IoT Enabled Smart Waste Management System Using RF technology Integrating Electric Vehicle

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Abstract
As the population grows, so does the amount of trash in and around urban areas. Here, we suggest an IOT-based and sensor-based smart dustbin that runs automatically to assist in resolving this issue. Ordinary trash cans need to be opened by pressing a foot against a lever before being filled with trash. In order to empty it and prevent overflow, one must also keep track of when it is full. An automated trash collector is created to address this. An automatic level sensing LDR sensor built into the trash can uses light intensity to determine when it is about to fill up. The dustbin now has a smart circuit that transmits this data to alert the facility's primary garbage collector to empty the specific garbage bin. This dustbin collector will automatically collect the waste and separate it into various products based on what is contained in it.

Keywords – Smart dustbin, Sensor, monitoring, automatic vehicle collection, waste materials.

1. INTRODUCTION

Urbanization has dramatically increased in recent decades. An increase in waste production is occurring at the same time. Waste management has been an important topic to think about. The garbage collection system needs to be smarter because it plays a key role in maintaining cleanliness. Additionally, people must have easy access to garbage disposal locations, and the process for garbage collection must be both time- and fuel-efficient. Currently, most waste collection in Indian cities is done manually, requiring all employees to travel to the locations where citizens leave their trash before using equipment to collect it. As of right now, this system is not automated. The garbage collection system needs to be smarter because it plays a key role in maintaining cleanliness. Additionally, people must have easy access to garbage disposal locations, and the process for garbage collection must be both time-and fuel-efficient.

This project is a means of achieving this admirable objective. Cleanliness plays an important role in everyone's life. Lack of sanity will disturb the society of living leading to the spread of diseases. The main motive of the project is to develop a smart sanitation model where automated vehicles are designed to collect the waste from the dustbin. Electric vehicles are those that operate on batteries. They serve a lot of purposes and when they are automated the advantages are abundant. Such advantage is used here such that when the dustbins get filled, waste gets collected automatically by the dustbin using a predefined path.

Once the dustbin reaches full, it sends information to the bot via the transmitter so that the vehicle will come and collect the waste substances from the dustbin and later segregate them as various categories of wastes. People can reuse the trash can after it has been cleaned out. The trash can will be checked at regular intervals. Waste can be managed effectively once these smart bins are implemented on a large scale, replacing our current traditional bins. This prevents waste from being piled up on the side of the road in unnecessary ways. Because of the

carelessness of the public and the negligence of the authorities, the foul smell from these rotting wastes may go untreated for a very long time and cause long-term issues.

The major objective of this project is to enhance the concept of a smart city while utilizing fewer overall resources and labor. Dustbins frequently overflow and dump trash onto the streets, therefore this issue needs to be fixed soon. The amount of rubbish that needs to be disposed of has increased in recent years due to the rapid growth of the population. Therefore, having a strong waste management system is crucial to halting the development of some fatal diseases.

2. LITERATURE REVIEW

F. Annie Lincy, T. Sasikala said in their paper that GSM, GPRS, and sensors are interfaced with the Arduino Uno board. The sensors are used to verify the dustbin's threshold level. If the garbage level reaches the specified threshold, a constant alert is issued to the appropriate authority until the garbage is retrieved, at which point the externally mounted LED becomes red. The LED switches to green once the trash from the bin has been removed. [1]. Sensors such as ultrasonic sensor, infrared sensor, rain sensor and weight sensor used to monitor garbage filling and segregation makes much easier [2]. Ultrasonic wave-based sensors are attached to an Arduino Uno and monitor the waste levels within the dustbin, sending an alert to the municipality's web application if the bin has reached its full capacity [10].

With the capability to gather and exchange data, Internet of Things (IoT) enables devices to be connected using the web. In order to complete smart recognitions, location, tracing, monitoring, and administration, the term "net of things" refers to a type of n/w that links everything with the net based on specified protocols during info sensing instruments [6].

RFID trash tracking tags are connected to a web-based online system, and the host server calculates the points and updates the virtual wallet database based on the weight of the additional waste. Additionally, it gauges how full the trash cans are and updates the status of each trash can on the municipal server. Based on the capacity of the municipal garbage loading vehicles, it alerts them when the dustbin is full and gives the quickest way to empty all the dustbins [4]. Paper presented by Md. Samiul Haque Sunny, Debopriya Roy Dipta, Shifat Hossain, Hossain Mansur Resalat Faruque, Eklas Hossain, has designed a smart garbage can that functions similarly to an ATM (ATM), The development of an effective convolutional neural network (CNN)-based image classifier that can count the number of labelled objects, detect and identify any object deemed to be garbage, and assign a price value to each object. Any person who brings rubbish to the ATD will have no trouble having it recognized by the image classifier, and they may take advantage of the recycle value that has been assigned to the object. Consequently, it is conceivable to swap garbage directly for its equivalent value [5].

Various dustbins positioned in various residential societies are monitored by an IoT and machine learning based trash management system. Dustbins come with sensors that keep an eye on their capacity, metal content, and hazardous gas content. To investigate how well the machine learning classification techniques SVM, NB, RF, DT, and KNN can forecast the accuracy of delivering alert messages to third parties [7]. As Vidya S, Deepa T says, Real-time monitoring can be done using a cloud platform built on IOT. The alarms are immediately delivered through GSM module to the municipal corporation after reaching the maximum amount of waste in the dustbin. A buzzer will sound if there is a fire in the trash cans [2]. Pradnya Kadam has shown a smart bin or garbage collection system with an automated alert system, and to notify the appropriate authorities, such as a business or local waste disposal team [11].

The dustbin's sensor detects garbage, and it then sends a command message to the dustbin's microcontroller. The microcontroller interprets the message and instructs the servo motor to raise the trash can's lid [9].

Sumit Badotra and their co-authors suggested in their Smart Waste Collection Monitoring System that the regular cleaning of dustbins is a difficult task, and if it is not done, the area may become unclean and provide many health dangers. The slow-moving waste management system currently in place in small and densely populated communities results in a lot of trash being left lying around the city. The rate of waste production is so

high that if the garbage collector misses a location for a few days, severe conditions result. It was crucial to adequately monitor and breakdown medical waste during the COVID-19 outbreak. Due to lockdown, handling regular household rubbish was particularly difficult. In this case, IOT-based autonomous monitoring and control of rubbish can be very important for garbage management. In order to speed up the process in an intelligent and smart way and thereby eliminate such hazardous conditions caused by the current sluggish system, this paper proposes a smart and quick approach for waste management by setting up a network of smart dustbins equipped with sensors and microcontrollers in a city that is monitored by a central control unit. The proposed method also considers the problem of inadequate internet access [12].

3. PROPOSED SYSTEM

Cleanliness is the first requirement of a smart lifestyle, and cleanliness starts with a trash can. Only if dustbins are strategically placed and regularly collected will a society have its waste transported in an efficient manner. In most places, the state of the dustbins is the main issue with the current waste management system. As part of this project, the trashcan, a critical component of the waste management system, is renovated.

The project's primary objective is to create a smart trash management system. This is achieved by utilizing a protocol for wirelessly transmitting the state of the trash can, which can produce an email to notify the recipient that the system is overflowing with trash. The sensor will indicate how full the trash can is, and the electromagnet sensors will separate the trash from the trash can if they find any metal waste. The main collection area is where the collected waste is dumped using a predetermined route and a vehicle equipped with an obstacle avoidance technique. With a pre-defined path vehicle and an obstacle avoidance technique, the main goals are to indicate the amount of waste that has been collected and send data through the cloud to determine the filling status, to separate metal waste from the garbage using an electromagnet and a soil moisture sensor and to dispose of the collected garbage at a main collection point.

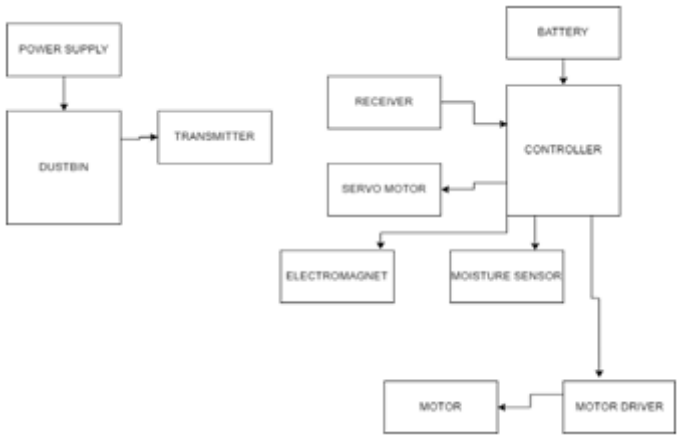

Fig .1.Block diagram

The system consists of two parts. The Controller and the Dustbin are the two components. The trash can include a radio frequency transmitter that transmits data to the vehicle's main controller. The information shows that the trash can is full and ready to be picked up. Inside the trash can is an LDR sensor that measures light intensity. When the trash bin is full, the trash covers the LDR Sensor, and since there is no longer any intensity present, the light turns off automatically. In this case, the light intensity serves as a key to indicate when the trash has reached the maximum level.

As soon as the LDR Sensor shuts off, it gathers the information and transmits it to the RF Receiver, informing it that the trash bin is full and that it should be taken out for disposal. The primary controller contains an ultrasonic sensor as well, which aids in tracking the trash level. To collect the trash, the controller (vehicle) moves in the direction of the trash can after receiving the data. The trash is separated into three categories: moisture, non-moisture, and electromagnetic trash. The block diagram is shown in the Fig. 1.

Here, the controller is composed of a servo motor that facilitates the vehicle's movement and a lithium-ion battery. More power is produced by lithium-ion batteries, and there is less power loss. A sensor is located in a specific area of the car to distinguish between moisture-containing and non-moisture particles. In order to separate the iron particles, it also has an electromagnet.

4. RESULTS AND DISCUSSION

4.1 HARDWARE SETUP AND RESULTS:

The hardware set up is shown in the Fig. 2. It consists of the following components shown in Table. 1.

Table. 1. Components of Hardware Setup

Component	Range
Arduino Uno Board	Operating Voltage: 5V. Input Voltage: 7-12V
H- Bridge	Double H-Bridge Drive Chip: L293D. Input Voltage : 5V
LDR Sensor	Input Voltage : 5V
Moisture Sensor	Moisture Sensor : FC – 28. Input Voltage : 3.3V - 5V
Electromagnet	Small coil based material made up of iron
Ultrasonic Sensor	Ultrasonic sensor model : HC – SR04
Lead Acid Battery	Input voltage : 2.2 V
Relay	Input voltage : 5V

The most popular large-capacity rechargeable batteries are lead acid batteries. Because they are dependable and affordable on a cost-per-watt basis they are very well-liked. Multiple individual cells with layers of lead alloy plates dipped in an electrolyte solution make up a lead acid battery.

The soil moisture sensor, which calculates the volumetric content of water, is made up of two probes. The two probes penetrate through the soil to determine the resistance value required to determine the soil's moisture content [14].

Holding electromagnets are magnetic components with steel bodies and internal coils that, after the coil is energized, are used to firmly hold ferromagnetic components. The magnets must have an electric current flowing through them in order for them to hold their energized state. The magnet is then turned OFF by cutting off the power. The degree of magnetizability and surface quality of the components that need to be secured have a significant impact on the holding forces of the securing magnets. For remote hold/release mechanisms, they are perfect.

A modern integrated high voltage, high current, four channel driver built to drive switching power transistors and inductive loads and take conventional DTL or TTL logic levels (such as relays, DC and stepping motors, and DC motors). An enable input is provided for each pair of channels to make it simpler to use them as two bridges. Internal clamp diodes are also present, and the logic has a separate supply input that enables operation at a lower voltage. Up to 5 kHz in frequency can be used with this device in switching applications. The four center pins of the L293D's 16-lead plastic package are used for heat sinking.

An LDR is a component whose variable resistance changes in response to the quantity of light it receives. As a result, they can now be utilized in light sensor circuits. The most typical application of an LDR is to automatically turn on a light when ambient light exceeds a predetermined level. Two instances of this are a street light and a garden light. LDRs can be used to control the shutter speed of a camera. After the LDR had determined the amount of light present, the camera shutter speed would be modified accordingly. The output of the hardware setup is shown in Fig.3.

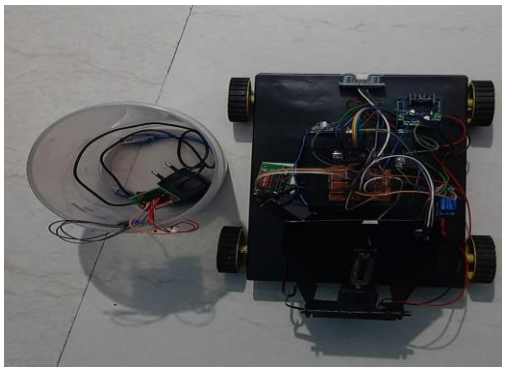

Fig .2. Hardware Setup

4.2 SIMULATION RESULTS:

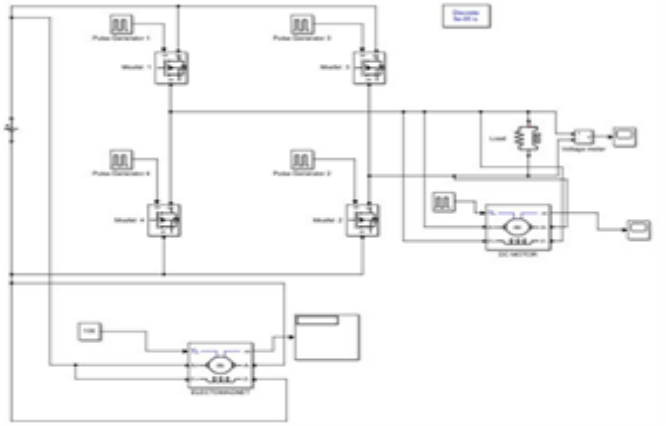

Fig.4. Simulation Diagram

The project is simulated using the MATLAB software. Here, the operation of an electromagnet and an H-Bridge is demonstrated. Four transistors and four pulse generators, which resemble Arduino pins [15], make up the H-bridge. Then resemble Arduino pins, make up the H-bridge. The load is used as a motor substitute. In the electromagnet circuit, the circuit is initially energized by adding 1 and is initially degenderized by adding 0.

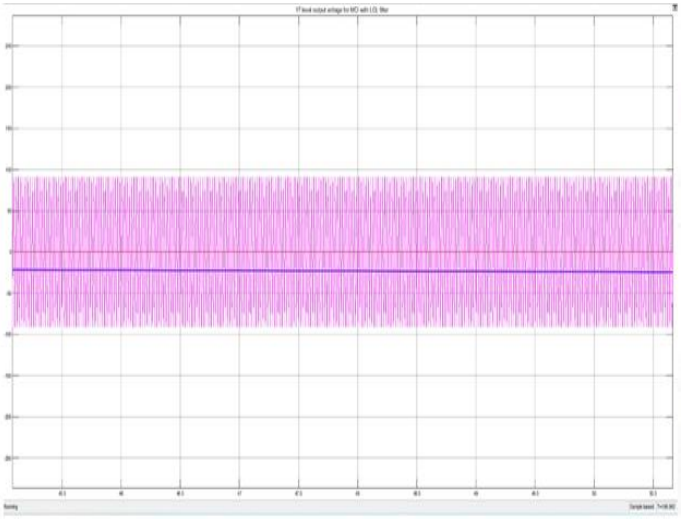

Fig.5. Simulation output of the dc motor

The Fig. 5 is the output of the dc motor which generates on and off pulses as its output which indicates the working of the motor.

If a load is used in place of the motor, then a similar output of pulses can be found as shown in Fig. 6.

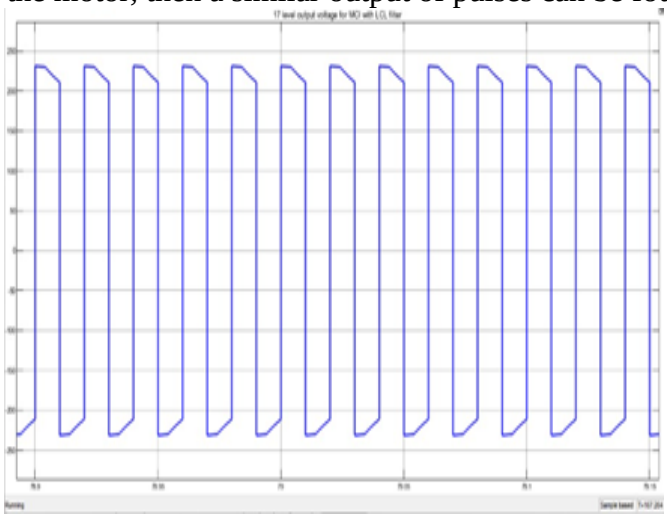

Fig.6. Simulation output of pulses

The signal from the LDR sensor, which is initially in the on stage, is shown in the image above. Now set to 1, the sensor is on. When the dustbin is full, it turns off, signaling that the bin is full and sending a message to the vehicle's controller. The trash will be collected by the vehicle and divided into categories such as moisture, non-moisture, and electromagnets.

The proposed system is designed to raise societal sanitization standards so that diseases cannot spread and that sanitization also occurs.

5. CONCLUSION AND FUTURE SCOPE

As stated above, this project will help in the improvisation of the cleanliness to the society. Implementing this technology on a day-to-day basis will bring the city to a better one. Due to its straightforward design and affordable production, it thus emphasizes the prototype's viability for mass production. With the help of the automated collection of the trash, the nation's garbage collection and disposal processes will be improved. When compared to traditional methods, the dustbin's features, such as garbage level sensing and dynamic mobility, will reduce the amount of human effort needed to collect the garbage. There are still some issues with the dustbin, such as the smell issue and the manual control that limits the dustbin's mobility, which can be fixed in later versions.

The current state of trash disposal is expected to deteriorate in the absence of sustainable waste management technology. By leaving the garbage cans littered once they are full, the problem of waste management is addressed in this piece in a more effective way. The system automatically sends a message alert to the controller once the bin is full, guaranteeing that the bin is made empty to prevent dumping trash on the floor. This reduces environmental littering and the health risks associated with improper garbage disposal. In the future, we can create multiple bots and increase the distance between the controller car and the trash bin being monitored.

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