Efficient Internet of Things based Smart Dustbin using GSM module

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Abstract: The main aim of this project is to develop a smart dustbin to maintain cleanliness in the environment . There are sensors in smart bins that can tell how full the bin is. Usually, this data is sent wirelessly via Wi-Fi or Bluetooth. This lets waste management teams find the best ways for collections and cut down on pick-ups that aren't needed. In this project the lid of the dustbin opens automatically by sensing an object in front of it. And also it can segregate waste into dry and wet waste additionally, it notifies the user through an SMS, when the dustbin becomes full. After all hardware and software connection, now smart dustbin will program and run. In this research work we can ensure environment cleanliness by which garbage are not thrown on the streets and also safe fuel of the garbage vehicle.

Keywords— Smart dustbin, GSM module, Waste level detection, Smart waste disposal, Arduino uno, Wet and dry waste, Good health, Cleanliness, Lid mechanism, Municipal authorities

I. INTRODUCTION

The aim of creating a smart dustbin is to separate wet and dry waste in a efficient manner.by using a GSM module we send msg after dustbin is full to clear the dust regularly. This will enhance cleanliness in the environment, which is safe for health. Embracing cleanliness is akin to embracing virtue, guiding us towards benevolence and righteousness. After witnessing the significant transformations catalyzed by the SWACHH BHARAT ABHIYAN since five years, particularly in areas such as community sanitation and waste management, we are inspired to embark on the SMART BIN project.

By merging progress with sustainability, we aim to pioneers innovative solutions that not only faster development but also safeguard our environment for future generations. The smart Dustbin with waste segregation represents a pioneering approach to waste management, especially tailored for urban areas in development. Through the utilization of GSM technology, this initiative seeks to revolutionize how waste is handled and supervised. By integrating sensor technologist system adeptly identifies and differentiates different types of waste as they enter the instreaming the segregation process with precision. Real-time data transmission via IOT connectivity ensures constant oversight from a centralized server, empowering authorities to remotely monitor and manage waste disposal efficiently.

A user-centric mobile application serves as a window into waste composition and disposal trends, fostering a culture of environmental consciousness among citizens. Moreover, the system is equipped with automated SMS notifications, ensuring prompt responses to pertinent waste management tasks. In essence, the deployment of a smart dustbin utilizing GSM technology signifies an innovative leap forward in optimizing waste management operations, enhancing sustainability efforts across communities.

As our world continues its march towards smart technology it's not just public spaces that are benefitting, but our private environments too. Waste, fundamental aspect of life for an organism, holds a key role in requirement for sustainable development and survival as a species.in response to this, many developing cities now boast dedicated solid waste management systems. This project, therefore, seeks to elevate waste management to a smarter level, leveraging the power of GSM technology. our aim is simple ,yet crucial to manage bin waste in a more intelligent manner. through seamless monitoring, facilitated by GSM technology, we can effortlessly track the fill levels of bins and execute predefined actions accordingly. The data gathered is just for immediate action; it serves as a foundation for insightful analysis, enabling us to optimize our waste management systems with intelligence and foresight.

The inclusion of automatic SMS alerts is just one of the many advanced features of the Smart Dustbin with waste segregation, a groundbreaking solution crafted to optimize waste management practices. This innovative system harnesses sensor technology to identify and categorize various types of waste as they are disposed of, streamlining the process through automated segregation. By integrating IOT capabilities, the dustbin seamlessly communicates real-time data to a centralized server, facilitating remote oversight and management with a user-friendly mobile application as its core, this solution not only offers valuable insights into waste composition and disposal trend, but also fosters environmental consciousness among users. In today's fast-paced world, where time is of the essence, the seamless and hassle-free automatic waste management provided by this

system becomes indispensable, not only saving time but also minimizing the environmental footprint and associated costs.

In recent decades, there has been a significant surge in urbanization, with many individuals flocking to cities for the sake of convenience and opportunities. This influx has led to fast increase in population, exacerbating environmental issues and waste production. Waste management has consequently emerged as a pressing concern. In metropolitan cities, the swelling population has caused waste levels to reach alarming heights. Overflowing bins have transformed streets into mini-dump yards, posing significant challenge for municipal authorities tasked with waste disposal. The inability to address this issue promptly has further compounded the problem.

Traditional dustbins, meant for collecting and storing both recyclable and non-recyclable items, have proven insufficient in managing the escalating waste. Moreover, the areas surrounding these bins become breeding grounds for polluting, contributing to air pollution and the spread of harmful bacteria and virus.

To mitigate these challenges, there is interest in adopting smartbin technology. However, this implementation remains limited in India, where conventional bins and compressor bins still dominate the landscape. Introducing the smart dustbin, as creative IOT project revolutionizing cleanliness in homes. This cutting edge gadget addresses the common issue of household mess caused by various items like electronics, wrappers and more. By leveraging technology, the smart dustbin ensures a cleaner living environment effortlessly.

At its core, the smart dustbin Arduino uno, the microcontroller board, along with GSM module, PIR sensor, and ultrasonic sensor. The ultrasonic sensor, positioned atop the dustbin, continuously monitors its height, effectively tracking the garbage level. A level is fixed which indicates the dustbin is full that level is called threshold level.by Arduino programming, we can display when dustbin is full. When the garbage reaches the threshold level, the ultrasonic sensor triggers GSM module to send continuous alerts to relevant authorities. Then the authorities will collect dust now we can reuse it. The engaging nature of smart dustbin makes it appealing to children, encouraging them to participate in maintaining cleanliness at home. It accommodates various types of waste and operates with proximity sensors, automatically opening and closing the lid as needed. This promotes cleanliness and health in cities by providing real-time information on garbage levels in bins.

II. Literature Survey

Without a doubt, one of the most important things in daily life is a clean environment. There are trash cans near most of Sri Lanka's higher education institutions. Some people question whether or not those bins are actually used to collect trash and get rid of it when they need to be. Also, some of the cases are not strong enough. This will lead to air pollution and health issues that kids and staff at the schools will have to deal with.[1]

Rapid population growth meant that more resources had to be used in daily life. As a result, a lot more trash is being made every day, which is bad for the environment's cleaning system and other health issues. Public places have too much trash, and the management needs to be better. [2]

In terms of waste management, the huge rise in population has led to a huge drop in the level of cleanliness. There are many places where the trash cans are all over the place and aren't cleaned when they should be. This is why the results are so bad. The huge amount of trash that comes in ruins the land and spreads diseases. It also makes people's living conditions dirty and the place looks strange. [3]

Getting rid of trash has become very dangerous in developing countries over the last few decades, along with pollution and high population growth. Indian garbage management has been ignored in many places, just like it has been in many other developing countries. This means that an effective answer is needed. It has been found that overflowing trash cans are not emptied on time in most places, which leads to disease-filled environments and sick countries. Garbage collection in bins changes every day in terms of both time and amount. The Municipal Corporation's trash collection cars, which come at set times, are becoming less reliable, and the collection system is not being watched. [4]

For making smart cities, we need a smart system that checks on the trash can and tells us what's going on with it in real time. India's Municipal Corporations don't get real-time knowledge about the trash cans right now. [5]

The Automated Garbage Management System (AGMS) that is being suggested here is a technological way to gather and handle trash in cities and suburbs. By combining a microcontroller-based system with a GSM module, the system will be able to let the local government know whether the bins are full or empty, which will keep the area clean. [6]

In many places these days, people just throw trash anywhere, and the roads are full of it. These unplanned events cause a lot of problems and can even lead to dangerous diseases. There needs to be a control system that stops this problem and keeps an eye on all the trash. [7]

The current method for dealing with trash in small, densely populated cities is slow, which leaves a lot of trash all over the city. It causes bad conditions when the garbage collector doesn't go to a place for a couple of days because of how much trash is being made.[8]

As of now, there isn't a good way to keep an eye on the work of corporate workers. If they don't clean the trash cans by the due date, there will be an overflow, which makes it easy for diseases and dangerous gases to spread, which is the worst kind of management for a city or town. The garbage cans would be cleaned regularly by workers, and our suggested system would keep track of that and report it to the right authority.[9]

As more people move to cities and the population grows, it becomes more important for cities and businesses to handle waste efficiently.[10][15]

More trash is being made because cities are growing so quickly. In public places where trash is flushed out of bins and could spread diseases, waste management is an important thing to think about.[11][13]

At the moment, people who want to live a healthy life choose to live in better areas. Home garbage bins that are kept by the panchayat, municipality, or corporation can hold both organic and inorganic waste. The overflowing bins are

caused by wild dogs picking up food scraps and trash that people throw out of moving cars, which is very bad for the health of the people in the neighbourhood. [12][14]

III. OBJECTIVES

The following are the three major goals achieved by this project :

i. Opening and closing of lid automatically: IR or PIR sensor are used to detect if a human or an object has moved in or out of the sensor's range, so it detects any object within its specific range, it will activate automatically and opens the lid of the bin.

ii. To find the status of the Bin: This can be done by sending via message to mobile phone. Ultrasonic sensor can be used to check the level of the bin, if the dustbin is full, the message is immediately recieved by the BBMP or concerned group so that they can empty it. Through this we can easily monitor the domestic wastage clearance at proper time to avoid damage to public health. These two applications are done by using GSM module, ultrasonic sensor, servo motor, jumper wires, power supply.

iii. Segregation of Waste: separation of wet and dry waste is done by using soil moisture sensor or water sensor. Through this application we provide smart and efficient way of waste management and control the pollution of the environment.

IV. COMPONENTS

A. Arduino Uno:

Fig. 1: Arduino Uno

The above figure 1 represents the Arduino uno can serve as the brain of the smart dustbin ,coordinating various components such as sensors ,actuators, and communication modules. It can manages the task like

- Sensor integration :Utilizing sensors like ultrasonic sensors to detect the level of the waste in the bin and segregate different types of waste.
- Actuator control: Controlling actuators like servo motors to opening and closing of the lid of the smart dustbin.
- Data processing: processing sensor data to determine when the dustbin needs emptying.
- Waste segregation logic: Implementing algorithms or logic to segregate different types of waste based on the inputs.

B. GSM SIM 900A

Fig. 2: GSM SIM 900A

- The module enables communication between the smart dustbin and the user's mobile device.
- It can transmit data related to waste segregation and their respective levels.
- The module can send alerts and notifications to users or authorities when the dustbin condition are met.

The GSM SIM 900A module enhances the functionality of the smart dustbin by enhancing remote communication and real time monitoring, thereby improving efficiency of the system and promoting environmental sustainability through effective waste segregation.

C. PIR sensors

Fig. 3: *PIR sensor*

Figure 3 represents PIR sensor used to sense the motion. It detects the presence of the person or an object with its sensor range. If the sensor senses any particular object, then the bin lid opens automatically, which it makes the users convenient to use. PIR sensors are energy-efficient because they gets activated only when the motion is detected.

D. *Ultrasonic sensors*

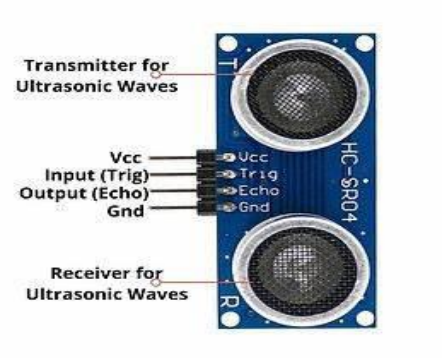

Fig. 4: *Ultrasonic sensors*

Ultrasonic sensors can accurately measure the level of the dustbin compartments. Ultrasonic sensor checks for the status of the dustbin and by continuously monitoring the fill levels, the system can send alerts via GSM.

E. Soil Moisture sensor

Soil moisture sensor measures the water content in the waste, Based on the waste detected, it gets collected under the respected slots. Figure 5 represents the soil moisture sensor.

Fig. 5: Soil Moisture sensor

F. Servo motor

Servo motor can be used to control the opening and closing of dustbin lid. By integrating it with gsm module, the lid can be controlled remotely.

The servo motor can facilitate selective disposal of waste by controlling which compartment opens based on the type of waste being deposited. Figure 6 represents the servo motor.

Fig. 6: Servo motor

G. Breadboard

Fig. 7: *Breadboard*

Using a breadboard for prototyping a smart dustbin with GSM technology for waste segregation involves creating temporary circuits to test and develop the electronic components of the system. The breadboard's solderless nature makes it ideal for this purpose, as components can be easily rearranged and reused as needed during the development process. Figure 7 represents the Breadboard.

H. Connecting Wires or Jumper Wires

In a smart dustbin using GSM, jumper wires are commonly used for connecting various components such as sensors, GSM modules, and power sources on a breadboard or a prototyping board. These jumper wires allow for easy experimentation and testing during the development phase.

Male-to-Male Jumper Wires: These wires have male connectors at both ends, ideal for connecting components with male pins, such as sensors.

Male-to-Female Jumper Wires: The wires consists of male connector at one end and a female connector at the other, allowing you to connect components with male pins to those with female headers, such as GSM modules and Arduino boards. Figure 8 shows the Connecting Wires.

Fig. 8: *Connecting Wires*

Female-to-Female Jumper Wires: These wires have female connectors at both ends, useful for bridging connections between components with female headers or pins.

I. Led bulbs

Fig. 9: *LED Bulbs*

LED bulbs can be used as indicator lights to signals different states of smart dustbin, such as when its full, when its being emptied, or when there's an issue with the system. LED bulbs can be used to provide warning signals ,such as when the dustbin is approaching full capacity or when there's a malfunction in the system. Figure 9 shows the LED bulbs.

J. Adapter

The adapter can provide the necessary power to the smart dustbin system, ensuring that all components, including sensors, GSM module, and LED bulbs, receive a stable power supply to function properly. Figure 10 represents the sample Adapter used in this research work.

Fig. 10: Adapter

If the smart bin includes a rechargeable battery as a backup power source, the adapter could be used to charge the battery when necessary, ensuring uninterrupted operation of the system.

V.METHODOLOGY:

The initial step involves understanding the needs and objectives of the smart dustbin project. Key requirements identified include automatic lid operation, waste level sensing, GSM-related alert system, and waste segregation capability. Automatic lid opens and closes ensure convenience and hygiene, waste level sensing helps in efficient waste management, GSM-based alerts enable timely notifications, and waste segregation promotes environmental sustainability. These requirements serve as the foundation for selecting appropriate components and designing the system.

To fulfill the identified requirements, suitable components are selected. An ultrasonic sensor is used for waste level detection, a servo motor is used for lid mechanism, a GSM module for alerts, a soil sensor is used for waste segregation, and a reliable power source. Each component is chosen based on its compatibility, reliability, and functionality in meeting the project objectives. The selected components are integrated into the smart dustbin system. The ultrasonic sensor is connected to the Arduino board to measure waste levels accurately. The servo motor is used to control the lid mechanism, allowing for automatic lid opening and closing. The GSM module is integrated to enable SMS alerts for notifying relevant authorities or users. The soil sensor is incorporated to facilitate waste segregation based on moisture levels. A reliable power source is ensured to power the system consistently.

Custom code is developed to interface with the various components via the Arduino. This includes implementing logic for detecting waste levels with an ultrasonic sensor, controlling lid movement via a servo motor, configuring and operating the GSM module for SMS alerts, and interpreting data from the soil sensor for waste segregation. The code is designed to be efficient, reliable, and capable of managing the interactions between different components seamlessly. Before deployment, each component undergoes rigorous testing to ensure functionality and reliability. The ultrasonic sensor is calibrated to ensure precise waste level measurement, and the lid mechanism is tested for smooth operation. The GSM module is verified for successful SMS transmission, and the soil sensor functionality is confirmed for waste segregation based on moisture levels. Additionally, the system is tested for resilience to power interruptions to ensure uninterrupted operation in real-world scenarios.

Once testing is completed successfully, the smart dustbin is deployed in the desired location. User training is provided to ensure proper usage and maintenance of the system. Users are educated on how to interpret GSM alerts and respond accordingly, enhancing the effectiveness of the alert system. Proper installation and user training are crucial for the successful adoption and utilization of the smart dustbin system. A maintenance schedule is established for regular inspection and servicing of the system to ensure continued functionality. Additionally, provisions are made to update the system for new features or improvements as required, ensuring its adaptability to changing needs or technological advancements.

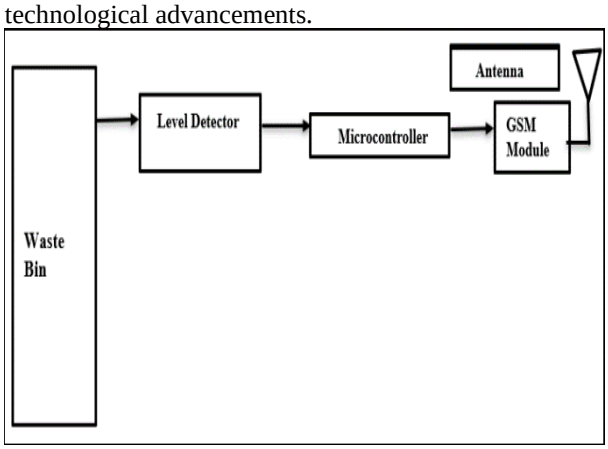

Fig.11: The block diagram of the transmitter

Bluetooth technology can indeed serve as a communication tool within the transmitter section, but it comes with limitations such as short range, low complexity, and modest data speeds. To overcome these drawbacks, GSM (Global System for Mobile Communications) modules are preferred for communication purposes. A GSM modem, a specialized wireless modem designed for GSM networks, facilitates data transmission and reception through radio waves. It incorporates a power supply circuit, allowing activation via a suitable adaptor.

Figure 11 shows the block diagram of the transmitter section includes a level detector with IR sensors for measuring the garbage level in the dustbin. This data is then relayed to a processor, which processes it to determine when the dustbin reaches its maximum capacity. Additionally, four LED bulbs serve to indicate various levels of garbage accumulation within the public dustbin. Once the dustbin reaches its maximum capacity, triggering the highest level indicator, the system initiates message transmission via the GSM module. This ensures timely alerts to relevant parties, facilitating efficient waste management. Figure 12 represents the Smart Dustbin system.

Fig. 12: Smart Dustbin system

VI. FUTUREWORK

Determine the features of the smart dustbin, such as the ability to detect its location to facilitate finding and emptying the bins. Develop a prototype of the smart dustbin that includes a built-in GSM module for cellular communication and a GPS module for location tracking. Try out the prototype to see if it works well. Based on the tests, make any necessary improvements to the design or functionality. Once it's working reliably, start using the smart dustbin in real-world settings, like public areas or buildings. If everything goes well, think about making more smart dustbins and deploying them in more places. The Dustbin is embedded with wheels that can locate the user and make a way to him/her based on the location so that whenever the user needs to throw garbage, he/she can just get the dustbin by a click of a button. Gas sensors embedded in bin circuitry can sense if any hazardous or toxic smell is coming from the bin and an alert to the user will be sent so that the bin can be emptied.

VII.RESULTS AND DISCUSSION.

We can segregate wet and dry waste in the bin without manually separating it. And also detect when the dustbin is full and send SMS to the garbage collector so that there will be no fuel wastage and also this involves automatic opening and closing of lid where IR sensor is used.

VIII. CONCLUSION

By this project, we can conclude that the waste that is disposed on the roads or streets can be prevented and can protect our environment. In this project, we can segregate waste that is wet and dry waste. Once the dustbin is full, SMS notifications will be sent to authorized user. Implementing a smart dustbin with a GSM module brings numerous benefits. Firstly, it enhances efficiency by enabling real-time monitoring of waste levels, allowing for timely collection and optimization of waste management routes. This can lead to cost savings and a more environmentally friendly approach by reducing fuel consumption and emissions from unnecessary collection trips. Authorities can receive alerts when the bin is nearing capacity or requires maintenance, ensuring timely intervention and preventing overflow or other issues.

Overall, the integration of a GSM module into smart dustbins enhances operational efficiency, promotes sustainability and facilitates informed decision-making in waste management practices. We can segregate wet and dry waste in the bin without manually separating it. And also detect when the dustbin is full and send SMS to the garbage collector so that there will be no fuel wastage and also this involves unmanned opening and closing of lid where IR sensor is used.

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