud platforms enhances scalability, accessibility, and data security. Through the Internet of Things, the system transforms conventional waste management into a dynamic, data-driven process, improving operational efficiency and fostering sustainable practices. The marriage of IoT and cloud technology signifies a significant leap toward intelligent, connected solutions for effective urban waste management.

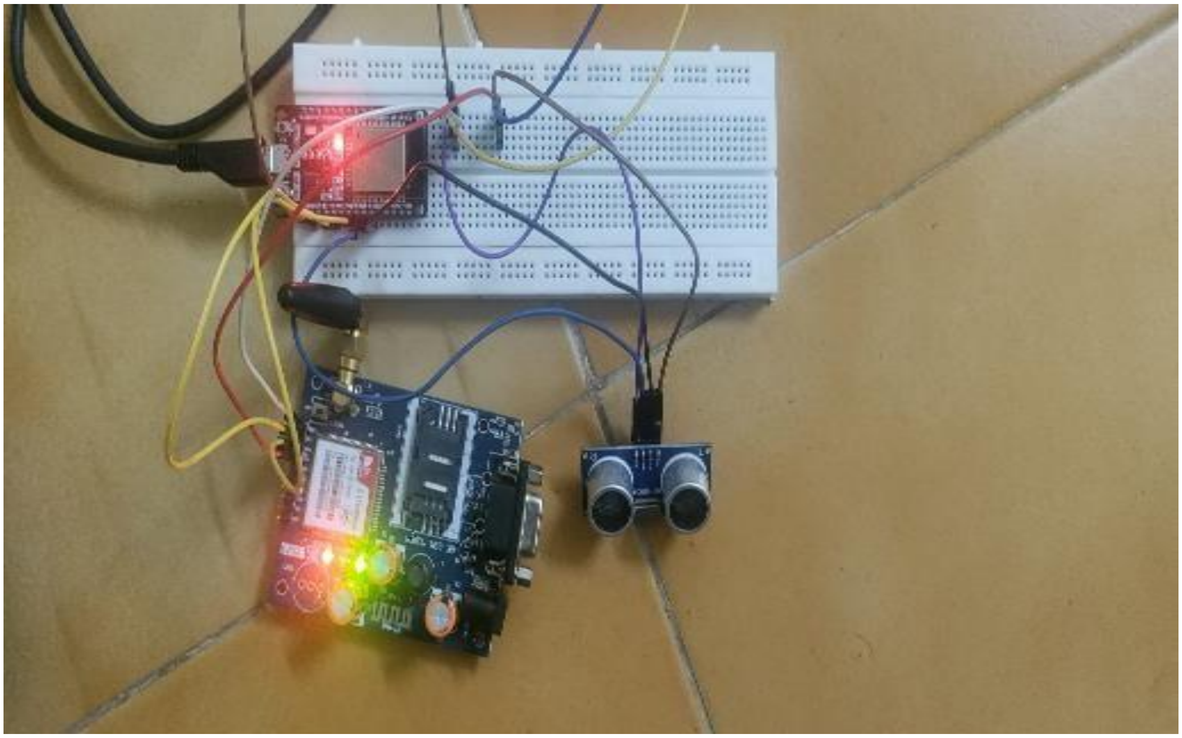


Fig 6.2.3.1 : CIRCUIT CONNECTION FOR MONITORING GARBAGE LEVEL IN CLOUD PLATFORM

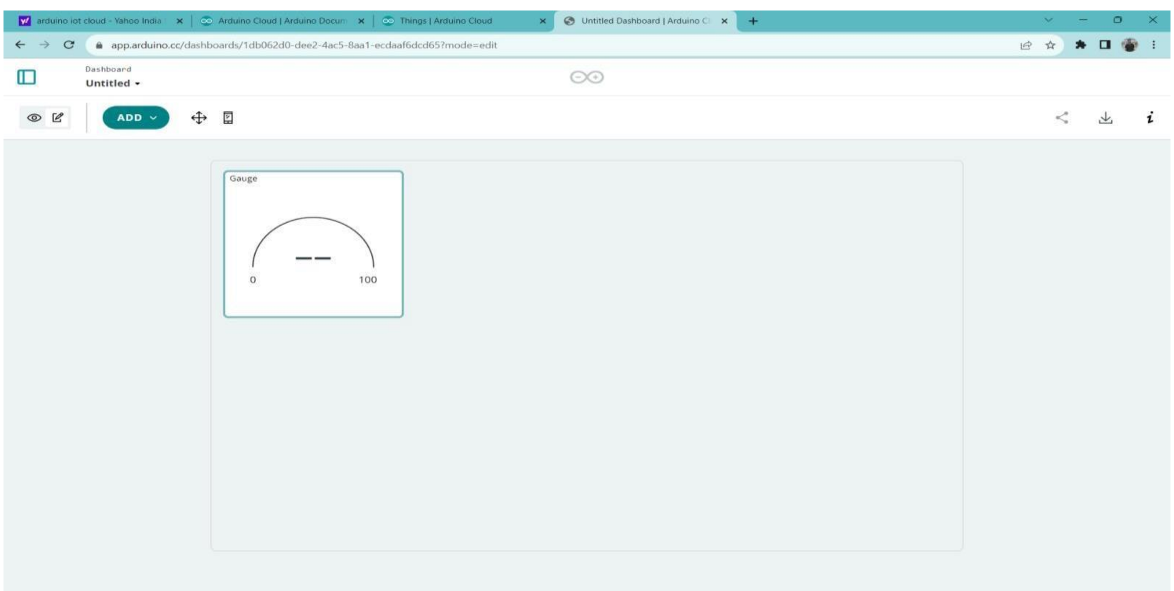


Fig 6.2.3.2 : OUTPUT FOR MONITORING GARBAGE LEVEL IN CLOUD PLATFORM

6.2.4 STORING DATA IN GOOGLE DRIVE

In the IoT-based garbage monitoring system, data can be efficiently stored in Google Drive for seamless accessibility and analysis. The system's microcontroller, such as ESP32, sends real-time garbage level data to a central server, which is then synchronized with a Google Drive repository. This integration allows for secure, cloud-based storage, facilitating remote monitoring and data retrieval. By leveraging Google Drive's collaborative features and scalable storage capabilities, the system ensures a centralized and easily accessible repository for historical garbage level data. This approach enhances the system's efficiency, enabling stakeholders to make informed decisions based on comprehensive and readily available information.

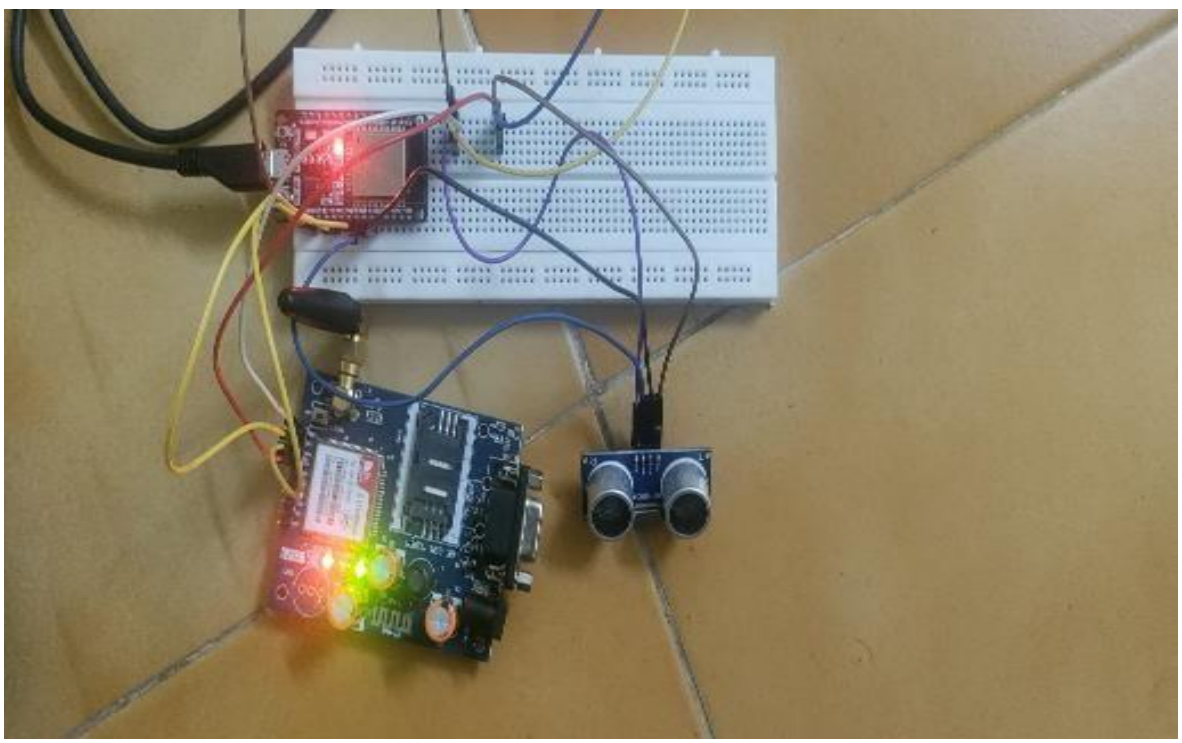


Fig 6.2.4.1 : CIRCUIT CONNECTION FOR STORING DATA IN GOOGLE DRIVE

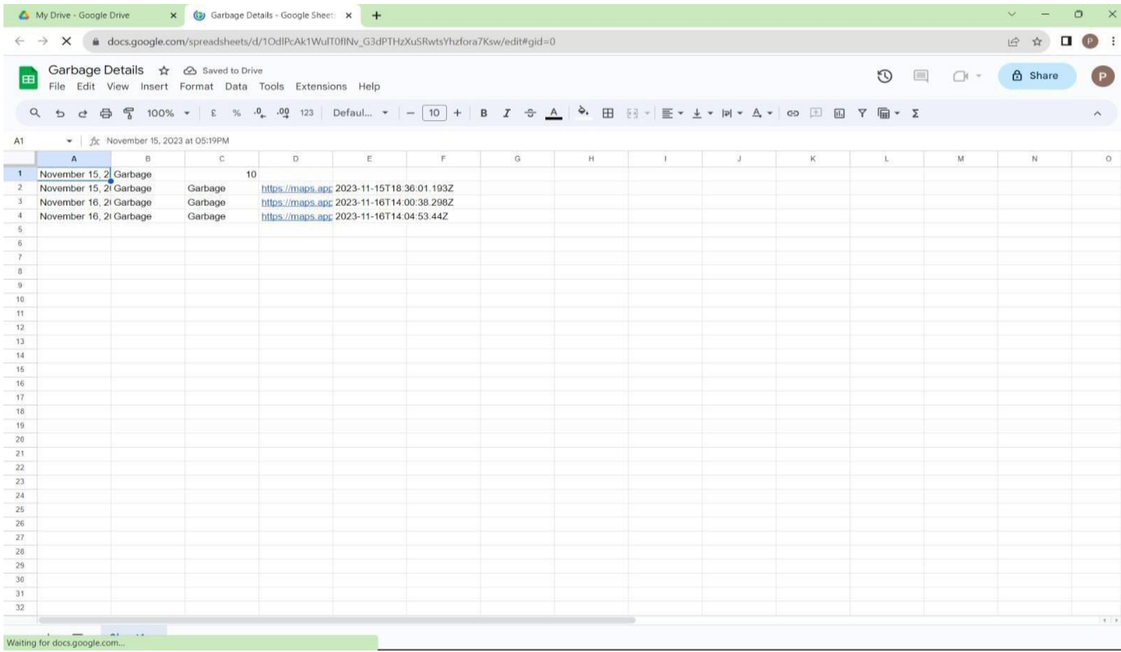


Fig 6.2.4.1 : OUTPUT FOR STORING DATA IN GOOGLE DRIVE

7 CONCLUSION AND FUTURE WORK

7.1 CONCLUSION

In summary, the IoT-based garbage monitoring system represents a pivotal advancement in waste management. By leveraging smart sensors and connectivity, it provides real-time insights into garbage levels, optimizing collection routes and schedules. This not only streamlines operational efficiency but also minimizes environmental impact. The system's ability to enhance precision in waste management aligns with the broader goal of creating smarter, sustainable cities. As a scalable and innovative solution, it exemplifies the transformative potential of IoT in addressing real-world challenges, paving the way for a cleaner, more resource-efficient future.

7.2 FUTURE WORK

Future work in IoT-based garbage monitoring systems involves refining the technology for even greater sustainability. Integration with machine learning algorithms can predict waste generation patterns, optimizing collection schedules further. Incorporating additional sensors for environmental monitoring, such as gas emissions or temperature, can provide a comprehensive waste analysis. Implementing blockchain technology ensures secure and transparent data management. Collaboration with municipalities for widespread adoption and exploring solar-powered, energy-efficient sensor solutions will enhance system scalability. Continuous innovation in IoT and environmental science will drive the evolution of garbage monitoring systems, contributing to smarter, more eco-friendly cities globally.

REFERENCES

1. *An IoT Based Smart Garbage Monitoring and Disposal Support System . Dr.T.M.N.Vamsi et.al, Proceedings of the Fifth International Conference on Computing Methodologies and Communication (ICCMC 2021) IEEE Xplore Part Number: CFP21K25-ART*

2. *Environmental Monitoring and Smart Garbage Sorting System Based on LoRa Wireless Transmission Technology. Chun-Yen Chung et.al,2nd IEEE Eurasia Conference on Biomedical Engineering, Healthcare and Sustainability 2020.*

3. *Implementation of a Smart Garbage Monitoring System using GSM . Dr.T.M.N.Vamsi et.al, Proceedings of the Fifth International Conference on Computing Methodologies and Communication (ICCMC 2021) IEEE Xplore Part Number: CFP21K25-ART .*

APPENDIX- 1 DATA SHEET

https://drive.google.com/drive/folders/1LH1iLOKTr2BTRrSEamKSLZS8_Zu2MgK?usp=drive_link