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Garbage Collection Robot and Monitoring System Using Wireless Communication

Thota Arun[1] , Divyavani K[1], Boini Varun[1] , Peter Moshe[1], K.Vasanth[1], P.Marish Kumar[2], Srinivasan K S[3]

[1]Vidya Jyothi Institute of Technology, Aziz Nagar, Chilukur Road, Hyderabad – 500075, India
[2]Easwari Engineering College, Chennai, India.
[3]Mohamed Sathak AJ college of Engineering, Chennai, India

Abstract. The Proposed System is to collect the garbage and also monitor the garbage level as well as the moisture content present in the bin .The line follower is an autonomous robot that detects and follows a line. The path may be visible like a black line on a white surface or vice versa. The proposed system uses different sensors in order to acquire the data. The project uses an Arduino UNO board as the central control unit .Here we use an ultrasonic sensor for monitoring the garbage level in the dustbin and the moisture content of the waste is provided with the use of moisture sensor. At the same time the buzzer starts making sound indicating the bin is full. The system has a Liquid Crystal Display (LCD) which provides an information about the amount of garbage present in the bin. We also used ESP8266 wi-fi module so that we can access our web page where the data is recorded and stored with the help of Amazon Web Services (AWS) and here the data gives the information about the percentage of garbage level and moisture content present in the bin. The web page get updated for every 10seconds. Hence, the user can monitor the garbage level and moisture status from anywhere. An IR sensor is used for following path .In manual mode using Blynk app we can control the locomotion of the robot which is connected using Bluetooth Module. When the garbage is filled the robot starts moving towards the destination through a predefined path and with the help of human the waste is then dumped to the garbage collection area. Here we are using toggle switch where the user is required to select the Automatic or Manual Mode initially. Hence this proposed system gives accurate results and can be operated in both Automatic and Manual Mode.

1. Introduction

In today's era as we know that where countries are developing at a rapid rate a lot of unwanted waste is being generated like electronics, plastics and many biodegradable products. Waste management being the utmost spurned factors in developing countries creates an urgency to address this problem. In metropolitan or city areas, the clearance of waste management has been a grind task for the majority of the country all over the world and also the lacking for gathering information is a major challenging task. Improper waste disposal can seriously affect the health of people living in contaminated areas or near landfills. A healthy environment is necessary to stay healthy and live healthy. Hence we made an autonomous robot that detects and follows a line. The path may be visible like a black line on a white surface or vice versa and at the same time we can monitor the garbage level present in the bin. The Main Motivation for the proposed system is at present, manual methods are majorly used for cleaning. Although garbage removal is a good source of manual labor, there are still some problems associated with manual garbage removal, Such as

excessive land pollution/garbage and the inability to provide sufficient labor in all cases. When it comes to eliminating the monotony of tasks, overcoming safety problems during manual labor, and reaching remote areas, autonomous robots are better choice. In some cases, the efficiency may be higher. The method is explained in detail in the upcoming sections.

2. Literature survey of existing methods

First, In order to understand the requirement for a smaller, cost effective and versatile framework, and before providing our own solution in depth, we have to initially understand the existing research and work done in the field. Therefore, in this section a many different research papers were investigated to collect relevant information about the project. Sirichai Watanasophon and Sarinee Ouitrakul [1] have developed Garbage collection robot on the beach using wireless communication. The mobile robot system consists of an IP Camera to relay live feed to the user and a Bluetooth module for wireless communication. Shobhit Khandare et al [2] developed autonomous garbage collector bot is to center it on a Raspberry Pi. The ultrasonic sensors detect the obstacles and the motors are made to rotate based on the pre-programmed instructions in Raspberry Pi. The image processing algorithm used here simply identifies the object as an animal or not. Kamal et al [3] proposed Garbage collection Robot using wireless technology. The user can control a robot via a program developed from web application. The robot was never really tested on real ground, everything was performed only on Proteus simulations. Thus, no real-world conditions or challenges were even attempted, and thus it is may not be reliable for one who wants to test. Rama Prabha et al [4] have developed Autonomous garbage collector –Robodumpster. The robot has a 7 Degree of Freedom arm that can be wirelessly controlled. There is no accuracy in waste classification here since the only parameter used is width of the object. This 7DoF arm is manually fabricated and therefore, this is an expensive technology, not cost effective. Apoorva et al [5] have developed Autonomous Garbage collector robot that uses a shaft with rotating blades to scoop up waste, which is a very good and effective scooping mechanism. Hence, this mechanism will scoop up anything it sees within a distance, and empty it in a bin mounted on it. The bin thrash level is continuously monitored. Twinkle et al [6] developed Smart Dustbin which indicates directly that the dustbin is filled to a certain level by the garbage and cleaning or emptying them is a matter of immediate concern. Metallic waste collection robot has been designed by Alshafi and Almaleky [7] and it was basically designed for reducing the environment pollution caused by the metallic waste. Additionally, Nurlansa and the team [8] has developed Automatic Garbage Collector to collect garbage in the rivers. They use engineering method to design the garbage collector and the main driver of this robot is rotor and also they use sensors for automatic navigations. Anukriti Jha et al [9] proposed Development of autonomous garbage collector Robot which is built on an aluminium .When it senses an obstruction, it follows the code and proceeds to lift the garbage as per the designed mechanism. Ketan H. Pakhmode et al [10] presented Solar powered water surface garbage collecting boat is very helpful by collecting the garbage which are floating on the surface of water. This project is working automatically and saves the man power and work on the solar energy no external power supply is required. The majority of the current work incorporates just thoughts and models. Numerous papers were proposed with no real-world conditions or difficulties were even attempted, and in this manner it is may not be reliable for one who needs to test. Minimal effort models which use proximity sensors can't distinguish between trash and other objects. These offers ascend to off base outcomes. Precise robots which use Computer vision and video processing utilizes very top of the line processors for Artificial Intelligence (AI) calculations which makes the cost shoot up. Thus we expect to bring the best by giving exact outcomes without utilizing high end processors and GPUs on-

board. Through our proposed framework we additionally plan to reduce the cost and in this way open entryways for versatile creation of self-ruling cleaning robots in the market.

3. Proposed system

The block diagram of the proposed system is shown in Figure. 1.The proposed system has three different sensors which are continuously active as soon as the power supply is given to the system. Here we use ATmega328p microcontroller which acts as a brain of the robot. The functions of different sensors present in the proposed system are shown in the table 1. A part from this sensors we also have Liquid Crystal Display (LCD), Buzzer, motors, motor driver, Wi-fi Module, Battery,Hc-05 Bluetooth Module and Toggle switch. Here LCD is used to display the trash level and moisture content present in the bin. A buzzer is a small yet efficient component to add sound features to our project/system. It is used as indicator or alarm to the user whenever the garbage present in the bin reaches the threshold level .In the proposed System we have used L293D as a motor driver which acts as interface between the motors and Arduino. In manual mode using Blynk app we can control the locomotion of the robot which is connected using Bluetooth Module. Here, in our project we are using 7.4v and 2800mah battery for supplying electric power. Here we are using toggle switch where the user is required to select the Automatic or Manual Mode initially. In our system we have used ESP8266 wi-fi module which is user friendly and low cost device that provide internet connectivity to our projects so that we can access our web page where the data is recorded and stored with the help of Amazon Web Services (AWS) and here the data gives the information about the percentage of garbage level and moisture content present in the bin along with date and time. The web page get updated for every 10seconds. In order to access the web page we created an account in Amazon web services so that we are provided with the unique Id (ours Unique Id is 3.17.74.57) and With the help of that unique Id we are able to access the web page (http://3.17.74.57/Office_Projects/Garbage_Monitoring/Garbage.php) .Hence, the user can monitor the garbage level and moisture status from anywhere.

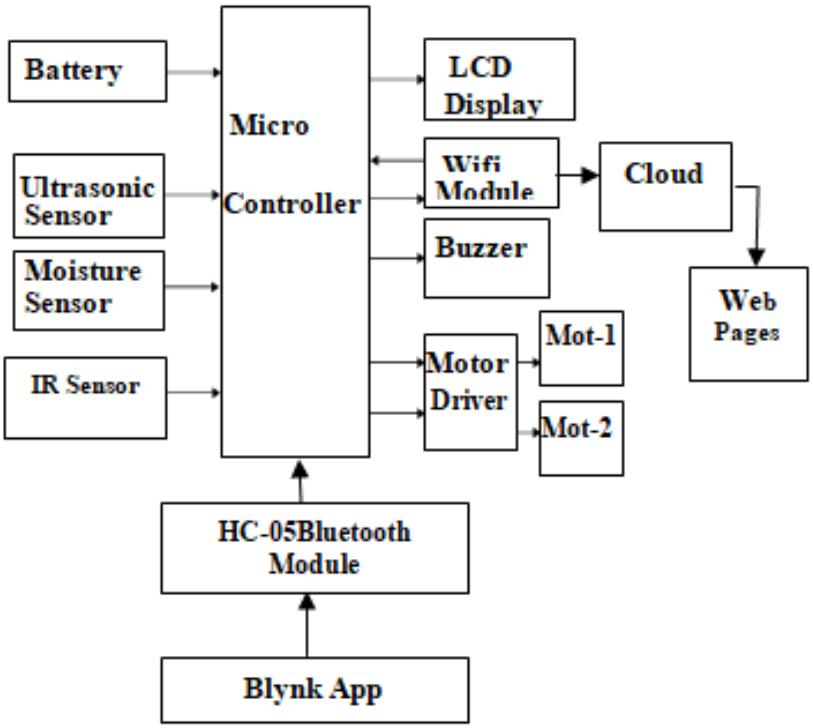

Figure 1: Block diagram of Garbage Collection and Monitoring Robot Using Wireless Communication

Table 1: Functions of sensors in proposed system

Sensor name	**Sensor role in the proposed system**
ultrasonic sensor	used for monitoring the garbage level in the bin
moisture sensor	used to know the moisture content present in the bin
IR sensor	used to follow the line on the surface. the path may be visible like a black line on a white surface or vice versa

In manual mode using Blynk app we can control the locomotion of the robot which is connected using Bluetooth module. The architecture of blynk app is shown on figure 2 and the description about the major components in blynk Platform is shown in the table 2. When the garbage is filled the robot starts moving towards the destination through a predefined path and with the help of human the waste is then dumped to the garbage collection area. Hence the Garbage collection Robot is operated in Automatic mode and Manual mode. With this proposed system we can obtain accurate results and also cost effective.

4. Flowchart of the proposed system

The working of the proposed project is explained below in form of flow chart. It can be operated in Automatic and manual mode. The illustration of algorithm (Fig 3) is as follows: When Power Supply is given to the device it will initialize Wi-Fi and all other output Modules. The Ultrasonic Sensor checks the trash level in the bin. If the amount of Garbage in the bin is greater than 80% then the Buzzer will switch on and make a continuous beep sound. Then the robot will guide itself to the garbage collection unit using predefined path with the help of IR sensors. In case the trash content is below 80 percentage then the web page get updated with the trash content and moisture content along with date and time and this process repeat continuously repeated until the power supply is on. With the help of toggle switch the the required mode (Automatic or Manual Mode) is selected by the user. If the user selects the Automatic mode the robot detects and follows the line. The path may be visible like a black line on a white surface or vice versa. If the user selects manual mode then the robot locomotion is operated using an android phone through blynk app which is connected using Bluetooth Module. When the data is received from the blynk app then the robot will move according to the instruction given by the user through blynk app application.

Table 2 : Description about the major components in the blynk app**.**

Major component name	**function of the major component**
blynk app	allows you to create amazing interfaces for your projects using various widgets we provide.
blynk server	responsible for all the communications between the smartphone and hardware
blynk libraries	for all the popular hardware platforms - enable communication with the server and process all the incoming and outgoing commands

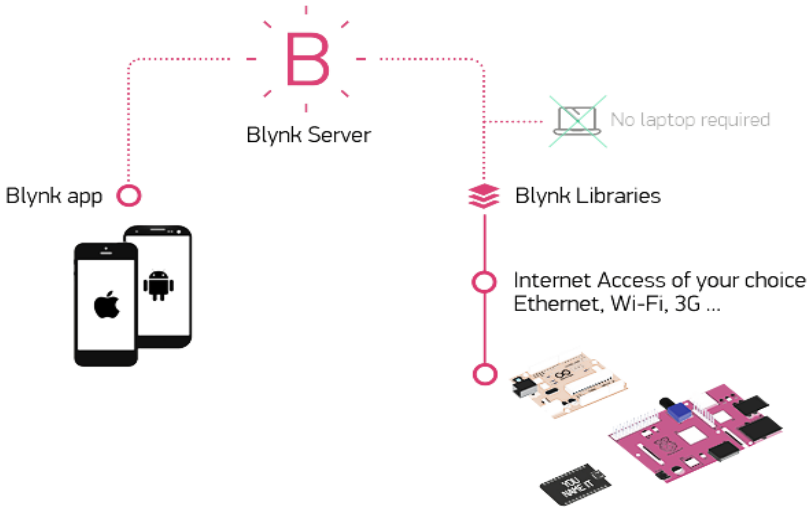

Figure 2: Blynk Platform Architecture

5. Hardware description of the proposed system

Circuit diagram of the proposed system is considered. In this circuit diagram different Components are interfaced with Arduino UNO microcontroller pins. Each sensor is connected to the different pins of the Microcontroller and Interconnections between Sensors to Arduino is shown in table 3.

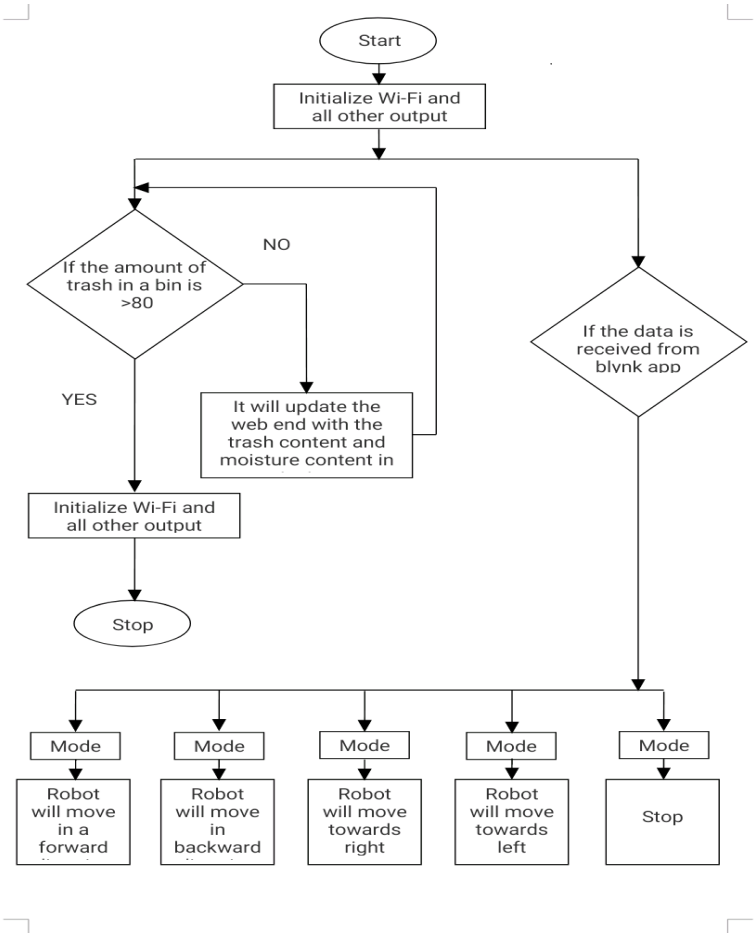

Figure 3 Flowchart of the Proposed System

Table 3: Interconnections between sensors to Arduino

SNO.	Sensor name	Sensor Pin	Arduino Pin
1.	Ultrasonic Sensor	Trig , Echo	D2, D3
2.	Moisture Sensor	A0	A0
3.	IR Sensor 1	Out	D4
4.	IR Sensor 2	Out	D5

Table 4: Arduino to other components

SNO	Component name	Component pin	Arduino Pin
1.	DC Motor 1	IN1 , IN2	D10 , D11
2.	DC Motor 2	IN3 , IN4	D6 , D 7
3.	ESP8266 Wi-fi module	Tx , Rx	D8 , D9
4.	Buzzer	-	D12
5.	LCD(16X2) I2C	SCLK, SDA	A4, A5
6.	HC-05 Bluetooth Module	Tx,Rx	D0,D1
7.	Toggle Switch	Input Pin	D13

5.1. Ultrasonic Sensor :

HC-SR04 Ultrasonic (US) sensor : In our proposed system ultrasonic is used for monitoring the garbage level in the bin .This sensor is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. The Trig pin is given to the Digital pin 2 of the Arduino and Echo pin is given to the Digital pin 3.The Operating voltage of Ultra sonic sensor is +5V.

5.2. Moisture Sensor:

Moisture Sensor: This sensor is used to know the Moisture content present in the bin in our proposed system. The sensor consists of two probes which are used to measure the volumetric content of water. This sensor can be connected in two modes; Analog mode and digital mode and it is a four pin module whose pin names are VCC, Gnd Analog and Digital. The analog output pin is given to the Analog pin (A0) of the Arduino here the output is in the form of percentages so we are using only Analog pin. The Input voltage is 3.3-5V.

5.3. IR Sensor:

The line follower is an autonomous robot that detects and follows a line which can be done using IR sensors .The path may be visible like a black line on a white surface or vice versa. Since we are using two IR sensors, the Output pins of the sensors are given to the

digital pins of the Arduino i.e, D4 for the left IR sensor and D5 for the right IR sensor. The operating Voltage is 5V. A part from the above sensors we also have different components. The below table 4 determines the connections between the Arduino and other components.

5.4. DC Motor:

DC Motor: Here DC Motor is used to rotate the panel in the required direction. In our project we have used two DC motors which are connected to the Arduino using L293D motor driver. The motor driver has 4 input pins and 4 output pins. Each input pin is connected to the Arduino and the output of the drivers are given to the DC motors. The Digital pins 6, 7 are used for second motor and Digital pins 10, 11 are used for the first motor. The Supply Voltage range of L293D is 4.5V-7V and the motor voltage range which is given to L293D is 4.5V-36V.

5.5. ESP8266 Wi-Fi Module

ESP8266 Wi-Fi Module: The **ESP8266** is a very user friendly and low cost device to provide internet connectivity to our projects. For the proposed system only 4 pins are required in the wi-fi module, the Transmitter (Tx) pin of the module is connected to the Digital pin 8 of the Arduino and theReceiver (Rx) pin is connected to the Digital pin 9. The sensor works at operating Voltage of 3.3V only.

5.6. Buzzer:

It is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard. This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is connected to the Digital pin 12 and the negative of the buzzer is given to ground.

5.7. Liquid Crystal Display(LCD):

The LCD used is (16x2) which is used to display the garbage level and moisture content present in the bin and this LCD basically has 16 pins but here we are using it with I2C module. By using this module we will be using only 4 pins for communication. The Serial clock pin (SCLK) of the LCD is connected to the Analog pin 4 (A4) in the Arduino board and the Serial Data pin (SDA) is connected to the Analog pin 5 (A5). The Operating Voltage is 4.7V to 5.3V.

5.8. HC-05 Bluetooth Module:

The **HC-05** Bluetooth module can add two-way (full-duplex) wireless functionality to our projects. We use this module to communicate between two microcontrollers like Arduino or communicate with any device with Bluetooth functionality like a Phone or Laptop. It has four pins they are Vcc, Ground, Transmitter (Tx), Receiver (Rx). Here, Vcc is given to 5v supply voltage, Tx of Bluetooth module is connected to the Digital pin D0 of Arduino and Rx of Bluetooth module is connected to the Digital pin D1 of Arduino.

5.9. Toggle Switch

SPDT Toggle Switch is a three terminal switch, mainly it is used in three-way circuit to turn **ON/OFF** an electrical appliance from two location. In our Project the user selects the required mode initially (i.e Automatic or manual mode) with the help of this toggle switch. The input pin of toggle switch is given to the digital pin 13 of Arduino

The power supply is provided to the whole system by using a Battery. The battery used here supplies a voltage of 7.4v and 2800mah. The battery has two terminals positive and the negative which is given to the breadboard. All the other components are supplied the same power supply provided by the battery. The positive pin from the bread board is connected to the 5v pin of the Arduino and the negative is given to the Gnd pin of the Arduino. The positive and negative terminals are differentiated by the red and black wires.

6. Experimental results

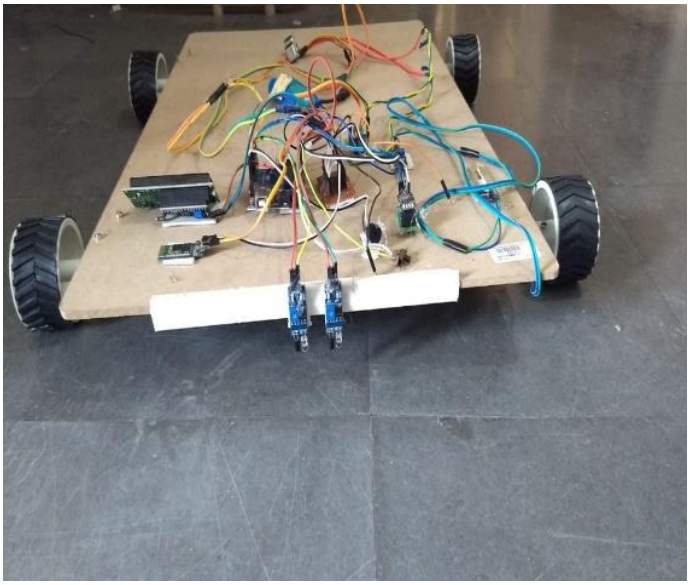

Figure 5 Hardware Implementation of Garbage collection Robot

We have implemented garbage collection robot with four wheel drive .At front of the robot we can see the IR Sensors which is used to detect and follow line (which can be seen in Figure 5) when the user selects Automatic mode. The dustbin which contains the moisture sensors can be movable and it can be of different size which depends on the user requirement and an LCD to display the trash level present in the bin which can be seen in fig 6. The fig7 represents our web page where the data is recorded and stored with the help of Amazon Web Services (AWS) and here the data gives the information about the percentage of garbage level and moisture content present in the bin. The web page get updated for every 10seconds. Hence, the user can monitor the garbage level and moisture status from anywhere. This Proposed system gives an accurate results and can be operated in both Automatic and Manual Mode.

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Figure 6 Wireless Garbage collection Robot

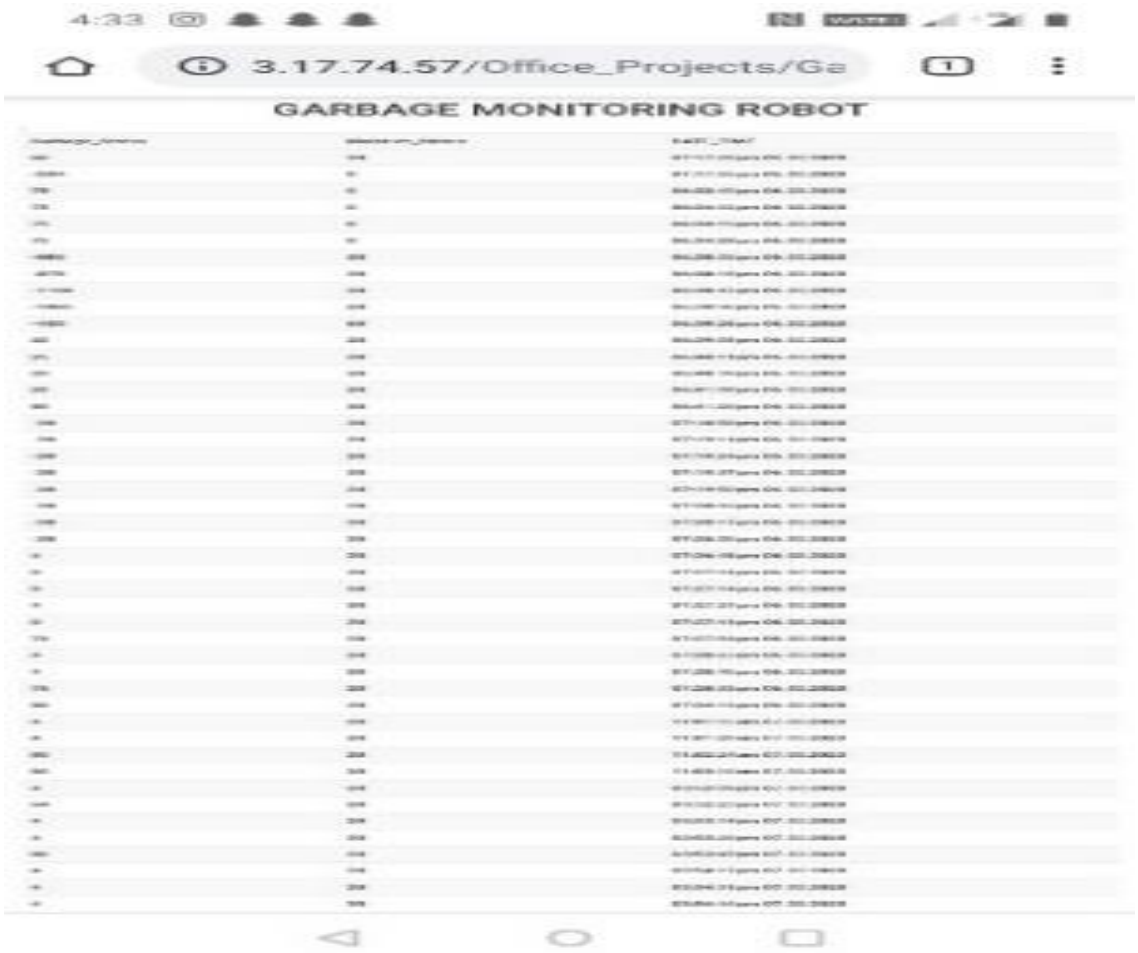

Figure 7 Webpage displaying the content of the Garbage in the bin

7. Conclusion

The proposed a framework that has effectively been executed. Through our proposed framework we also aim to significantly reduce costs and thereby we provide open entryways for versatile creation of self-sufficient cleaning robots in the market. In future our robot can be improved in such a way that it can differentiates between static and dynamic objects. We can develop our project in such a way that the robot should have ability in identifying metallic and non-metallic objects. We can also develop "Automatic Waste Segregator" sorts wastes into three different categories, namely metal, dry and the wet waste. Besides, the appropriation and improvement of the best highlights from existing advancement into a solitary incorporated framework makes it productive

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