DESIGN OF SMART GARBAGE DISPOSAL AND COLLECTION SYSTEM

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Abstract: To understand the principle of our proposed system, we must first find out the current state of our country's garbage collection and treatment system. The garbage bins are improperly maintained, or sometimes due to the lack of proper trash, people throw their trash on the side of the road. During the current Covid-19 pandemic, this is a major challenge. Therefore, our goal is to provide an efficient and economical garbage collection and disposal system that provides a clean, healthy, and environmental-friendly society. Technically, we will use technologies like GSM and GPS. So, the proposed system aspires to create a better system that will help meet the needs of the target audience. In short, we are helping the community for a cleaner environment. We have few technologies around us right now that can be used in this way for a better tomorrow.

Index Terms: **Smart Dustbin, GSM Module, Arduino Uno, Ultrasonic sensor and Waste management.**

I. INTRODUCTION

In society, the rate of waste generation is increasing exponentially in all facets of society, leading to more and more threats to living things. Waste management is a critical issue, but one that is often overlooked. Waste management takes time and requires a lot of effort. Because of the less time required and the inefficient effort, we see poor management in the garbage disposal system. Trash cans are found to overflow in many places. This overflow creates a dirty environment which also turns out to be unsanitary. Solid waste disposal is an expensive urban service that consumes around 30% of urban society's annual budget in many developing countries [1]. Methods to reduce fuel consumption have been investigated and observed. According to a literature study, the constant use of optimal collection routes can save an average of 7.5 liters of fuel per truck per day [2]. Some modern methods along with the improvement of smart cities, garbage has many direct and indirect harmful effects on the environment. The direct effects cause physical damage to people and the environment. The indirect effects add to the opinions and behaviors that we as a society contribute to the problem. Kolkata being one of the fastest developing cities, according to the Kolkata Municipal Corporation [KMC] generates around 1,300 to 1,400 tons of waste per day. India generates around 147,613 metric tons of solid waste per day. Statistics also show that in small towns around 0.17 kg of waste per person per day and in large cities around 0.62 kg per person per day [3].

Krishna Nirde *et al* [1] suggested the idea of continuous monitoring of garbage containers by waste disposal authorities. Arduino board then processes the information received at the RF receiver.

Suresh *et al* [4] gave the idea of the Internet of Things (IoT) topic and additional details on IoT, the right intelligent environment, and other applications.

Vikrant Bhor *et al* [5] provided us with additional details and designs required for the flow and handling of garbage during collection.

M. T. H. Shubho *et al* [6] have performed a quantitative analysis between existing trash cans and their service population. The study first examines the spatial distribution of trash cans in some areas of Dhaka using the GIS average functions for the nearest neighbor. Surprisingly, the spatial circulation of today's trash cans appears to have a predominantly inclusive pattern.

Narayan Sharma *et al* [7] have equipped the intelligent containers with ultrasonic sensors that measure the fill level of the garbage container to be filled. Every time the recycle bin crosses a level, the sensors receive the fill-level data as an instant message to the garbage scanner with the help of the GSM module.

Balamurugan S. *et al* [8] shows an example of sending warning messages to the authorities when the containers are completely full. In this proposed system, ultrasonic sensors detect the level of garbage.

Vinoth Kumar *et al* [9] proposed a system based on RFID and GSM. Red LED on the trash can lights up, indicating that the trash can is full. Otherwise, the green LED lights up. The coordinates of the location where the garbage can is located are sent to the authorities via the GSM system.

II. MATERIALS AND METHODS

The hardware setup of the smart bin is shown in figure 1. The components used for the model are as described below:

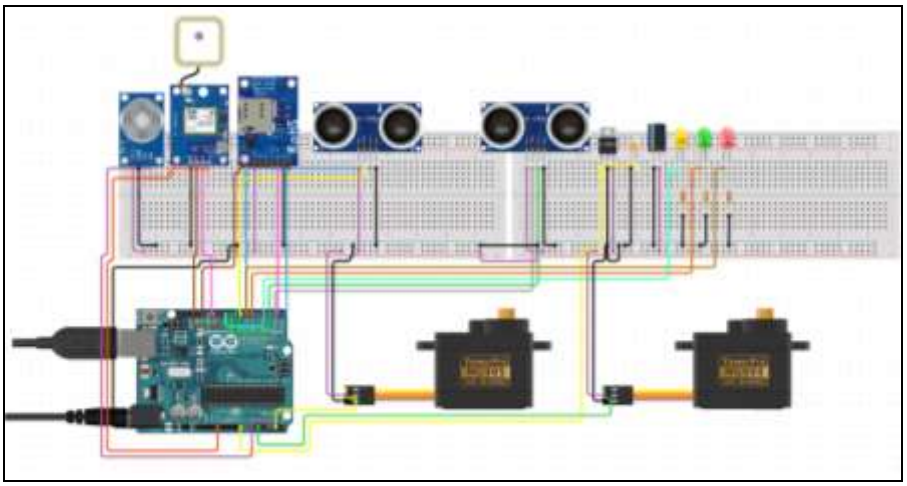

Figure 1 Circuit of proposed smart garbage disposal and collection system

A. ***Arduino Uno:*** It is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc [10]. The board is equipped with sets of analog and digital input/output (I/O) pins that can be interfaced to different expansion boards and other circuits. The board has 14 digital I / O pins (six with PWM output function) and 6 analog I / O pins, and can be programmed using Arduino IDE (Integrated Development Environment).via a type-B USB cable. It can be powered by any type-B USB cable or with an external 9V battery, though it accepts voltages between 7V and 20V. The Arduino Uno uses the original STK500 protocol for communication along with the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Figure 2 Arduino UNO microcontroller used in the system

B. ***Motor*****:** A servomotor is a linear actuator or rotary actuator that allows for accurate control of linear or angular position, acceleration and velocity. For the purpose of position feedback, it consists of a suitable motor coupled to a sensor. Often a dedicated module designed specifically for use with servomotors since it requires a relatively sophisticated controller.

Figure 3 A servomotor used in the proposed system

C. ***Smoke Sensor:*** A smoke sensor is a device that senses smoke, typically as an indicator of fire. Security devices used commercially usually send a signal to the fire alarm system as part of a fire alarm system, while home smoke alarms, generally trigger a local audible or visual alarm from the alarm itself or from several alarms, if there are several interconnected smoke alarms.

Figure 4 smoke sensor used in our proposed system

D. ***Ultrasonic sensor (HC-SR04):*** The ultra-sonic sensor emits high-frequency sound pulses, and then measures the time required for the reflected sound to echo. There are 2 holes on the front of the sensor. One hole sends ultrasonic waves (such as a small speaker), and the other hole receives ultrasonic waves (such as a small microphone).We all know that the speed of the sound in the air is close to 341 meters per second. The ultrasonic sensor uses this information and the time difference between sending and receiving the sound pulses to determine the distance to the object [11].

Figure 5 Ultrasonic sensor used in the proposed system

E. ***GSM module:*** When the trash bin exceeds the set threshold, it is used to send a message to the Corporation. Using the connected GSM module, we can send short text messages to the desired Corporation or its nearby collection vehicle. The GSM module is provided by the SIM card which uses mobile services from the provider sends the SMS to the relevant departments as planned. It can work in the frequency range of 900 MHz or 1800 MHz.

Figure 6 GSM module used in the proposed system

F. ***GPS module:*** The GPS system of our model can help identify various garbage dustbin locations in the community. If the waste within a container is full of the alarm level in a certain area, the controller will send a command or warning signal to the relevant corporation or its nearby vehicle through the microcontroller aided by the GPS system.

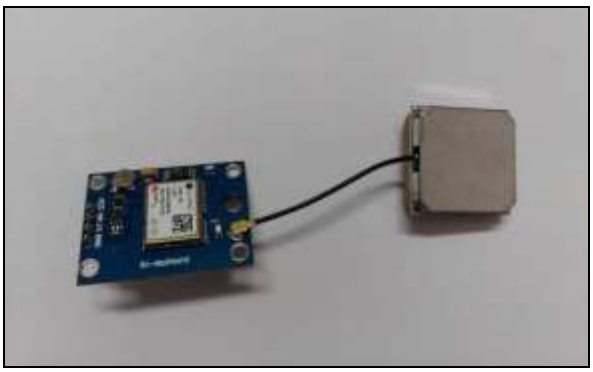

Figure 7 GPS module used in the proposed system

The software we use is the Arduino IDE, an open source software mainly used for writing and compiling the code in the Arduino module. It is available for operating systems such as Windows, Linux / Unix, and Mac, and runs on the Java platform, which comes with built-in functions and commands that play an important role in debugging, editing, and compiling the code in the environment, also known as the Sketch is known and created on the platform, finally generates a hexadecimal file, which is then transferred to the controller on the board using a USB cable and uploaded. This environment is compatible with the C and C ++ languages.

Our proposed system's flowchart can be as shown in the figure 8:

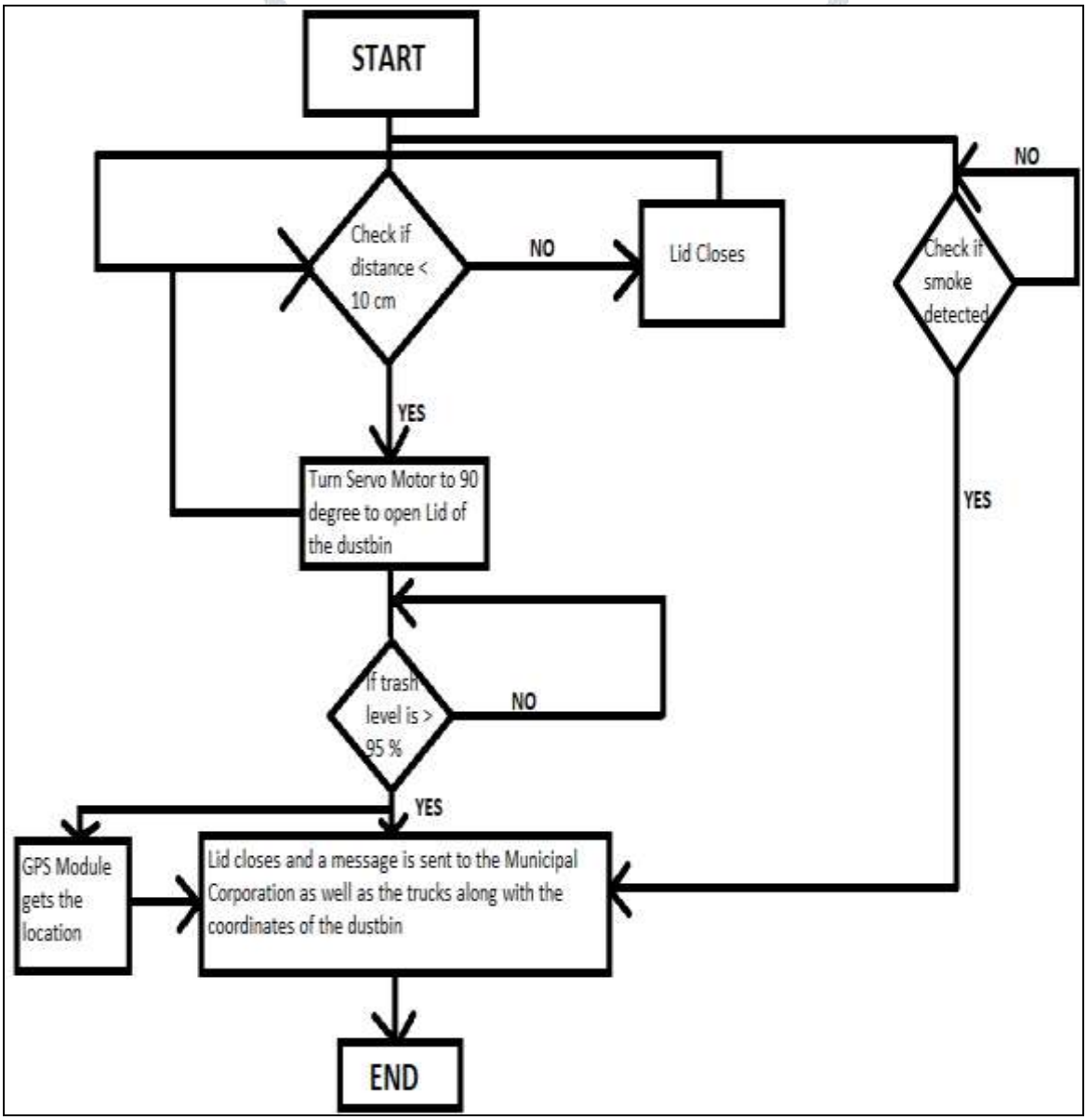

Figure 8 Flowchart of the proposed Smart Garbage Disposal And Collection System

III. RESULTS AND DISCUSSION:

Our proposed system can be implemented on a larger scale to keep the city clean and tidy. With this implementation, the ultrasonic sensor detects the garbage level in the garbage can and when it reaches alarming levels, a message is sent to the authorities concerned. In some cases, the level is not full but it causes a bad smell in this situation. In addition, the garbage can must be cleaned. It is recognized by a gas sensor and sends a message to the registered cell phone number. These interfaces are connected to the Arduino Uno and the various sensors and modules are controlled by the same. Also keeping in mind, the Covid-19 pandemic which is going on, we have added functionality about self-sanitizing the surroundings of the dustbin at an interval of 30 minutes.

The results of our proposed system include two separate parts: one is the garbage disposal part where the ultrasonic sensor fitted outside of the dustbin detects any movement near the dustbin and as soon as someone is detected the ultrasonic sensor sends signal to the Arduino which in turn sends signal to the servo motor which is fitted inside the lid of the dustbin to turn 90 degrees so that the lid opens. Now coming to the second part of the Garbage collection system which includes a communication part. The ultrasonic sensor is fitted inside the dustbin which is used to measure the level of garbage inside the dustbin. LEDs are present which indicates the amount of garbage. Garbage level below 50% is indicated by the green LED, garbage level between 50% and 90% is indicated by the yellow LED and as soon as garbage level hits 90 % the red LED starts to glow. As soon as the garbage level hits 90%, the GPS module fitted inside the dustbin gathers the coordinates of the location and then with the help of the GSM Module the coordinates is sent in the form of Google Maps link to the concerned authorities responsible for garbage collection. A sanitizer system is also fitted outside the dustbin which sprays every 30 minutes to keep the surrounding areas disinfected. Smoke detectors are also present inside the dustbin which detects any presence of smoke or harmful gases inside the dustbin and as soon as it detects it, the GSM module sends message to the concerned authorities.

The garbage collecting van gets the locations of all the bins that are to be collected. Dustbins with more than the threshold level of garbage and their co-ordinates are sent using a text message as opposed to partially filled bins, which don't need to be collected. This helps in better time management and fuel efficiency.

Advantages of this proposed system are that it has minimum human intervention [3]. It will help the users to maintain a green and clean surrounding which is the vision of many a countries. It will have reduction in fuel consumption of the garbage collecting van as it is already notified about which dustbin is ready to be collected. Also keeping in mind the Covid-19 pandemic which is going on, we have added functionality about self-sanitizing the surroundings of the dustbin at an interval of 30 minutes. This comes with the added benefits of the safe disposal of all types of garbage.

The block diagram of our proposed system can be represented as:

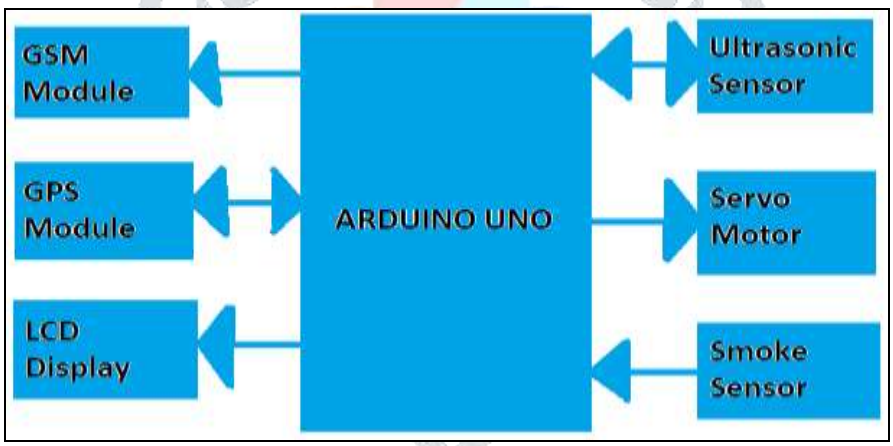

Figure 9 Block Diagram of the proposed system

As we can see from the block diagram:

1. Signal travels both ways between Arduino and Ultrasonic Sensor. The Arduino sends instructions to the Ultrasonic Sensor to detect any movement within a particular distance as programmed by the user and in return the ultrasonic sensor detects movement and sends signals to the Arduino board.

2. The Arduino sends signals to the servo motor to turn 90 degree or 180 degrees as programmed which only operates then.

3. The function of the Smoke Sensor is to detect any smoke and send signals to the Arduino.

4. Arduino sends signals to the GSM Module as programmed which instructs the GSM Module to send messages to the destination

5. The Arduino send signals to the GPS Module which fetches the coordinates of the location of the device and then sends the information back to Arduino

6. LCD display or the LEDs receive signal from the Arduino and then lights up or shows the data required.

Figure 10 Working Prototype of our proposed Smart Garbage Disposal and Collection System.

As we can see the working prototype of our system in this given figure, we can see the ultrasonic sensor fitted in front of the dustbin and the servo motor present inside which is used to open and close the lid of the dustbin and the ultrasonic sensor fitted inside the lid is used to measure the level of the dustbin. The Arduino Uno boards and other components are fitted to the backside of the dustbin.

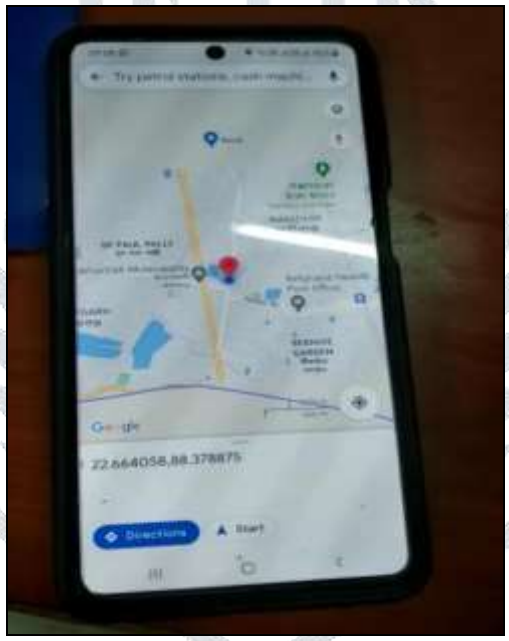

Figure 11 Location Coordinates of the System

The location of the dustbin is shown in the above picture which is fetched after clicking on the link that is messaged by the GSM Module of our System.

V. CONCLUSION:

With this proposed system users, i.e. garbage collectors and the corporation can easily use the project for garbage collection and recovery. It can be used anywhere for proper disposal and waste collection, helping to keep the environment clean. The hardware detects the garbage level, and the application sends garbage recovery notifications. The project saves energy in the garbage collector trucks by saving time and fuel costs by providing a convenient method of the garbage disposal to ensure that the container will not be completely filled and overflowed. This is an effective way to eliminate waste, keeping costs and ease of use in mind. This system can be implemented in various situations that require either high manual labor like shopping malls and residential complexes or pose serious health risks like hospitals and laboratories.

IV.FUTURE ASPECTS

There are many future aspects to our System. To improve the conventional waste collection system and prevention of garbage spread in our country, our system is a great alternative to the current Garbage Collection and Disposal Systems. Our System is also an efficient way to eliminate spread of disease and if it is applied for public use by the government, our environment would be much cleaner and safer for people from different types of disease and also pollution.

In the future we can add an RFID System to our Dustbin which will allow the dustbin to close automatically after the garbage level hits 95% and can only be opened by the Municipal Corporation people who will have an RFID tag or card, which when swapped will open the lid of the dustbin.

Also, with the further iterations of this project, we can further improve the design to gain better knowledge in the application of our project.

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