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SAFEGUARDING PUBLIC HEALTH: IMPLEMENTING SMART WASTE COLLECTION SYSTEMS IN URBAN AREAS

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Abstract: In our city, overloaded public garbage bins often lead to unpleasant odors and unsightliness, posing health risks and facilitating the spread of diseases. To address this issue and promote public health and cleanliness, we propose implementing a Smart Waste Collection and Management System. This system includes Smart bins equipped to detect hazardous gases and monitor bin fullness, with data transmitted via wireless mesh network. This data helps waste management providers and cleaners make informed decisions, improving public cleanliness and health. The system alerts the municipal web server when bins need cleaning based on garbage levels and hazardous gas presence, using ultrasonic and gas sensors connected to a microcontroller. A WIFI module and IoT technology facilitate this process, enabling real-time monitoring of waste collection by municipal authorities. Additionally, a web-based application linked to the server notifies authorities of alerts and allows remote monitoring, reducing manual oversight and enabling timely action.

Index Terms - Smart waste management, Internet of things (IoT), Smart Garbage Bins (SGB's), Waste Monitoring, IoT Based Garbage or Dustbins, IoT in Waste Management.

I. INTRODUCTION

Today, diverse urban areas are expanding all over the world, and as these urban areas develop, the population density of the area increases as well. As a result of the rise in population, the possibilities of an unsanitary environment increase as the volume of rubbish and waste products increases. The problem with today's society, particularly in India, is that most individuals lack a feeling of responsibility, and many people in our society lie around surrounded by rubbish. Pollution rises because of the filthy rubbish containers, which is detrimental for the environment. This gives the city an extremely unappealing appearance, which contributes to air pollution and the spread of infectious diseases. Bacteria and viruses can be spread via dustbin contamination, which might cause life-threatening conditions for humans. To overcome this kind of situation, this project is designed, which mainly aims at the hygienic condition and cleanliness of any society [1].

The things that must be done to control trash from the point of origin to the point of disposal are called waste management tasks. Along with monitoring and controlling the waste management procedure, this also covers the collection, transportation, treatment, and disposal of trash. The handling of solid waste has become a major environmental concern since it affects our society's environment and health. An object's surroundings can be automatically linked via wired and wireless networks under the Internet of Things (IoT) concept. The goal of the Internet of Things is to enable advanced intelligent services for users through the communication and exchange of information between items. With smart cities having under-optimized garbage collection systems, this project addresses the issue of waste management and collection. We're going to suggest a solution in this project for the instant cleaning of the dustbins. Cleaning every dustbin as it is full is crucial to maintaining the standard of cleanliness. We intend to employ an ultrasonic sensor to notify us when the rubbish level has beyond its maximum capacity. The bins should then be emptied as quickly as feasible. Due to the current circumstances and the daily development in waste, it is typical to see dustbins or garbage bins overflowing. These spilling might make an unhygienic environment and a foul stench. This encourages the spread of bacteria and viruses that can lead to a wide range of illnesses. With every day as the world's population increases, the disposing of dustbins must be done to ensure clean and hygiene for our better lives.

II. MATERIAL AND METHODOLOGY

This section covers the different resources used to create the system's software and hardware models.

A. Material Required

We will need the following hardware to complete our project.

1. Ultra sonic sensor
2. Gas sensor
3. ESP 32
4. Jumper wires
5. Breadboard
6. GPS.
7. VVM ESP32 4G LTE A7670 MODULE

1.Ultra Sonic Sensor:

Ultrasonic sound waves are used by the Ultrasonic Sensor, specifically the HC- SR04 type, to measure distances. Its transducer, which can send and receive ultrasonic pulses, is its main component. This sensor works well for measuring the distance between the top of a lid and the top of the trash in a bin since it is good at detecting objects and rubbish. A high-frequency sound wave is emitted by the HC- SR04, reverberating off the closest object before returning to the sensor. The sensor calculates the distance to the item by measuring the time it takes for the sound wave to return. This technique makes it possible to measure distance accurately, which is crucial for automated systems that control waste levels, guarantee prompt collection, and stop overflow. Its dependable operation across a range of environmental circumstances makes the HC-SR04 a popular choice for distance measurement tasks.

Figure 1: Ultrasonic Sensor

2.Gas Sensor:

As the name implies, gas sensors are apparatuses made to identify and react to particular kinds of gases present in a given space. They are able to track variations in the concentrations of a number of gases, including carbon dioxide, methane, and carbon monoxide. These sensors' primary goal is to protect people and the environment from harm.

Figure 2: Gas Sensor

3. ESP32:

Espressif Systems created the potent microcontroller and Wi-Fi module known as the ESP32. It is an improved version of the ESP8266 with more features and functionalities. The ESP32's adaptability, low power consumption, and simplicity of usage make it a popular choice for Internet of Things applications.

The dual-core CPU of the ESP32, which enables effective multitasking, is one of its primary characteristics. For applications that need both processing power and connection, this makes it perfect. Furthermore, the ESP32 has integrated Bluetooth and Wi-Fi, allowing for easy wireless connectivity.

The ESP32's extensive peripheral set, which includes GPIO pins, SPI, I2C, UART, and ADC interfaces, is another noteworthy feature. As a result, interacting with a variety of sensors, actuators, and other external devices. Along with support for many sleep modes and power-saving measures, the ESP32 is also incredibly programmable. Because of this, it can be used in battery-powered applications where energy economy is essential.

The Arduino IDE, ESP-IDF (Espressif IoT programming Framework), or other programming platforms can be used to program the ESP32. With compatibility for both C and C++, the ESP32 is programmed by a broad spectrum of developers. All things considered, the ESP32 is a strong and adaptable microcontroller that works well with a wide range of Internet of Things applications. Developers wishing to construct connected products and systems frequently choose it because of its low power consumption, connection choices, and computational capability.

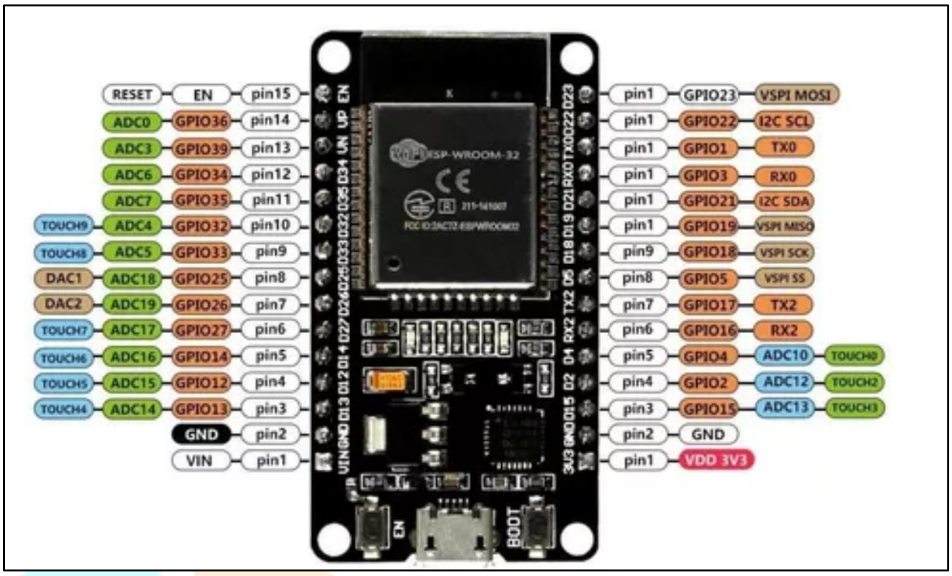

Figure 3: ESP32

4. Jumper wires

Simply said, jumper wires are cables having connector pins on either end that may be used to join two places together without the need for solder. Usually used in conjunction with breadboards and other prototyping tools, jumper wires allow for simple circuit modification as needed.

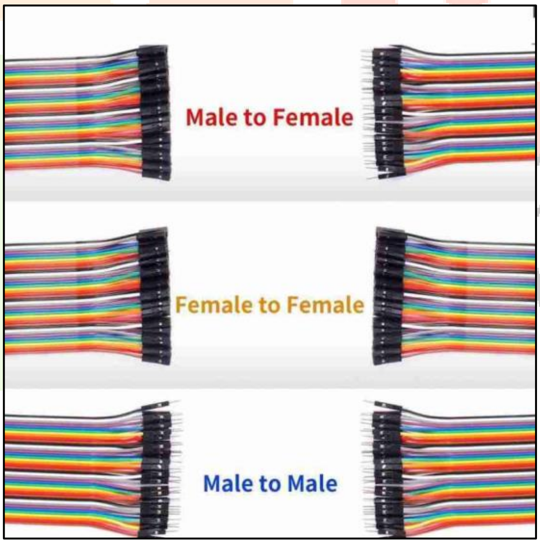

Figure 4: Jumper Wire

5. Breadboard

A breadboard serves as the building block for electronic prototyping. At first, it was only a polished wooden bread board that was used to slice bread. Since the advent of the solderless breadboard (also known as a plug board or terminal array board) in the 1970s, the term "breadboard" has come to be used interchangeably with these. "Prototype" might also be synonymous with "breadboard". The solderless breadboard is reusable as it doesn't need to be soldered. Solderless breadboards are therefore very well-liked by students and in the field of technology education. An earlier variety of breadboard lacked this feature. Reusing a stripboard (Vero board) or other prototyping printed circuit boards, which are used to create one-offs or semi-permanent soldered prototypes, is difficult. With breadboards, one may prototype a wide range of electronic systems, from tiny analog and digital circuits to whole central processing units (CPUs). A contemporary solderless breadboard is made up of a plastic block with several phosphor bronze or nickel silver alloy spring clips plated in tin underneath the holes. The breadboard's specification frequently includes the number of tie points.

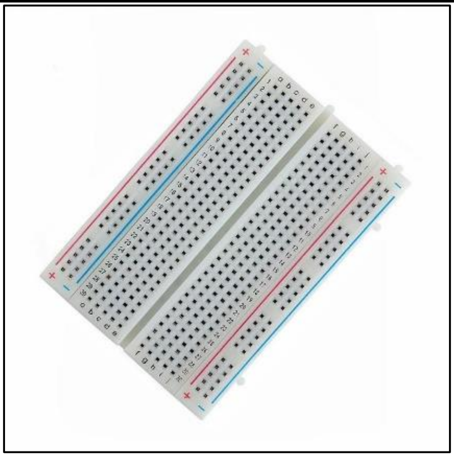

Figure 5: Breadboard

6. GPS

GPS provides very accurate item location data by utilizing its own constellation of military satellites. Trilateration is a technique that does this by having the target object or gadget wirelessly communicate with at least three visible satellites. These satellites can supply data that is utilized to determine the precise coordinates of the object.

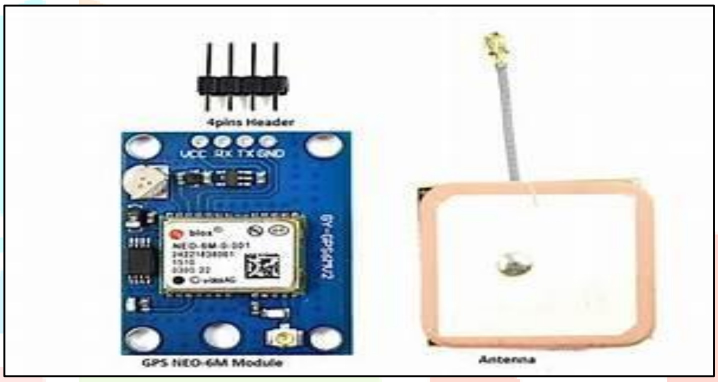

Figure 6: GPS

7. VVM ESP32 4G LTE A7670 MODULE

The VVM ESP32 4G LTE Module is an embedded SoC with ultra-low power consumption that is intended for fast wireless connection. It incorporates the most recent LTE module standards and offers a wide range of functions, including high-speed radio transmission, adaptable antenna topologies, and cutting-edge modulation and coding technologies. With this module, switching from a 2G/3G to a 4G network is now simple and easy. Businesses that depend on wireless communication are rushing to switch to 4G LTE connectivity as network providers are in the process of discontinuing service for 2G and 3G connections. IoT and Industry 4.0-ready legacy devices that are still dependent on 2G or 3G networks can be updated to 4G networks.

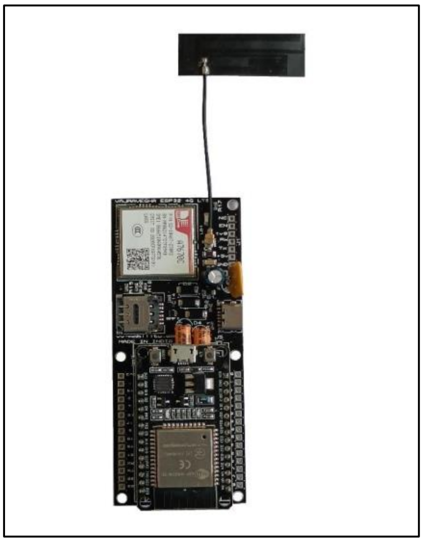

Figure 7: VVM ESP32 4G LTE A7670 MODULE

B. Methodology

The implementation of a Smart Waste Collection system adheres to a methodical approach that is designed to maximize waste management procedures and foster urban sustainability. To find problems and opportunities for enhancement in the waste management infrastructure as it is now, a comprehensive requirements assessment is first carried out.

A new smart dustbin for Urban city usage has been proposed after an evaluation of the many rubbish monitoring systems currently in use. The ESP32 microcontroller and an ultrasonic sensor are used by this system to track the amount of trash in the trashcan. In addition, a GPS module is utilized to track the location of the dustbin, and a gas sensor is used to identify harmful chemicals.

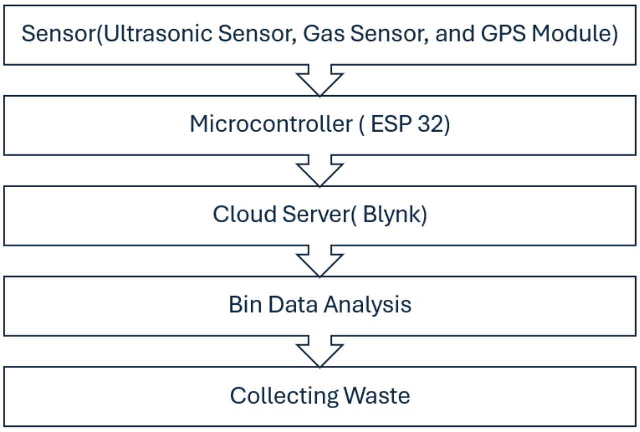

Figure 8: Working Flow Diagram of Project

The working flow diagram in Figure 8 above shows the general flow of the system. A GPS module was used to identify the trash can, an ESP32 was used to program the downloading of a code for Wi-Fi connectivity, an ultrasonic sensor was used to measure height and distance on a trashcan, and a gas sensor was used to detect harmful gas. The intended result of this project is that the user will be able to monitor the amount of garbage using the Blynk server and receive alarm messages via message on the mobile phone. The serial monitor of the Arduino IDE displays the data that was acquired from the ESP32.

III. RESULTS AND DISCUSSION

In our smart dustbin system, we integrated several key components: the ESP32 microcontroller, ultrasonic sensor, gas sensor, GPS module, and VVM ESP32 4G LTE A7670 module. The ESP32 serves as the central hub, connecting to Wi-Fi and managing data communication. The ultrasonic sensor measures the depth of the bin, providing real-time updates on whether the bin is full or empty. The gas sensor monitors the air quality around the bin, detecting harmful gases that could indicate health hazards. The GPS module provides the live location of the bin, ensuring accurate tracking and efficient waste collection routes. The VVM ESP32 4G LTE A7670 module enables high-speed wireless communication, ensuring reliable data transmission to a central monitoring system. Our final smart bin is shown in Figure 9.

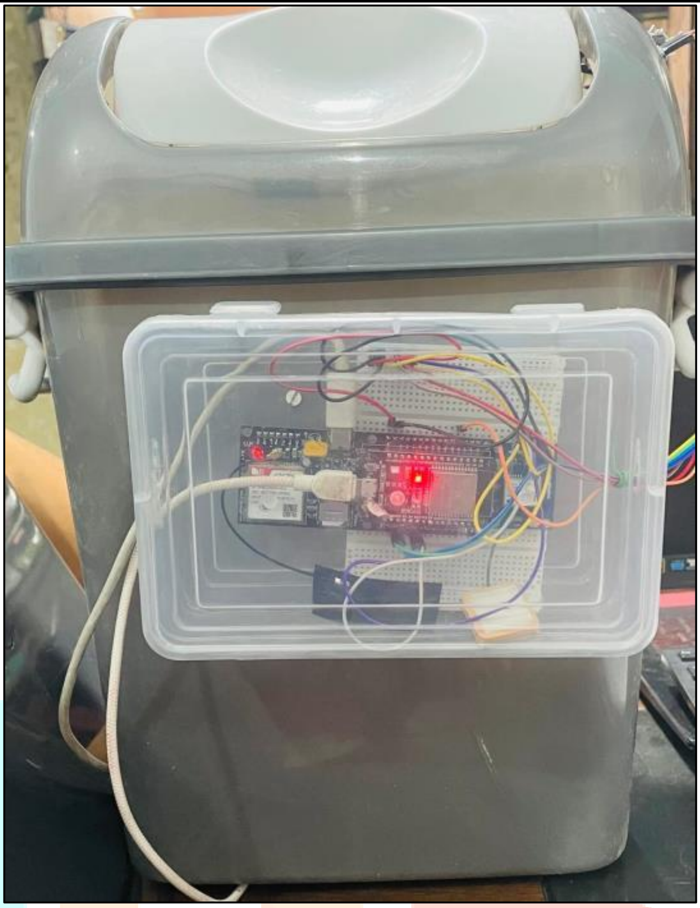

Figure 9: Smart Bin

All sensor data transferred to the cloud server; it will show the statistics of the bin graphically as shown in Figure 10.

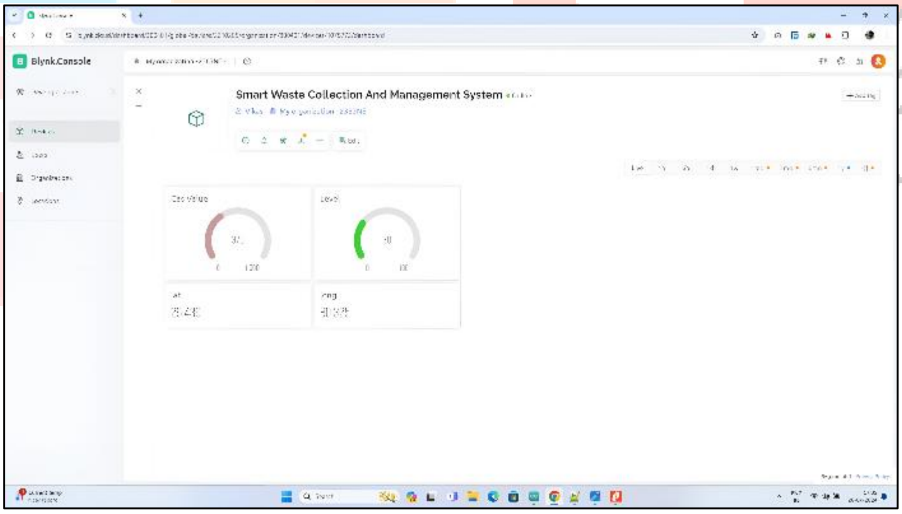

Figure 10: Dashboard

The user will be able to monitor the amount of garbage using the Blynk Dashboard and receive alarm notifications via message on the mobile phone as shown in Figure 11.

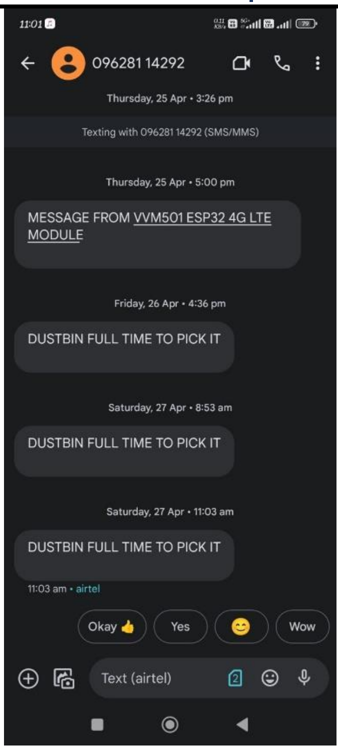

Figure 11: Message Alert

IV. CONCLUSION

In conclusion, the problems caused by overflowing public trash cans must be resolved in our community by putting in place a Smart Waste Collection and Management System. Timely and effective garbage collection is ensured by the system's capacity to identify dangerous gases and track bin fullness through the use of smart bins with sensors and a wireless mesh network. The technology helps waste management companies and cleaners make educated judgments by sending data to a municipal web server, which eventually improves public health and cleanliness. Real-time monitoring of garbage collection activities is made possible by the combination of gas and ultrasonic sensors with a microcontroller, a WiFi module, and Internet of Things technology. This lessens manual monitoring while also allowing authorities to respond promptly when bins need to be cleaned in response to the presence of dangerous gas and waste levels. By facilitating remote monitoring and offering alarms, the web-based application connected to the server further improves the functioning of the system and guarantees that garbage collection activities may be efficiently managed by municipal authorities. All things considered, the Smart Waste Collection and Management System offers a thorough answer to the problems associated with overflowing public trash cans. Its execution would greatly enhance our city's cleanliness and public health, making it an important project for sustainable urban growth.

REFERENCES

[1] Kumar, A., & Kumar, P. (2019). Smart Waste Management System Based on IoT. International Journal of Innovative Technology and Exploring Engineering, 8(4), 509-514.

[2] Jovicic, S., & Ristic, S. (2020). Optimization of Waste Collection Routes Using IoT Data. Waste Management & Research, 38(3), 345-353.

[3] Al Mamun, M. A., Hannan, M. A., & Hussain, A. (2017). Implementation of Wireless Sensor Networks for Waste Management. Journal of Cleaner Production, 167, 1390-1400.

[4] Abdel-Basset, M., Manogaran, G., & Gamal, A. (2018). Community Engagement Through Smart Waste Management. Sustainable Cities and Society, 40, 77-86.

[5] Silva, S., Khan, M., & Han, K. (2018). Eco-Friendly Waste Management Solutions Integrating IoT and Machine Learning. Journal of Environmental Management, 223, 349-361.

[6] Aazam, M., & Huh, E. N. (2016). Multi-Sensor Integration for Waste Monitoring. Sensors, 16(11), 1867.