A Project Report on

WASTE SEGREGATION AND GARBAGE MONITORING SYSTEM

Submitted in partial fulfillment of the requirements

in VIIIth Semester of

Bachelor of Engineering

in

Electronics and Telecommunication Engineering

By

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Certificate

This is to certify that report entitled **"Waste Segregation and Garbage Monitoring System"** is a bonafide work of **"Swaraj Deshmukh (301611), Humera Khan (301629) , Rashid Khan (301630) , Pankaj Patil (301643) and Tejashree Shendge (301650)"** submitted to University of Mumbai **in partial fulfillment of the requirement for the award of the degree of "Bachelor of Engineering" in "Electronics and Telecommunication Engineering".**

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This project report **Waste Segregation and Garbage Monitoring System** by **Swaraj Deshmukh (301611), Humera Khan (301629), Rashid Khan (301630), Pankaj Patil (301643) and Tejashree Shendge (301650)** is approved for the degree **Bachelor of Engineering** in **Electronics and Telecommunication Engineering** of **University of Mumbai, Mumbai.**

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Declaration

We declare that this written submission represents our ideas in our own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Abstract

Efficient waste collection is the need of the hour as increase in population has led to an increase in the amount of waste generated every year. India generates about millions of tonnes of waste annually and lacks adequate systems for waste collection, segregation, treatment or disposal that are important to curb the spreading of diseases. Even in metropolitan cities, including Mumbai, large amount of waste is neither collected efficiently nor properly segregated. Therefore, a smart monitoring system would increase the efficiency of waste management. Also, the economic value of the waste is not properly realized unless segregated. Segregating the wastes at the source would be more efficient than segregating it later. So, at the source, a set of two bins is used with a humidity sensor to segregate the wet and dry wastes. On detection of the type, the lid of the bin for that particular waste would open. Garbage monitoring system would help in detecting the level of the waste in the garbage bins and it would aid in sending trucks to only those areas where the bins are full, thus ensuring that the truck's fuel is not wasted and the garbage is collected on time. The location of the bin that is fully loaded is taken using Global Positioning System (GPS) modem. Once the bin is full, the message is sent to the driver with the help of Global System of Mobile (GSM) module. The message also contains the URL to the Google Maps for finding the path to the location of the garbage bins. The status of the level of the garbage in the bins is updated onto a website as well which would be used for the central monitoring of the system.

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Chapter 1

Introduction

1.1 Background

Waste management means the activities and actions required to manage waste from the time it is formed to its final disposal. It is collection, transportation, treatment and disposal of waste, together with monitoring of the process. Waste can be of any form (solid, liquid or gaseous) and each has a diverse treatment procedure. Cities without an effective waste-disposal plan face risks of diseases running rampant. Urban waste management is drawing increasing attention, as it can easily be observed that a large amount of garbage lies uncollected on the roads, leading to environmental pollution, and posing public health risk. The poor waste management situation in recent years has led to a high incidence of sanitation related illness, such as cholera, intestinal worms and typhoid. Thus, developing an efficient system for waste segregation and monitoring has become a necessity.

1.2 Problem Overview

The health of all organisms depends on their surrounding or their environment. Therefore, public cleanliness is important for individual health, which makes collecting and clearing the garbage regularly an important factor. Developed countries make more waste than the developing countries but they have efficient methods for treatment and disposal. Reducing the use of plastic by using paper bags/cloth bags, buying food with less packaging, reducing paper usage etc. will reduce the garbage, but whatever waste is generated needs to be disposed-off properly. Thus, timely collection and segregation of waste is needed that can be achieved through modern technologies.

1.3 Aim and Methodology

1.3.1 Project Objective

A garbage monitoring system is the need of the hour for an improved waste management and a healthy environment. A system that separates waste into different categories using sensors and later monitors the garbage/garbage bins in all localities and clears it once the bin is filled will save the time and fuel of the traditional garbage collecting trucks.

1.3.2 Methodology

In order to study the aim of the project, it is necessary to study the background of existing techniques, to get an identification of problem, specifying the research objective, carrying out a literature survey of the work published over the years to study the problem and find a way to solve it. Therefore, flow of work carried by us is:

1. Literature study of techniques used: Studying different papers to find out the working of the systems employed by the developed countries for efficient waste disposal was done. Also, the suggestions for smart management of waste by people of our country for smart cities was done.
2. Designing the system: Implementing a system for proper garbage monitoring and waste segregation will be done.

1.4 Organization of Report

The report consists of the chapters outlined below. These chapters are discussed in brief in this section.

Chapter 1 - Background of our project, problem overview, aim and methodology, organization of report.

Chapter 2 – Literature review, a study of the existing systems.

Chapter 3 – Block diagram of the proposed system and the project flow.

Chapter 4 – Experimenting with the hardware and the results.

Chapter 5 – Conclusion and future scope.

Chapter 2

Literature Review

2.1 Existing Waste Management Techniques

In this chapter, literature review is given on different garbage monitoring techniques that have been proposed over years.

2.1.1. Garbage monitoring using microcontroller AT89S52.

AT89S52 Microcontroller is used to interface sensor system with GSM system. It has 128 bytes of RAM, 4K bytes of on-chip ROM, two timers, one serial port and four ports all on a single chip. Sensors are used to monitor level waste in the dustbin. After acquiring desired information, output is given to microcontroller to send message via GSM module [1].

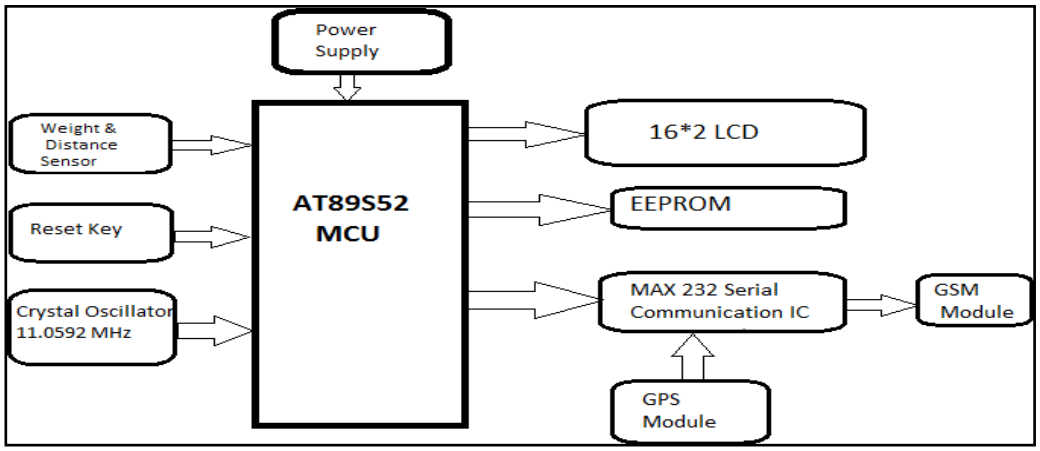

Fig.2.1 Flow of the System [1]

2.1.2. Garbage monitoring using Arduino

Ultrasonic sensors placed on top of bin are triggered by Arduino Mega 2560. After reaching the threshold value, the sensor sends the signal to Arduino mega which in turns activates GSM Module & GPS Modem [2].

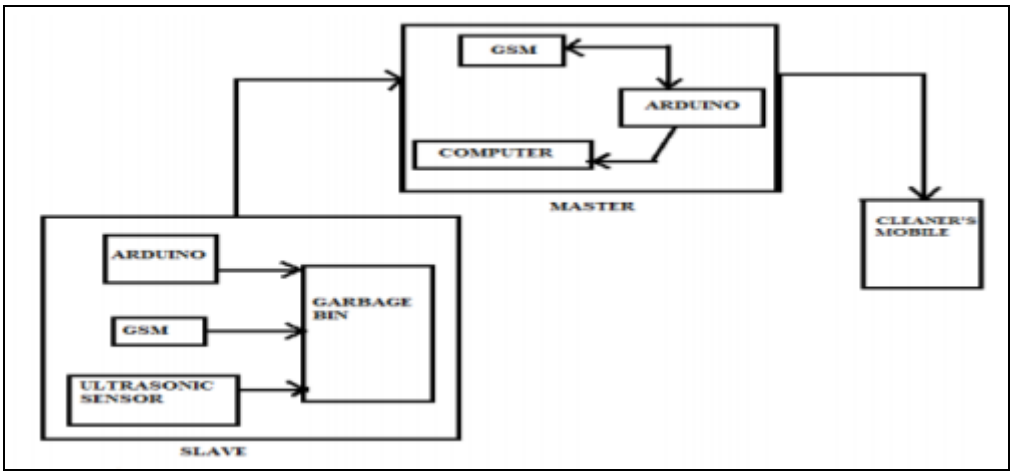

Fig.2.2 Block diagram of smart garbage system [2]

2.1.3. Waste Segregation technique using sensors

The automated waste material segregator is used to segregate three types of materials, namely Metal, Glass and Plastic. The controller used is Arduino UNO. An object is placed on the conveyor which runs on a motor of 12V, 1A which is connected to the motor driver and is programmed to run in clockwise direction by the Arduino. When the object is placed on the conveyor, depending on the output of inductive sensor and capacitive sensor, the motor driver drives the motor. If the material detected is metal, then the conveyer stops and metal is collected in the metal bin. If the material is found to be a non-metal, then the object moves in clockwise direction towards the capacitive sensor. If the capacitive sensor's output is high, indicating the material is glass, then the motor driver stops the conveyor motor and the Arduino controller drives the Motor so as to push the glass material into the glass bin. If capacitive sensor output is low, then the conveyor motor continues to rotate in the same direction and the plastic material is collected in the plastic bin [3].

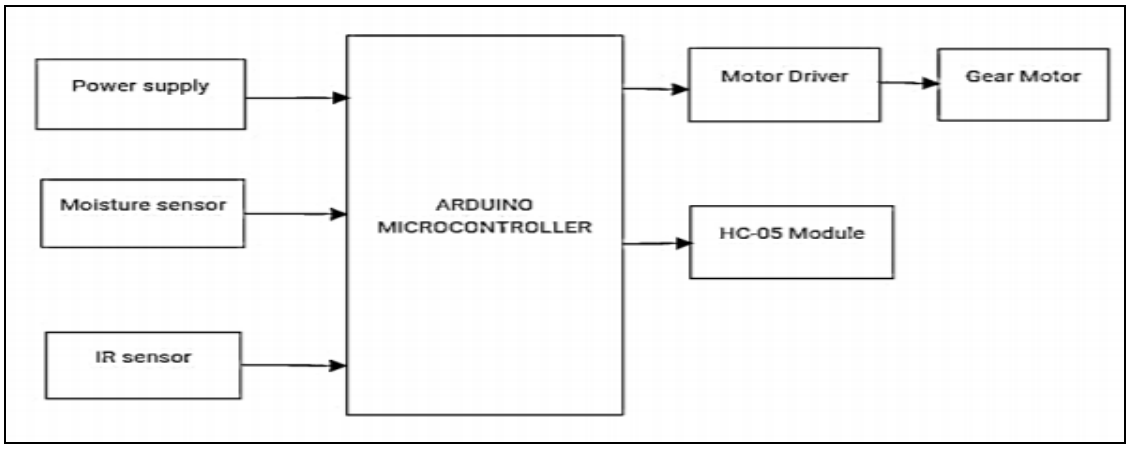

Fig.2.3 Block diagram of proposed system [4]

2.1.4. Waste Segregation technique using ML and sensors

IoT based waste segregation and administration machine assesses the wastes in the dustbins through the usage of sensor systems and as soon as it detects the type of waste substance in it, it will be segregated with the assistance of sensors and the data will be updated on to the cloud via IoT. Microcontroller acts as a mediator between the sensor devices and IoT system. Ultra-sonic sensor is used to detect the presence of the waste material. The moisture sensor's work is to detect the moisture in the waste, and if there is moisture present, then the waste cannot be put in the dustbin. Metal sensor is used to separate the metal items and is separated to a section. Image processing is used to identify the plastics and degradable items and is separated to another separate sections. The dustbin data are uploaded to the cloud database using IoT in real time [5]

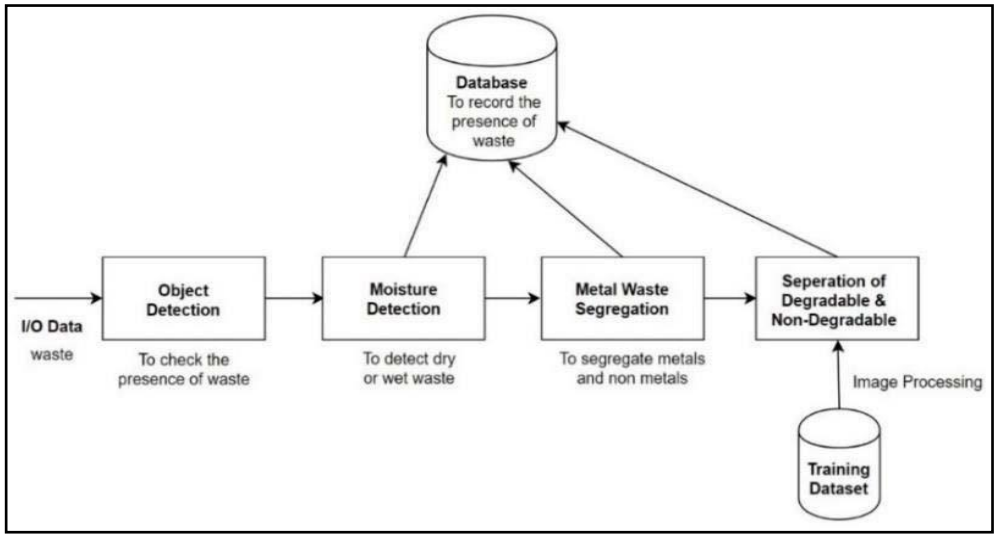

Fig.2.4 Block diagram of proposed system [5]

2.2 Statistical Data

India generates 62 million tons of waste every year, out of which less than 60% is collected and around 15% is processed. With megacities spurting a growth of 30.47% (Census 2011), India's basic necessities have sometimes been ignored. With an increasing focus towards services such as water, electricity and food for the growing population, the Indian administration has unfortunately ignored another major public service: waste management [6].

MUNICIPAL SOLID WASTE MANAGEMENT

Bottom 10 states

State	Daily waste generated (MT)	Waste Proce-ssed
Arunachal	181	0%
D & N Haveli	35	0%
J & K	1,374	1%
Jharkhand	2,327	2%
Odisha	2,650	2%
Bihar	1,318	3%
Puducherry	350	3%
Mizoram	201	4%
West Bengal	7,700	5%
Haryana	4,514	6%

Top 10 states

State	Daily waste generated (MT)	Waste Proce-ssed
Chhattisgarh	1,680	74%
Telangana	7,371	67%
Sikkim	89	66%
Goa	260	62%
Meghalaya	268	58%
Tripura	420	57%
Delhi	**10,500**	**55%**
Manipur	176	50%
Kerala	1,463	45%
Maharashtra	22,570	39%

All states
Daily waste generated (MT) 1,43,558
Waste Processed 24.8%

Fig.2.5 Share of states in MSW generated [7]

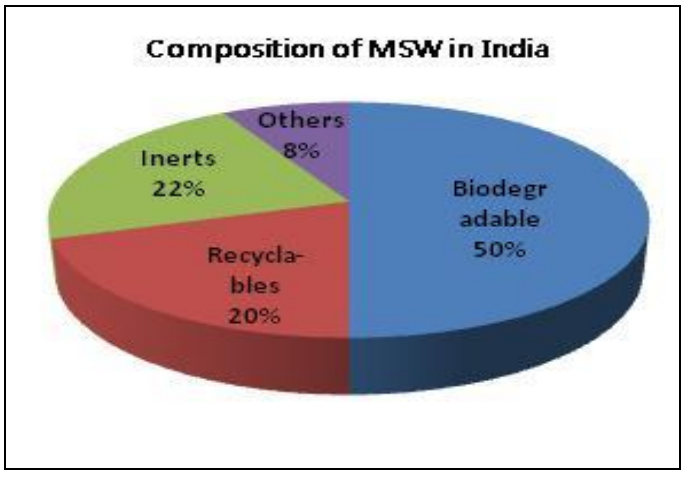

Fig.2.6 Composition of MSW waste [8]

2.3 Components

2.3.1. Arduino Mega 2560

The **Arduino Mega 2560** is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with AC-to-DC adapter or battery to get started [9].

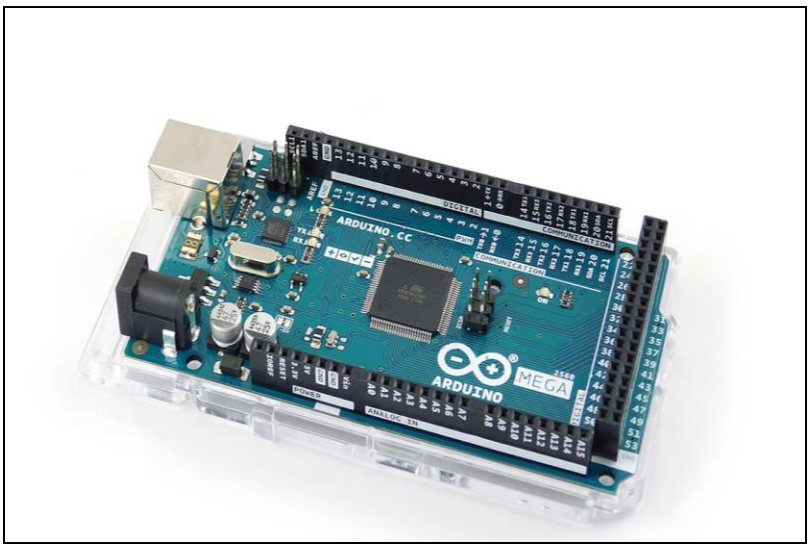

Fig.2.7 Arduino Mega 2560 [9]

Table 2.1 Specification of Arduino Mega 2560 [9]

Microcontroller	Microcontroller: Microchip ATmega328P
Operating Voltage	5 Volts
Input Voltage	7 to 12 Volts
Digital I/O pins	54 (of which 6 provide PWM output)

Analog pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8KB
EEPROM	1KB
Clock Speed	16MHz
Length	101.52 mm
Width	53.3 mm

2.3.2 GPS Module

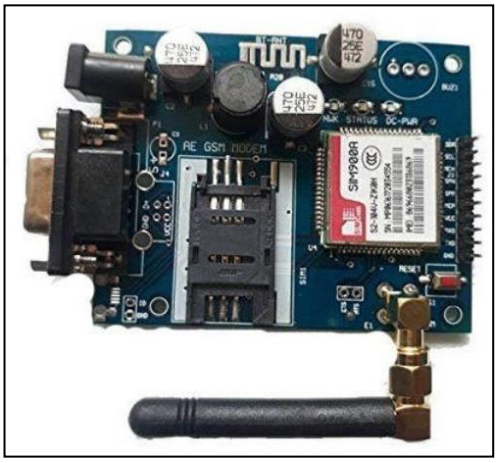

Fig.2.8 GPS Module NEO-6M [10]

The NEO-6M GPS module is a well-performing complete GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna, which provides a strong satellite search capability. With the power and signal indicators, the status of the module is monitored. With the help of data backup battery, the module can save the data when the main power is shut down accidentally. Its 3mm mounting

holes can ensure easy assembly on aircraft, which can thus fly steadily at a fixed position, return to Home automatically, and automatic waypoint flying, etc. [10]

2.3.3 GSM Module

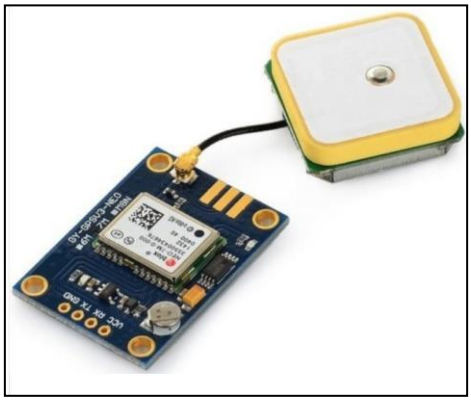

Fig.2.9 GSM Module [11]

This is an ultracompact and reliable wireless module. The SIM900A is a complete Dual-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications, thus allowing benefits from small dimensions and cost-effective solutions. Featuring an industry-standard interface, the SIM900A delivers GSM/GPRS 900/1800MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900A can fit almost all the space requirements for various applications, especially for slim and compact demand of design [11].

Table 2.2 Specification of GSM Module [11]

PCB size	71.4mm X 66.0mm X1.6mm
Indicators	PWR, status LED, net LED
Power supply	5V
Communication Protocol	UART
Operation temperature	40°C to +85 °C

Low power consumption:	1.5mA (sleep mode)
Baud rate	115200 bps
Current Consumption (pulse)	2A

2.3.4 Ultrasonic Sensor

Fig.2.10 Ultrasonic Sensor [12]

Ultrasonic (US) sensor is a 4-pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has a transmitter and a receiver. The sensor works with the simple formula given below [12].

Distance = Speed x Time x 0.5

Table 2.3 Specification of Ultrasonic Sensors [12]

Sensing range	40cm to 30 cm
Target dimension for max. measure dist.	5cm*5cm
Response time	50 ms to 200 ms
Accuracy	±1.5%

Resolurion	1mm
Beam angle	Approx. 5
Sensor output	0V DC to 10 V DC
Ultrasonic frequency	12OkHz
Weight	Approx 150g

2.3.5 Humidity Sensor

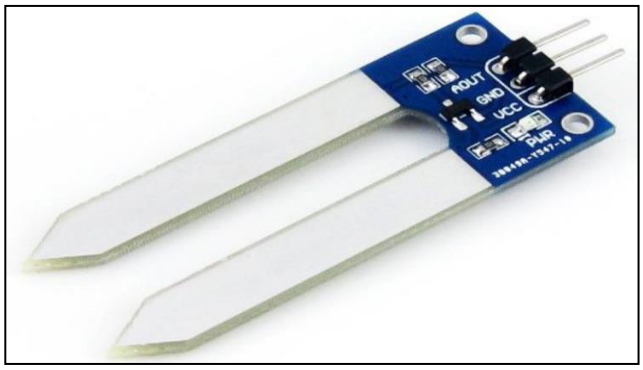

Fig.2.11 Humidity Sensor [13]

A humidity sensor (or hygrometer) senses, measures and reports both moisture and air temperature. The ratio of moisture in the air to the highest amount of moisture at a particular air temperature is called relative humidity.

There are three basic types of humidity sensors:

1. Capacitive
2. Resistive
3. Thermal

A capacitive humidity sensor measures relative humidity by placing a thin strip of metal oxide between two electrodes. The metal oxide's electrical capacity changes with the atmosphere's relative humidity. Weather, commercial and industries are the major application areas.

Resistive humidity sensors utilize ions in salts to measure the electrical impedance of atoms. As humidity changes, so do the resistance of the electrodes on either side of the salt medium.

Two thermal sensors conduct electricity based upon the humidity of the surrounding air. One sensor is encased in dry nitrogen while the other measures ambient air. The difference between the two measures the humidity [13].

2.3.6 Saving data of Arduino to database

Fundamentals of an advanced project are to be able to store data read from the connected sensors. This way one can monitor live data, and are also able to get historic information. It also allows to capture data from multiple data input devices and display them when and how we want. Even though this could also be done with a dedicated web page by adding a little more code to Arduino, it is easier to store it to a database and create a web page (or user interface) that reads data from the database [14].

The following are the steps to be performed:

Step 1: Connect Arduino to local network.

Step 2: Prepare the database.

Step 3: Create files that will capture data sent from Arduino and write it to database.

Step 4: Write Arduino code.

Step 5: Display the data in the database.

2.3.7 Machine Learning and its algorithms

Machine learning (ML) is the scientific study of algorithms and statistical models that computer systems use to perform a specific task without using explicit instructions, relying on patterns and inference instead. It is seen as a subset of artificial intelligence. Machine learning algorithms build a mathematical model based on sample data, known as "training data", in order to make predictions or decisions without being explicitly programmed to perform the task. Machine learning algorithms are used in a wide variety of applications, such as email

filtering and computer vision, where it is difficult or infeasible to develop a conventional algorithm for effectively performing the task [15].

TensorFlow is an end-to-end open source platform for machine learning. It has a comprehensive, flexible ecosystem of tools, libraries and community resources that lets researchers push the state-of-the-art in ML and developers easily build and deploy ML powered applications.

Easy model building-Build and train ML models easily using intuitive high-level APIs like Keras with eager execution, which makes for immediate model iteration and easy debugging.

Robust ML production anywhere-Easily train and deploy models in the cloud, on-prem, in the browser, or on-device no matter what language you use.

Powerful experimentation for research-A simple and flexible architecture to take new ideas from concept to code, to state-of-the-art models, and to publication faster [16].

2.3.8 About application -Blynk

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things.

There are three major components in the platform:

- **Blynk App** - allows to you create amazing interfaces for your projects using various widgets we provide.
- **Blynk Server** - responsible for all the communications between the smartphone and hardware. You can use our Blynk Cloud or run your private Blynk server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.
- **Blynk Libraries** - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

Features of Blynk application

- Similar API & UI for all supported hardware & devices
- Connection to the cloud using:

  - WiFi
  - Bluetooth and BLE
  - Ethernet
  - USB (Serial)
  - GSM
- Set of easy-to-use Widgets
- Direct pin manipulation with no code writing
- Easy to integrate and add new functionality using virtual pins
- History data monitoring via SuperChart widget
- Device-to-Device communication using Bridge Widget
- Sending emails, tweets, push notifications, etc.

Hardware -An Arduino, Raspberry Pi, or a similar development kit.
Blynk works over the Internet. This means that the hardware you choose should be able to connect to the internet. Some of the boards, like Arduino Uno will need an Ethernet or Wi-Fi Shield to communicate, others are already Internet-enabled: like the ESP8266, Raspberri Pi with WiFi dongle, Particle Photon or SparkFun Blynk Board. But even if you don't have a shield, you can connect it over USB to your laptop or desktop (it's a bit more complicated for newbies, but we got you covered). What's cool, is that the list of hardware that works with Blynk is huge and will keep on growing.
A Smartphone-The Blynk App is a well design interface builder. It works on both iOS and Android [17].

2.3.9 Circuit Simulator Software

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

The Proteus Design Suite is a Windows application for schematic capture, simulation, and PCB (Printed Circuit Board) layout design. It can be purchased in many configurations, depending on

the size of designs being produced and the requirements for microcontroller simulation. All PCB Design products include an auto-router and basic mixed mode SPICE simulation capabilities.

Schematic Capture

Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations.

Microcontroller Simulation

The micro-controller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables its use in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design. It also finds use in the general hobbyist community and, since no hardware is required, is convenient to use as a training or teaching tool. Support is available for co-simulation of:

- Microchip Technologies PIC10, PIC12, PIC16,PIC18,PIC24,dsPIC33 Microcontrollers.
- Atmel AVR (and Arduino), 8051 and ARM Cortex-M3 Microcontrollers
- NXP 8051, ARM7, ARM Cortex-M0 and ARM Cortex-M3 Microcontrollers.
- Texas Instruments MSP430, PICCOLO DSP and ARM Cortex-M3 Microcontrollers.
- Parallax Basic Stamp, Freescale HC11, 8086 Microcontrollers [18].

Chapter 3

Implementation of System

The design of garbage monitoring and waste management system is done using the ultrasonic sensors for level detection, GPS modem to find the location and SIM900A GSM module to send the message stating that the garbage bin is about to be full, or is completely filled to the garbage collector.

3.1 System Block Diagram

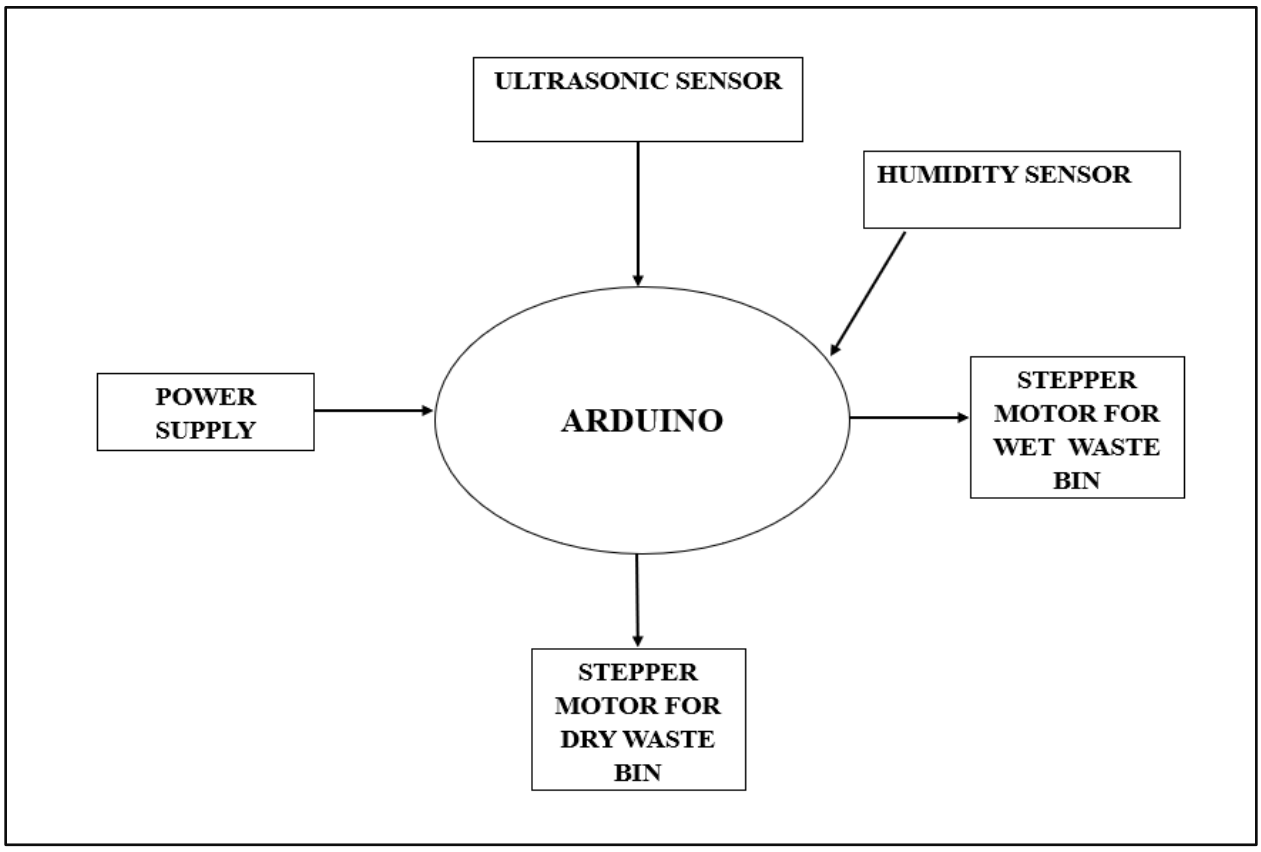

Fig 3.1 Block Diagram for Segregation

Fig 3.1 shows that Arduino is centrally placed which manages both monitoring and segregation. For segregating into dry and wet waste, it is connected to ultrasonic sensor, humidity sensor, power supply, stepper motor of both dry and wet waste bin. The system ensures automatic opening of bin via stepper motor when appropriate kind of waste is brought.

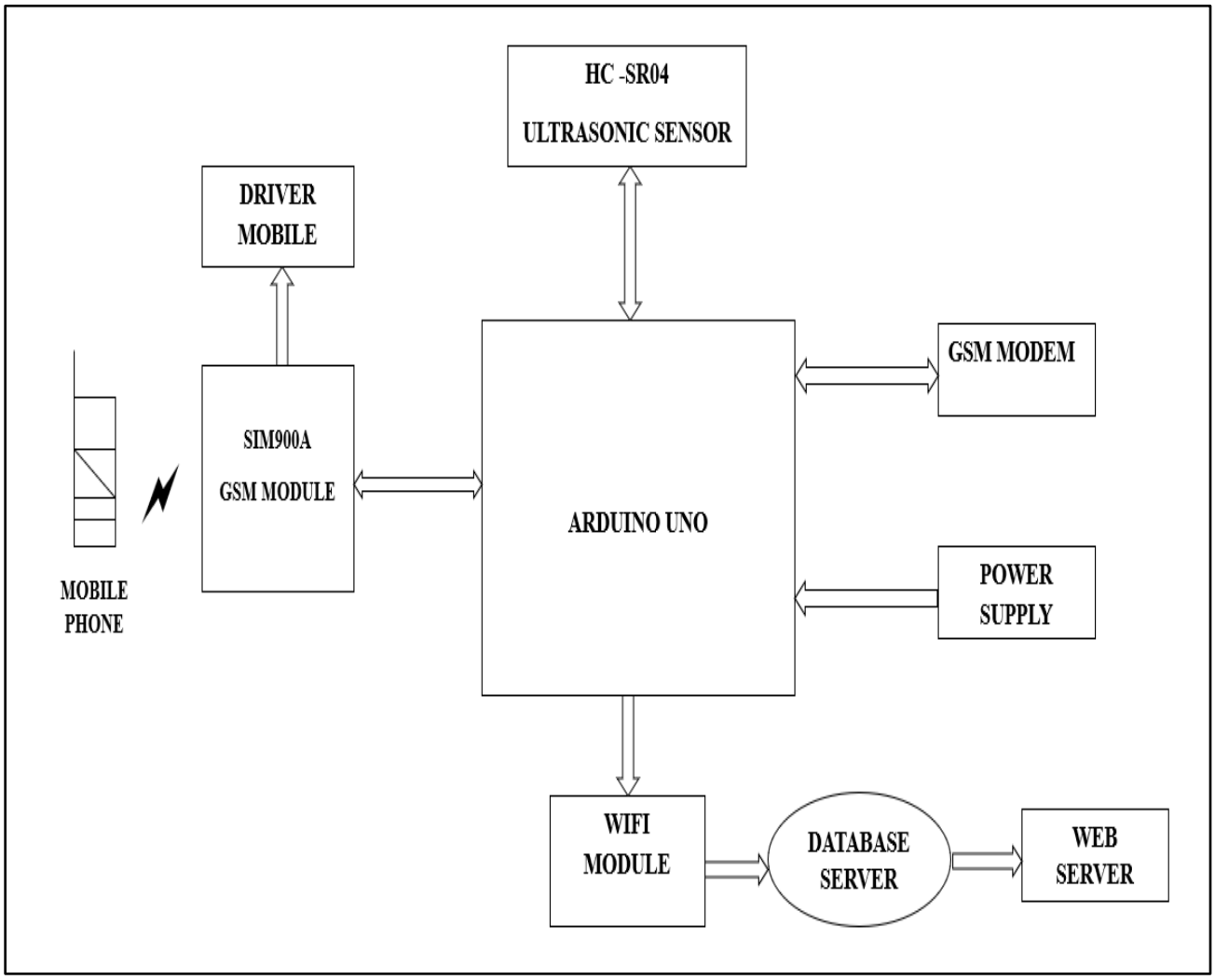

Fig 3.2 Block Diagram of Garbage Monitoring System

Ultrasonic sensor is used to determine the level of garbage in the dustbins as shown in Fig 3.2. Once filled up to the threshold level, it sends a message to the driver via GSM module stating the same, plus using GPS modem to send the location. The data is sent to the webpage via database server for central monitoring of the dustbins.

3.2 Flowchart

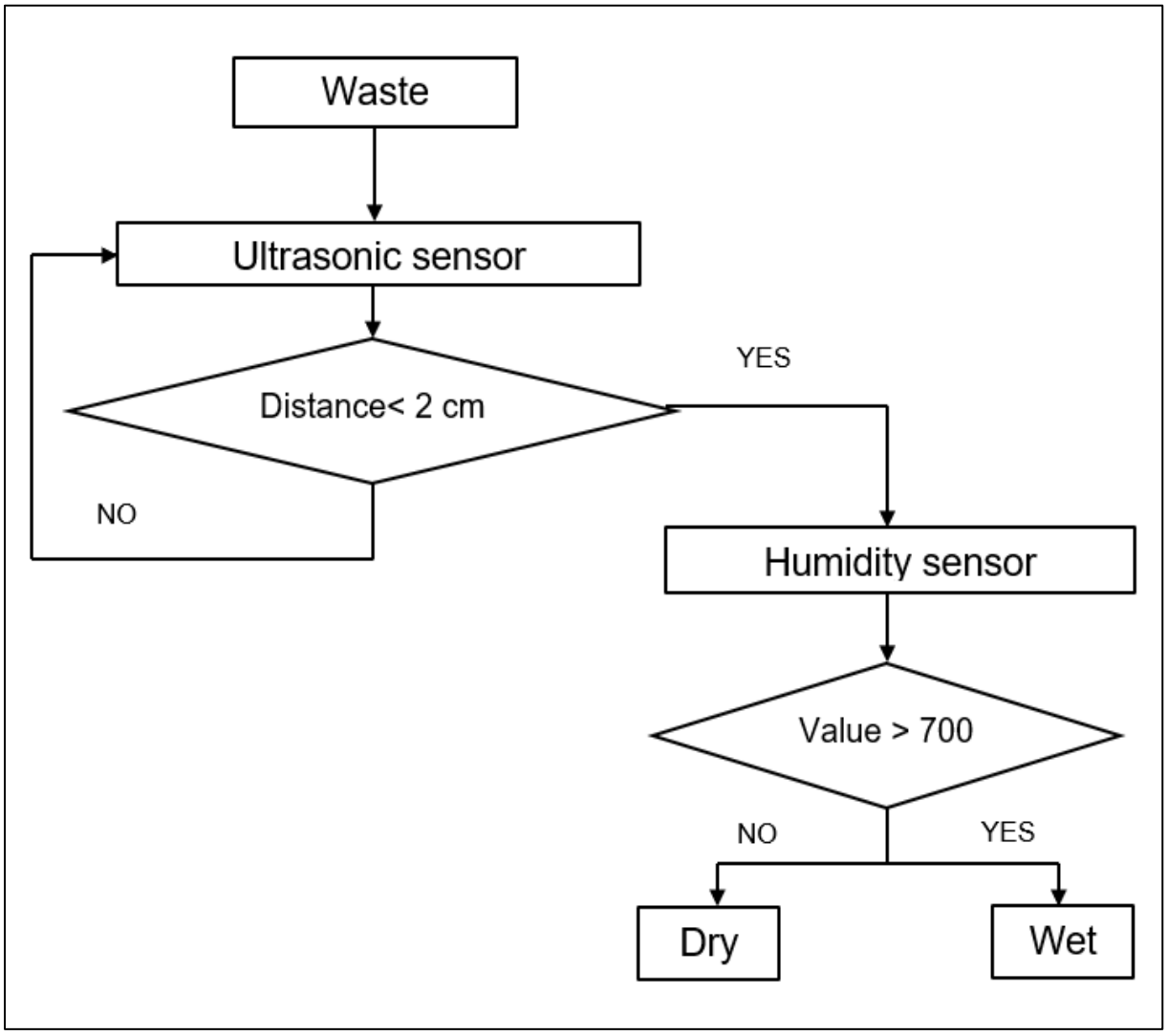

Fig 3.3 Flow chart of segregation part

Fig 3.3 shows that the system consists of two bins placed adjacent to each other, one for wet and other for other. The ultrasonic sensor is placed inside to check the level of garbage. At the bin ultrasonic and humidity sensor is placed on one bin when a person goes near the bin his presence will be detected if the distance is less than 2 cm with the help of ultrasonic sensor. The waste is brought in contact if its wet the wet bin opens else dry bin gets open.

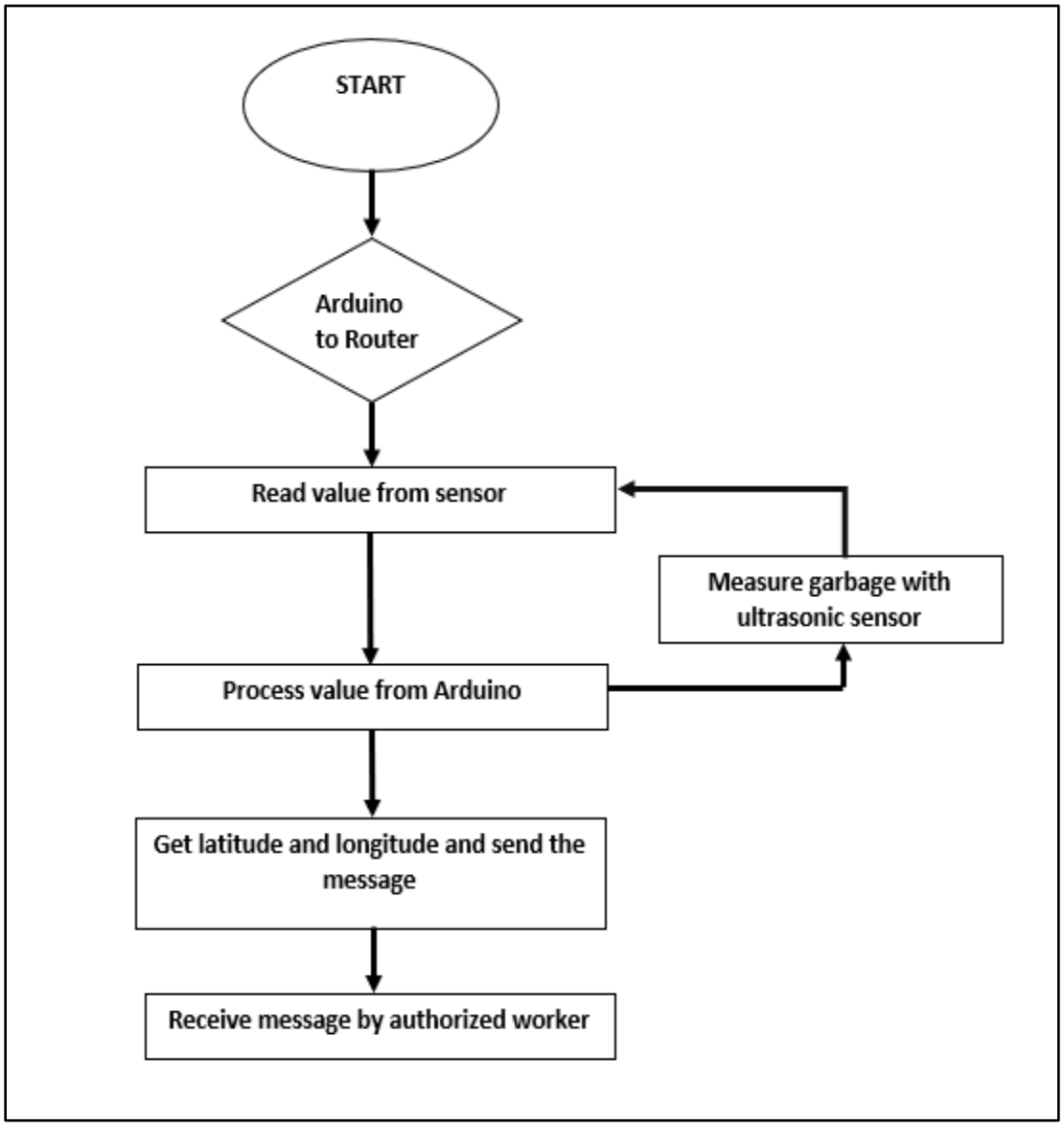

Fig 3.4 Flow chart of the monitoring system

The level of waste in the garbage bin is measured with the help of ultrasonic sensor and when the threshold level is reached, the message is about the location that was received using the GPS modem is sent via the GSM module to the mobile phone of the garbage collector for collection of the garbage as shown in Fig 3.4. The same information is passed onto the website for central monitoring of the garbage bins.

3.3 Interfacing of Components

3.3.1 Interfacing of the ultrasonic sensor

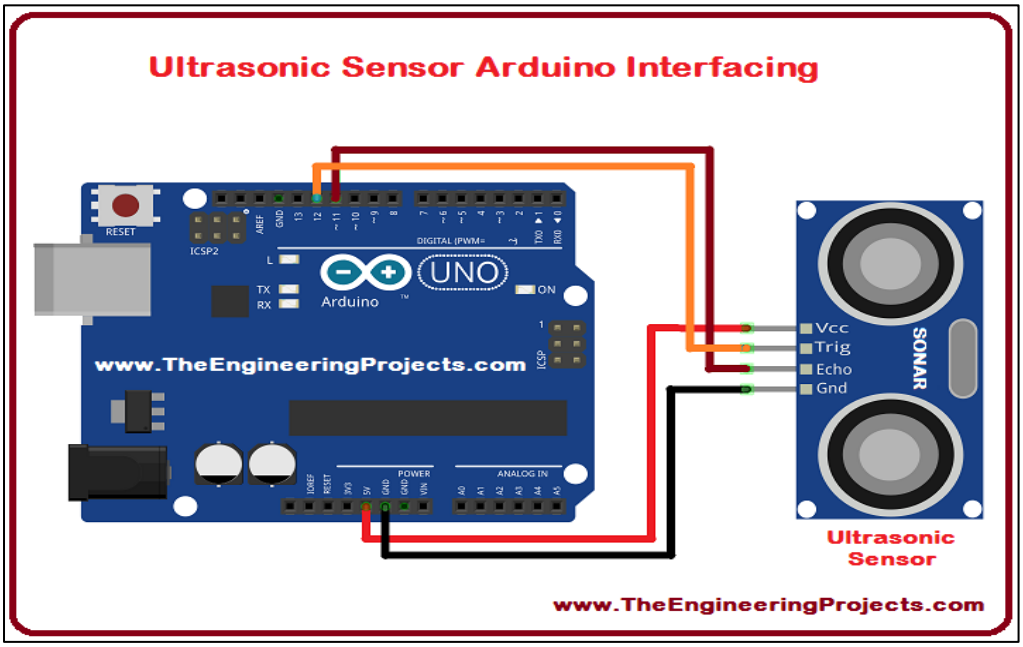

Fig 3.5 Ultrasonic sensor Arduino interfacing [19]

The HC-SR04 ultrasonic sensor uses SONAR to determine the distance of an object just like the bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package from 2 cm to 400 cm or 1” to 13 feet.

The operation is not affected by sunlight or black material, although acoustically, soft materials like cloth can be difficult to detect. It comes complete with ultrasonic transmitter and receiver module [19].

3.3.2 Interfacing of the GPS Modem

GPS satellites circle the Earth twice a day in a precise orbit. Each satellite transmits a unique signal and orbital parameters that allow GPS devices to decode and compute the precise location of the satellite. GPS receivers use this information and trilateration to calculate a user's exact location. Essentially, the GPS receiver measures the distance to each satellite by

the amount of time it takes to receive a transmitted signal. With distance measurements from a few more satellites, the receiver can determine a user's position and display it.

To calculate your 2-D position (latitude and longitude) and track movement, a GPS receiver must be locked on to the signal of at least 3 satellites. With 4 or more satellites in view, the receiver can determine your 3-D position (latitude, longitude and altitude). Generally, a GPS receiver will track 8 or more satellites, but that depends on the time of day and where you are on the earth [20].

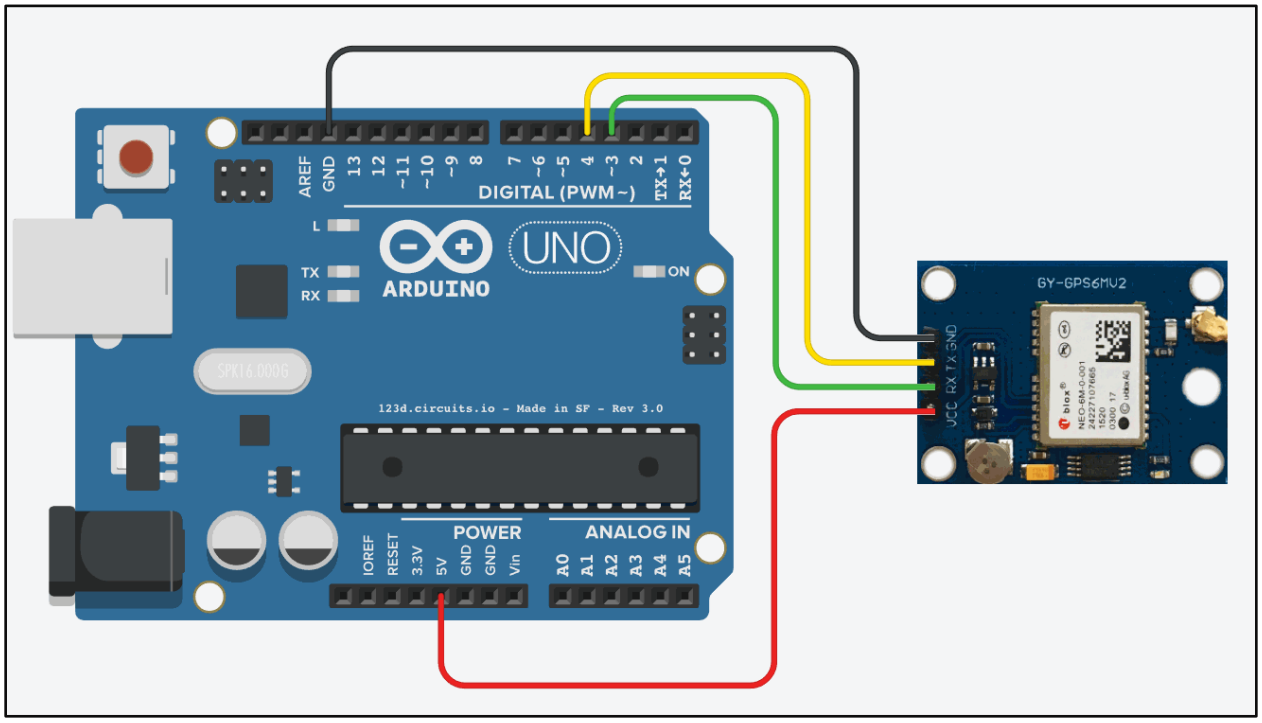

Fig 3.6 GPS - Arduino interfacing [20]

3.3.3 Interfacing of the GSM Module

Connect RX Line of Arduino to TX Line of GSM Modem and vice versa TX of Arduino to Rx of GSM modem. Make sure use TTL RX, TX lines of GSM modem.

Give 12V 2Amp power supply to GSM modem, use of less current power supply can cause reset problem in GSM modem, give sufficient current to GSM modem [21].

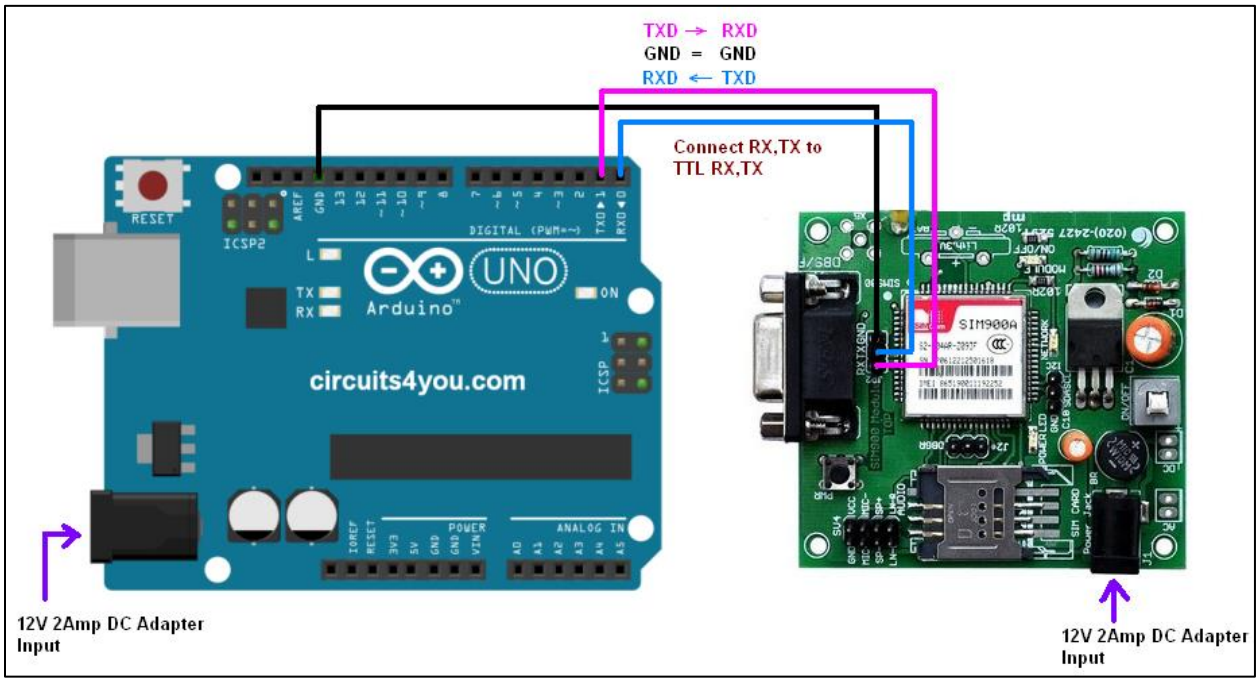

Fig 3.7 GSM – Arduino interfacing [21]

3.4 Implementation of the System

The heart of the system is Arduino UNO which controls the other components of the system. Ultrasonic sensing is one of the best ways to sense proximity and detect levels with high reliability. It measures the distance using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect from boundaries to produce distinct echo patterns. The time required for the waves to reflect back is utilized to calculate the distance. Thus, for separation of waste into dry and wet at the source itself, two bins are placed at the particular location - one for dry and other for wet. An ultrasonic sensor is placed just above the humidity sensor to detect the presence of human hand. When the person places the garbage on the humidity sensor for detection, the distance detected by the ultrasonic sensor is lesser than the threshold (2cm) decided on trial-error method, the humidity sensor gets activated to check the type of waste. If the waste detected is wet, then the lid of the wet garbage bin opens up with the help of stepper motor, else the bin for dry waste opens up. This ensures not only the segregation but also the hygiene.

Similarly, to detect the level of garbage in the bins, if the average distance calculated by the four ultrasonic sensors becomes lesser than the given threshold (10 cm), a message is sent to the driver stating that the dustbin of that particular location is about to be full. The same message is passed onto the webpage for the central monitoring of the dustbins.

Fig 3.8 Implementation of the System

Chapter 4

Results and Discussion

The interfacing of various components like GSM Module, GPS Modem and ultrasonic sensor was discussed in Chapter 3. The chapter includes the outcome and the following discussion in light of the technique being mentioned.

4.1 Results

This section discusses the results of the ultrasonic sensor, GPS modem and GSM module under different test conditions. The experimental tests involve testing of sensor and output analysis of various stages.

4.1.1 Object recognition using ML

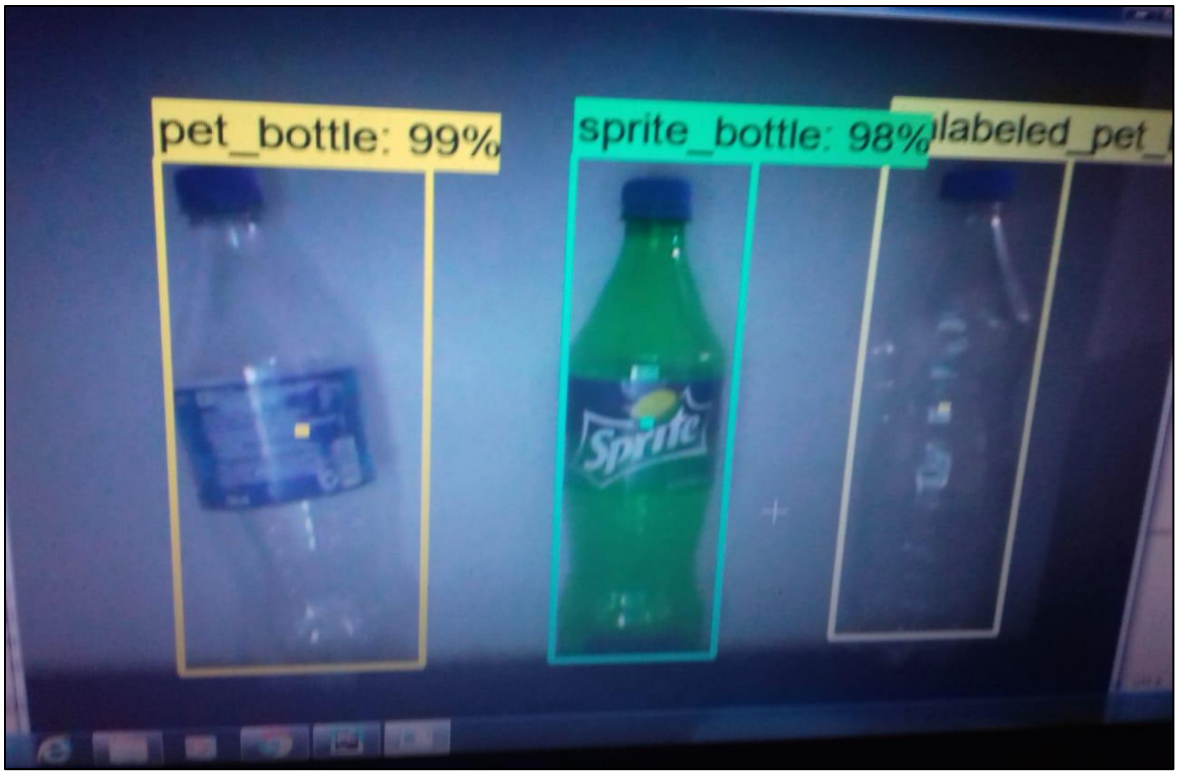

Fig. 4.1 Plastic bottle detection using ML (a)

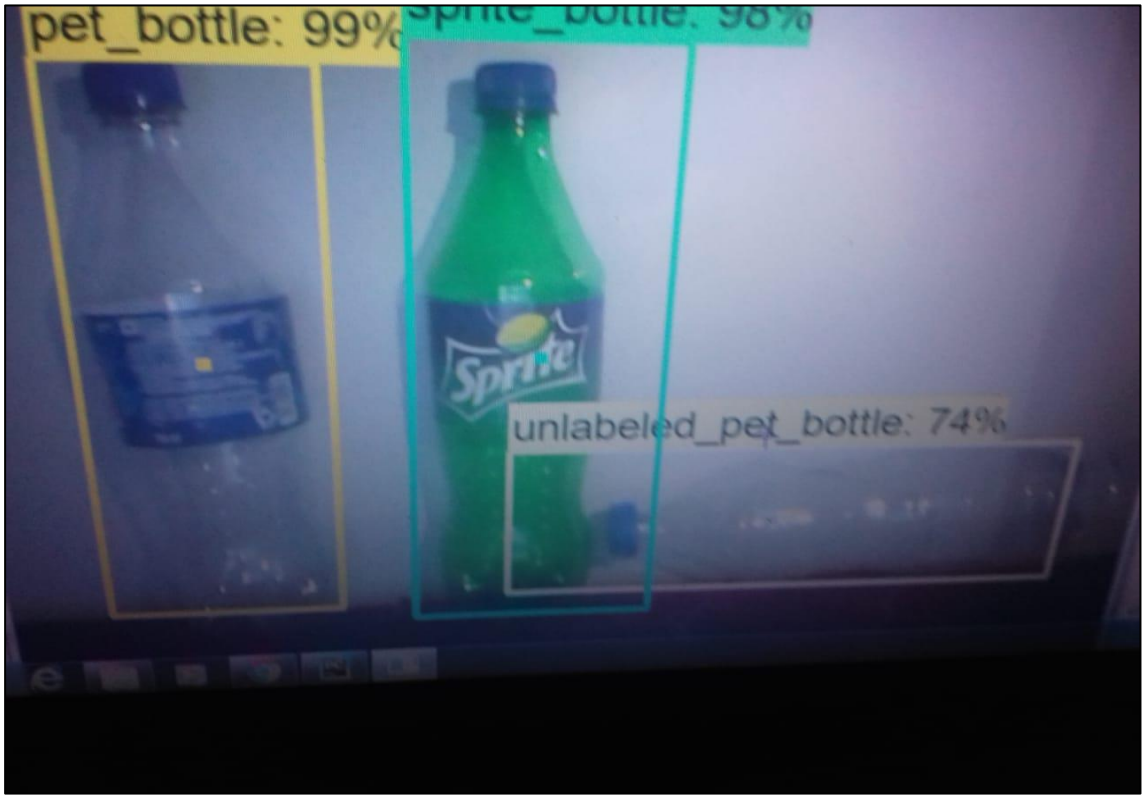

Fig. 4.2 Plastic bottle detection using ML (b)

Plastic bottle are detected with the help of ML using Tensorflow algorithm. Here total 400 images were trained to get the adequate output. However more the number of images more is an efficiency of the training model.

4.1.2 Simulating using Proteus

Demonstration of the segregation part of the system using Proteus simulation software where the ultrasonic sensor helps in determining the level of the garbage and measures it seperately for dry and wet waste .

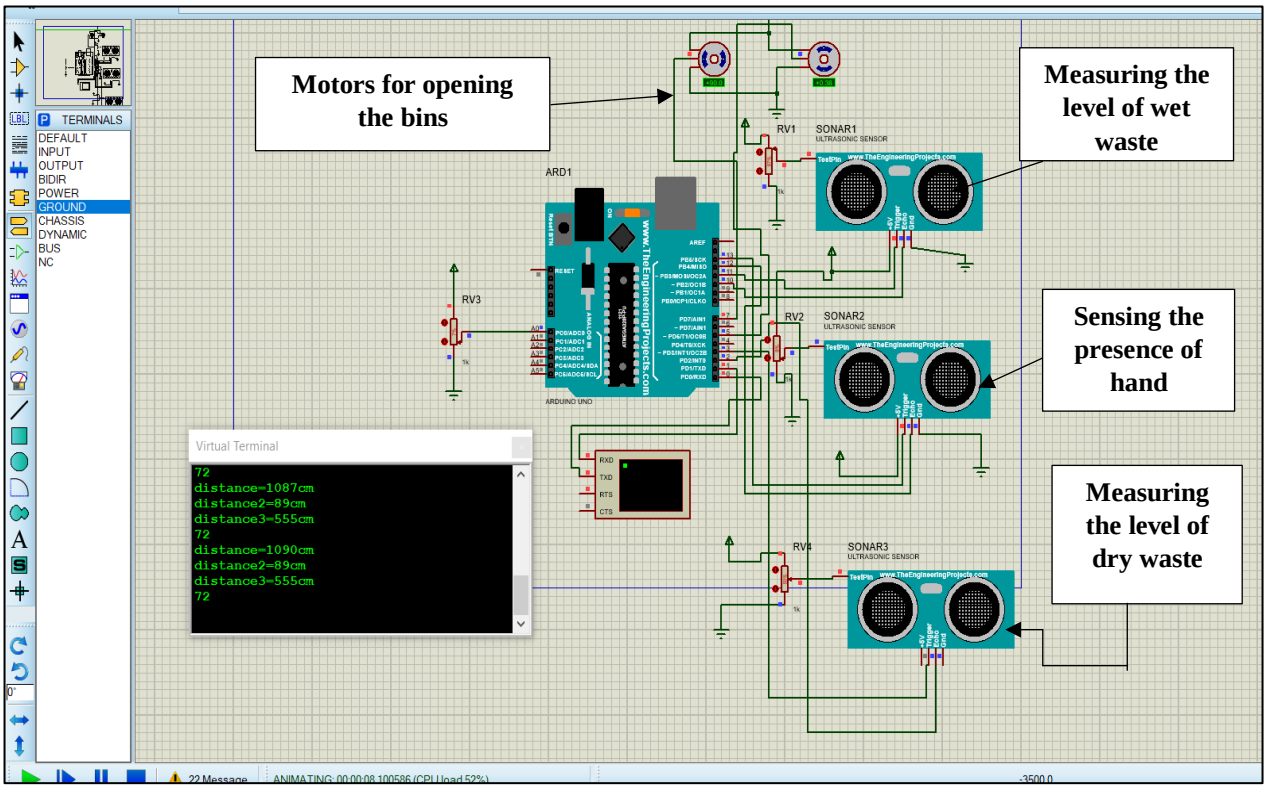

Fig 4.3 Proteus simulation output

4.1.3 Ultrasonic sensor

The ultrasonic sensor was tested to find out if it was giving the right measurements. The height of the dustbin used was 30 cm. Following are the test results:

Table 4.1 Results of the distance of ultrasonic sensor

Level of the garbage (in cm)	Distance from the sensor (in cm)	Distance measured by the sensor (in cm)
0	30	30
5	25	25
20	10	10

The distances calculated using ultrasonic sensor were same as the actual levels of the garbage.

4.1.4 GSM module and GPS modem

The GSM module is tested to see the correct reception of the message on the mobile phone. The module did not send message when the garbage bin was filled only up to a few centimeters, i.e. when the bin had garbage level lesser than the threshold (10 cm), but it successfully sent the message when the bin had garbage level greater than the threshold (10 cm), i.e. when the bin is about to be full.

The GPS modem is used to send the location of the garbage bin. Whether the location sent by the GPS modem is correct or not is verified using the Google Maps app.

The GPS modem gives the proper results but it does not work properly during the rains or at certain locations where the network is not easily available.

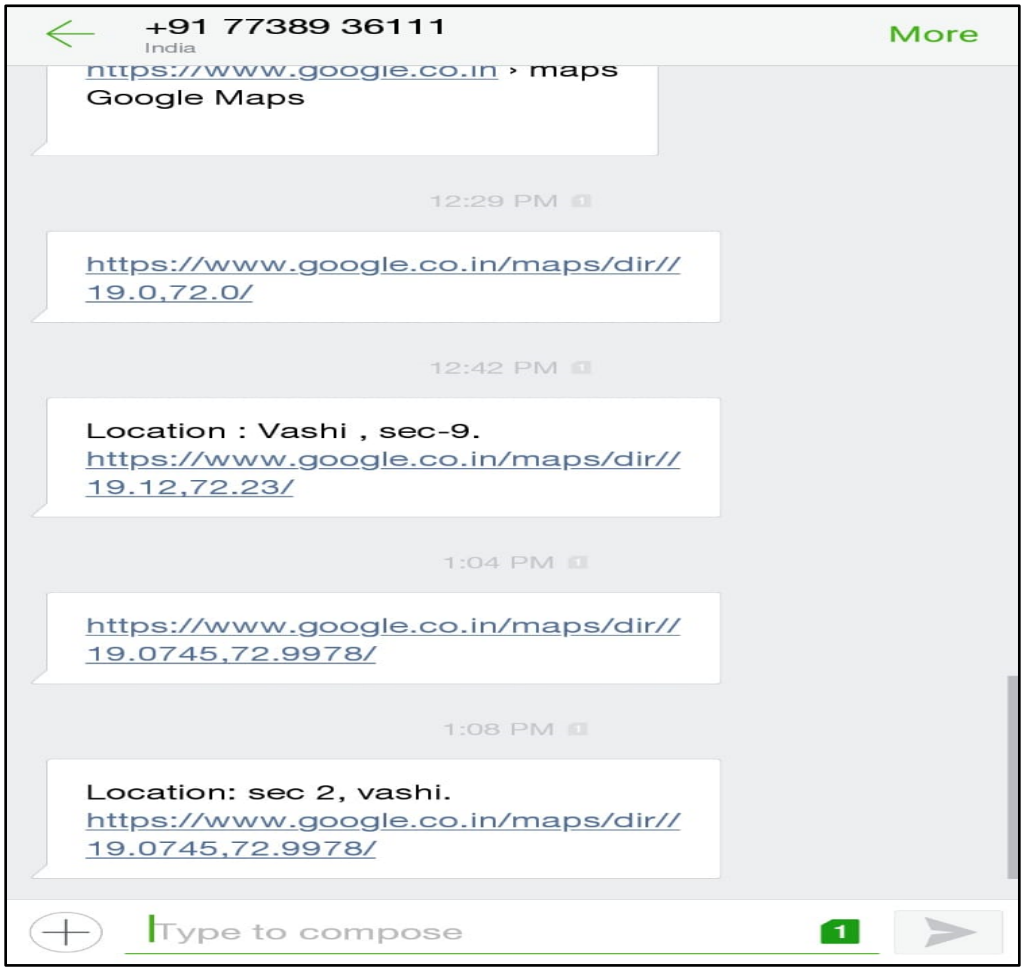

Fig 4.4 Message received on the mobile phone

The sensors and the modules need to be protected from the damage due to the rains, and from erroneous triggers or false information. The ultrasonic sensor could be covered on four sides to protect it. The GSM module can be protected using plastic covers.

The below figures 4.5 and 4.6 depicts the status of the bin whether it is full or not, initially if the bin is not filled up completely the status of the flag is 0 and when the bin gets filled completely it shows status as 1 also it shows the location and identity number assigned which helps in acting backup in absence of internet connection.

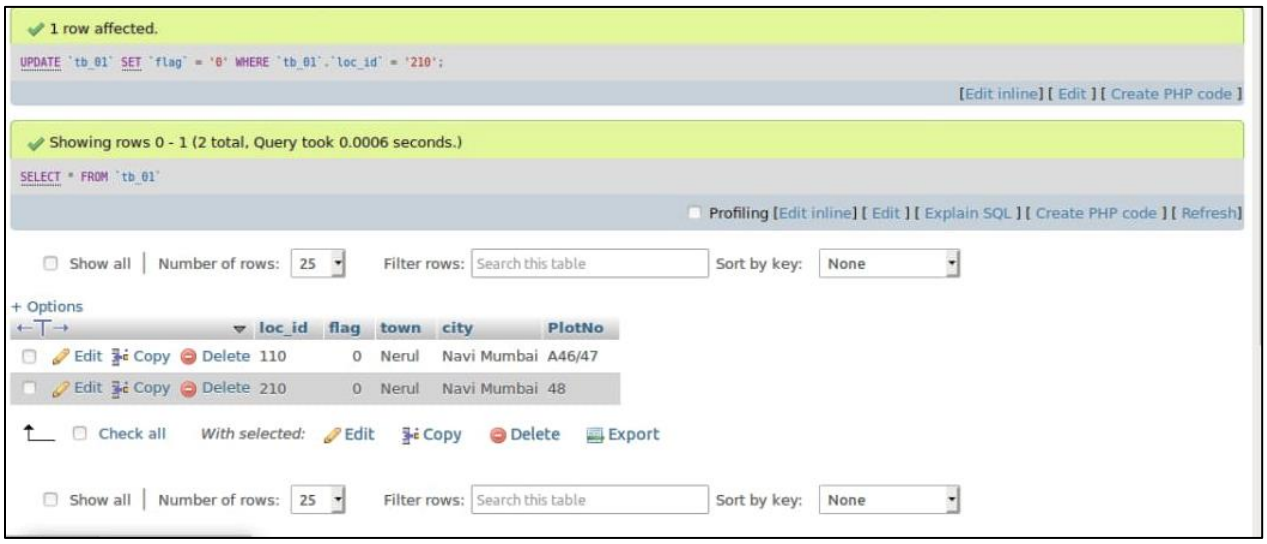

Fig 4.5 Database showing the status of the bin (empty)

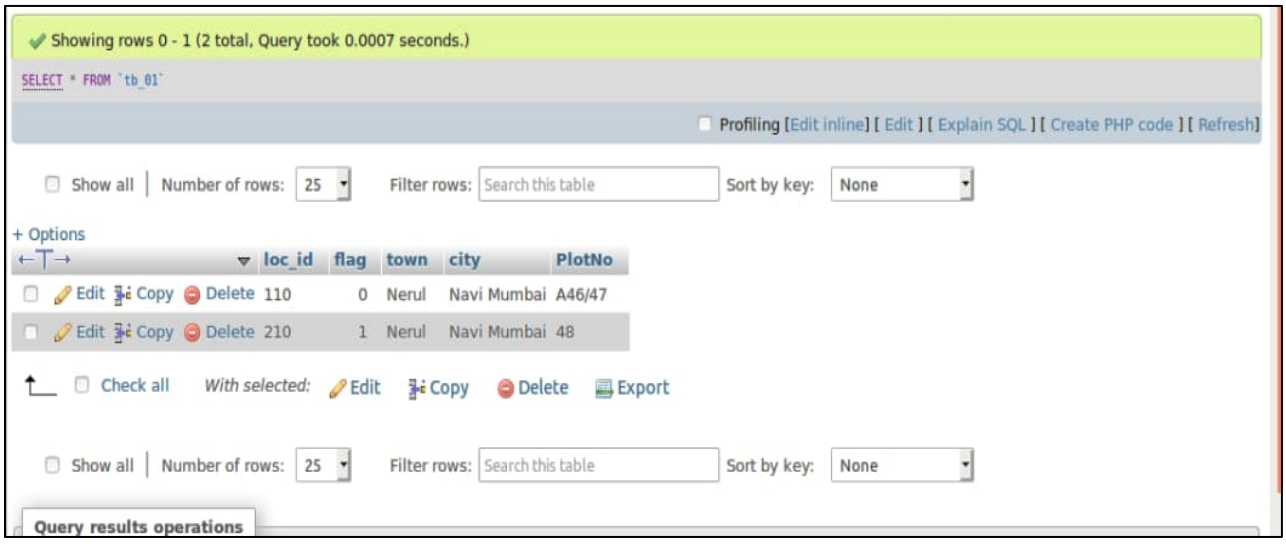

Fig 4.6 Database showing the status of the bin (full)

The webpage fig 4.4 shows the garbage bins that are full and need the waste to be collected. Once the waste is collected, the status of that bin will be updated and won't be displayed on the website. This will ensure that there is a central monitoring system to keep a tab on the states of the garbage bins. It can also act as a backup if GSM and GPS modules fail due to some reason.

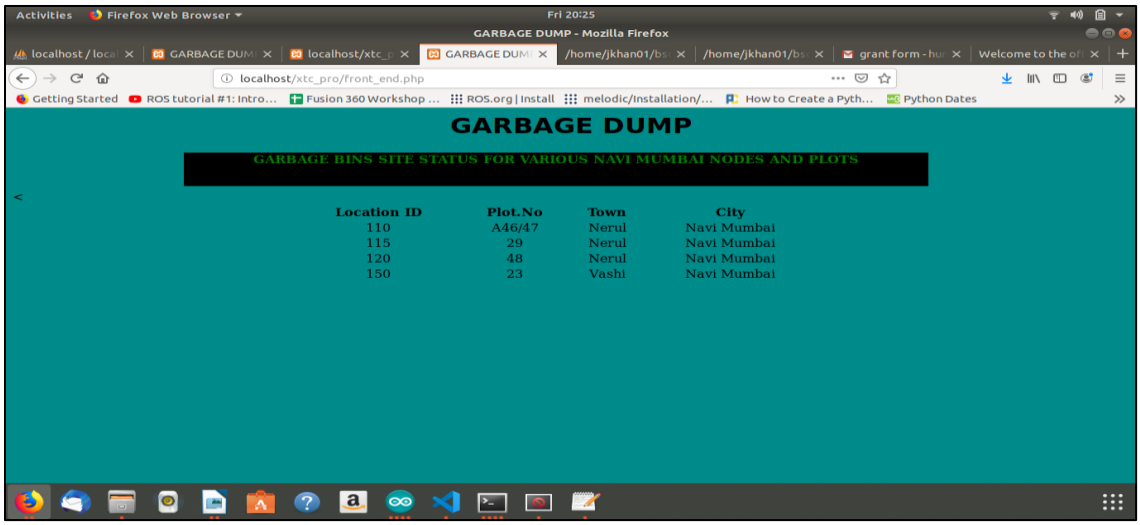

Fig 4.7 Webpage for Central Monitoring

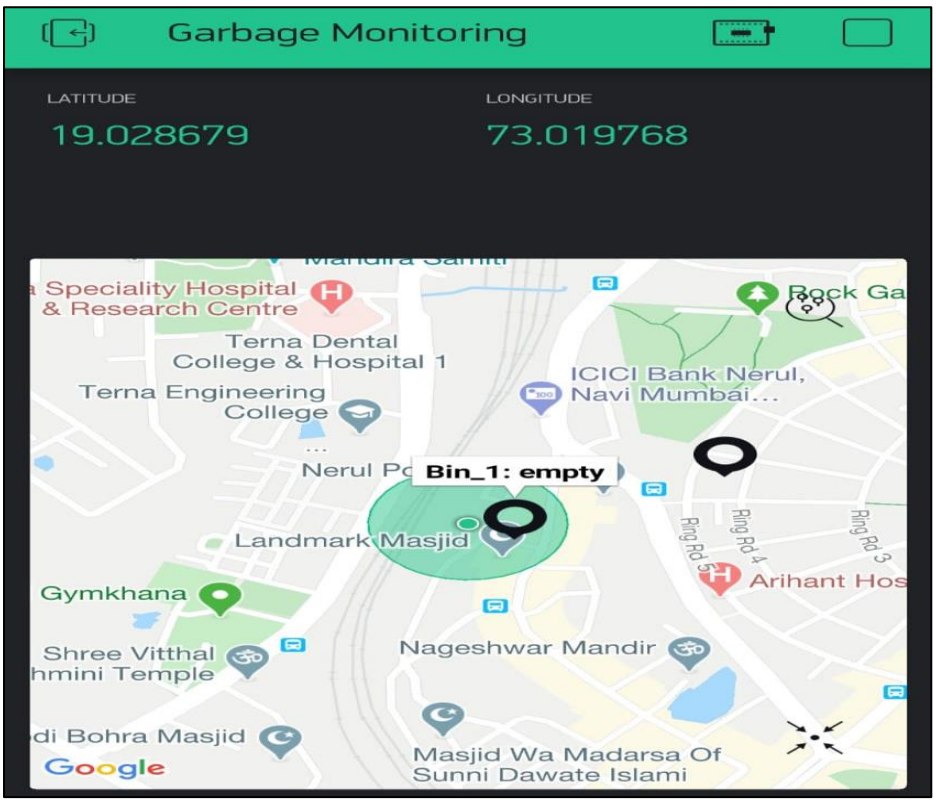

Fig 4.8 Application for monitoring garbage

The app created with the help of Blynk app can be used to find the location of the bins in the area and helps one to know the status of the bins i.e. if the bins are empty, 70% filled or 90%. This will ensure that citizens can find the bins in the area and not throw away the snack wrappers, waste papers etc. on the sides of the roads if they are in a new locality and don't know where to find the bins.

Chapter 5
Summary & Conclusion

5.1 Summary

The project is built to increase the efficiency of garbage collection and segregation and monitoring. The garbage level monitoring will help to reduce the fuel wastage and also, make sure that the waste is collected from all the places at the right time. The segregation system will help to classify the waste into wet and dry wastes - all of which undergo different treatment procedures for proper disposal.

5.2 Conclusion

The conclusion that can be drawn from the results are-

1. The system is made for monitoring the waste which is useful for saving the fuel of the trucks and also helps in efficient collection of the garbage.
2. The monitoring system sends a message regarding the status of the dustbin.
3. With the help of web page designed, the authorities will be able to do the central monitoring of the system.
4. An app is designed for finding the location of the bins and knowing their status.

5.3 Future Scope:

More functions and features can be added to the existing system. Some of them are as follows:

1. Adding more features to the website such as date and timing for when the bin was last emptied.
2. Waste can be segregated into biodegradable and non-biodegradable, or recyclable and non-recyclable, or metallic and non-metallic etc.

APPENDIX I

PROJECT COURSE LEARNING OUTCOMES

I.A Introduction

At the end of project stages, 1and 2 we will be able to:

• (CO-1): Apply the knowledge based on curricular and co-curricular activities to solve electronics and telecommunication based project work:

The knowledge acquired from subjects like microcontrollers, analog communications, mobile communication system, micro- processor, integrated circuits, etc. that are part of the curriculum and knowledge gained by studying about these subjects helped us to understand our project better.

• (CO-2): Systematically analyse electronics and telecommunication related project based on the literature review:

The papers were referred where various technologies used in the developed countries and various ideas related to the project were studied.

• (CO-3): Design and develop hardware circuit and/or software code based on the problem specifications about the project:

Our project is concerned with the need of implementing an efficient system for waste management. This involves learning about the different sensors, motors and microcontrollers etc.

• (CO-4): Carry out different experiments to generate data, analyse and interpret the data, and draw valid conclusions related on the project work:

In our project, the level of the waste in the dustbin was interpreted for proper monitoring. The waste was segregated using moisture sensor, and metallic sensor into different categories for efficient treatment

• (CO-5): Select and apply appropriate modern tools for the solution of their project problem:

We will create an app to find the path to the dustbin. We created webpage for central monitoring of the dustbins.

• **(CO-6): Know the responsibility of the engineer towards the society with respect to their project work.**

As Electronics and Telecommunication Engineers, it is our responsibility to analyse the current needs and problems faced by the society and if possible plan, design & develop effective solutions for the same. Therefore, we are making a low cost and efficient system for waste management.

• (CO-7): Understand the impact of engineering solutions related to their project work in societal context for sustainable development.

Engineers are increasingly required to play a leadership role in sustainable development, overcoming global challenges, such as depletion of resources, environmental pollution, rapid population growth and damage to ecosystems.

• (CO-8): Apply professional ethical principles while project implementation, report writing, and publication.

An engineer must be able to make decisions taking into concern the risk and safety of citizens, moral values and the general wellbeing of the society. We have therefore given proper references for the materials we have referred.

• (CO-9): Work effectively as an individual and as a member of the team while the project work is carried out:

While we learnt Python programming and started to work with the project, we realized the importance of teamwork and perseverance needed for the successful completion of the project in context of helping each other.

• (CO-10): Communicate effectively while project report writing and oral/visual presentations.

Communication is an excellent skill that helps us to express and understand ideas and interests, and the presentations have helped us achieve this skill.

• (CO-11): Gain knowledge of engineering and management aspects while the project is being implemented.

The knowledge of various engineering and management aspects such as performance, feasibility, accuracy, cost effectiveness, etc. was gained while doing this project.

• **(CO-12): Engage themselves in independent and lifelong learning**.

Technology never remains stagnant. It keeps evolving over the years, and as engineers, we realize that we have to keep ourselves updated throughout in order to improve our technical knowledge

I.B Mapping Course Outcomes with Program Outcomes

Table shows mapping of course outcomes with program outcomes.

(Note: 1: Slightly 2: Moderately 3: Substantially If there is no correlation the cell to be left blank or put -)

Course Outcome	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	2	-	-	-	-	-	-	-	-	-	-
CO 3	-	-	3	-	-	-	-	-	-	-	-	-
CO 4	-	-	-	3	-	-	-	-	-	-	-	-
CO 5	-	-	-	-	2	-	-	-	-	-	-	-
CO 6	-	-	-	-	-	3	-	-	-	-	-	-
CO 7	-	-	-	-	-	-	3	-	-	-	-	-
CO 8	-	-	-	-	-	-	-	3	-	-	-	-
CO 9	-	-	-	-	-	-	-	-	3	-	-	-
CO 10	-	-	-	-	-	-	-	-	-	3	-	-
CO 11	-	-	-	-	-	-	-	-	-	-	2	-
CO 12	-	-	-	-	-	-	-	-	-	-	-	3

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Smart Garbage Monitoring System

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***Abstract*- Efficient waste collection is the need of the hour as increase in population has led to an increase in the amount of waste generated every year. Through waste collection the workers are prone to various diseases and infections. Proper segregation and management of the waste is important to curb the spreading of diseases. In metropolitan cities, like Mumbai, large amount of waste is neither collected efficiently nor properly segregated. Therefore, a smart monitoring system would help in increasing the efficiency and contributing to some extend in Swachh Survekshan as well. Garbage monitoring helps in detecting the state of the garbage bins and send trucks to only those areas where the bins are full, ensuring that the truck's fuel is not wasted and the garbage is collected on time. The location of the bin that is fully loaded is taken using Global Positioning System (GPS) modem.**

Keywords – Arduino UNO; NodeMCU; GPS modem; GSM module

I. INTRODUCTION

Waste management are the activities and actions required to manage waste from the time it is created to its final disposal. It is collection, transportation, treatment and disposal of waste, together with monitoring of the process. Waste can be of any form (solid, liquid or gaseous) and each has a different treatment procedure. Domestic waste disposal is an issue that is important to the management of any urban area. Cities without a functioning waste-disposal plan face risks of disease running rampant and economic activity grinding to a halt.

Globally, millions of tons of municipal solid waste are generated every day. Urban waste management is drawing increasing attention, as it can easily be observed that too much garbage is lying uncollected in the streets, causing inconvenience, environmental pollution, and posing a public health risk. The poor waste management situation in recent years has led to a high incidence of sanitation related illness, such as cholera, intestinal worms and typhoid. These are among the top ten diseases that have been recorded, which raises the alarm of a public health crisis.

Thus, developing an efficient system for waste monitoring has become a necessity.

II. MOTIVATION

The health of all organisms depends on their surrounding or their environment. Therefore, public cleanliness is important for individual health, which makes collecting and clearing the garbage regularly an important factor. Developed countries make more waste than the developing countries but they have efficient methods for treatment and disposal. A garbage monitoring system is the need of the hour for an improved waste management and a healthy environment. A system that monitors the garbage/garbage bins in all localities and clears it once the bin is filled will save the time and fuel of the traditional garbage collecting trucks.

III. LITERATURE REVIEW

A study of different garbage monitoring systems over the years was done.

A. Garbage monitoring using microcontroller AT89S52

In [3], AT89S52 Microcontroller is used to interface sensor system with Global System for Mobile Communication (GSM) system, it has 128 bytes of RAM, 4K bytes of on chip ROM, two timers, one serial port and four ports - all on a single port. Sensors are used to monitor level of dustbin. Fig. 1 shows the flow of the system. After acquiring desire information, output is given to microcontroller to send message via GSM module.

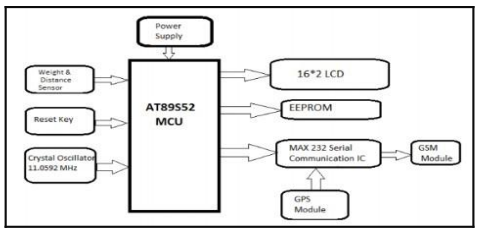

Fig.1 Flow of the System [1]

B. Garbage monitoring using Arduino

In [4], Ultrasonic sensor is placed on top of the bin and triggered by Arduino Mega 2560. Fig 2 shows that after reaching threshold value, the sensor sends the signal to Arduino mega, which in turn activates GSM Module & Global Positioning System (GPS) Modem.

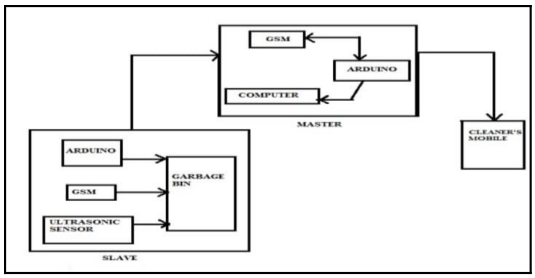

Fig. 2 Block diagram of smart garbage system [2]

C. Statistical Data

According to [2], India generates 62 million tons of waste every year, of which less than 60% is collected and around 15% processed. With megacities spurting a growth of 30.47% (Census 2011), India's basic necessities have sometimes been ignored. Also, there has been an increase in the focus towards services such as water, electricity and food for the growing population, the Indian administration has unfortunately ignored another major public service: waste management.

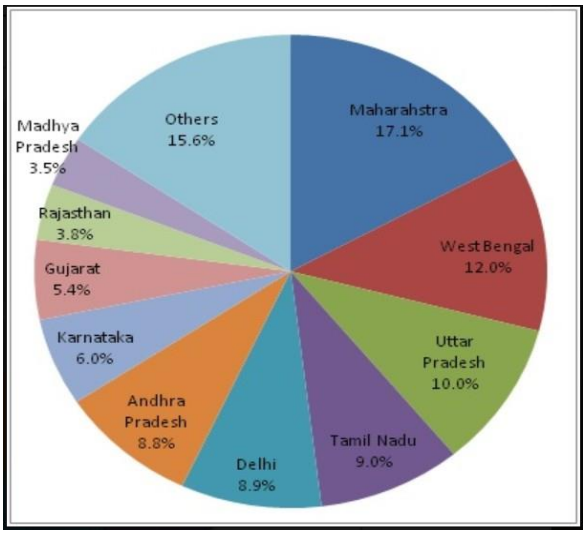

Fig.3 Share of states and UT in Urban MSW generated [1]

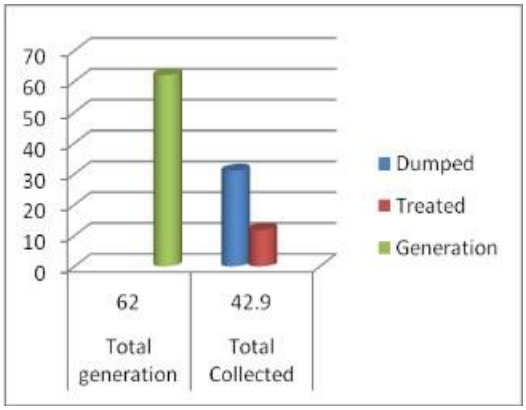

Fig. 4 Collection vs Dumped Statistics (numbers in million MT per annum) [2]

IV. SYSTEM DESCRIPTION

The flow of the system and block diagram is as shown and explained below.

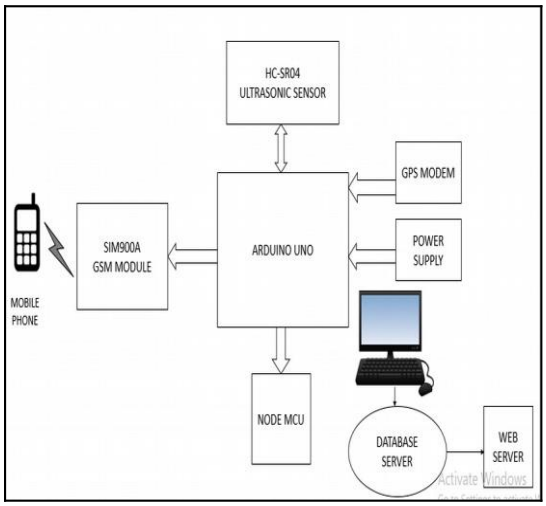

Fig 5. Block diagram of the system

Ultrasonic sensor, placed at the top of the bin, is used to determine the level of garbage in the dustbins. Once filled up to the threshold level, it sends a message to the driver via GSM module stating the same, plus uses GPS modem to send the location. The data is sent to the webpage via database server for central monitoring of the dustbins.

The heart of the system is Arduino UNO which controls the other components of the system. Ultrasonic sensing is one of the best ways to sense proximity and detect levels with high reliability. It measures the distance using

ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High frequency sound waves reflect from boundaries to produce distinct echo patterns. The time required for the waves to reflect back is utilized to calculate the distance. If this distance becomes lesser than the given threshold (10 cm), a message is sent to the driver stating that the dustbin of that particular location is about to be full. The same message is passed onto the webpage for the central monitoring of the dustbins.

V. RESULTS

The results of the ultrasonic sensor, GPS modem and GSM module under different test conditions were studied. The experimental tests involve testing of sensor and output analysis of various stages.

The ultrasonic sensor was tested to find out if it was giving the right measurements. The height of the dustbin used was 30 cm. Following are the test results:

Table 1

Results of the distance of ultrasonic sensor

Level of the garbage (in cm)	Distance from the sensor (in cm)	Distance measured by the sensor (in cm)
0	30	30
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The distances calculated using ultrasonic sensor were same as the actual levels of the garbage. Thus, ultrasonic sensor gave the proper results.

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The GPS modem was used to send the location of the garbage bin. Whether the location sent by the GPS modem was correct or not was verified using the Google Maps app. The GPS modem gave the proper results but it does not work properly during the rains or at certain locations where the network is not easily available.

The webpage shows the garbage bins that are full and needs the waste to be collected. Once the waste is collected, the status of that bin will be updated and won't be displayed on the website. This will ensure that there is a central monitoring system to keep a tab on the states of the garbage bins.

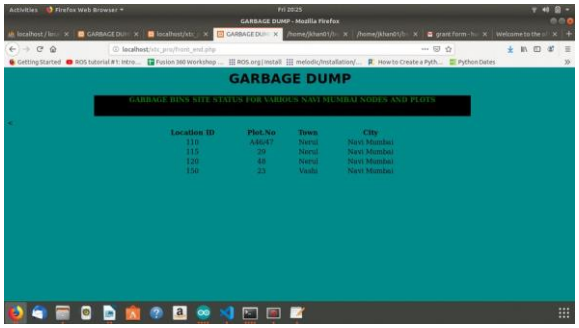

Fig 6. Website for Central Monitoring

VI. CONCLUSION

The system is made for monitoring the waste which is useful for saving the fuel of the trucks and also helps in efficient collection of the garbage. The monitoring system sends a message regarding the status of the dustbin via the GSM module.

The bins that are full will be printed onto the website to enable central monitoring and to increase the efficiency of the system.

ACKNOWLEDGMENT

This project became a reality with the kind support and help of many individuals. We would like to extend our sincere thanks to all of them.

Foremost, we are highly indebted to our supervisor, Ms. Amruta Pabarekar and Ms. Sadhana Pai, for their guidance and constant supervision. We would thank them for imparting their knowledge and expertise in this study and support in completing this endeavor. We would like to extend our gratitude to Dr. Milind S. Shah (Head of Department, Dept. of Electronics and Telecommunication) and Dr. S.M. Khot (Principal) for giving us the opportunity to work at Fr. C.R.I.T, Vashi on this project and for their support. We would like to thank everyone in the Department of Electronics and Telecommunication as well.

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Humera Khan

Paper Title: Smart Garbage Monitoring System

Prof. Gautam Majumdar
(HOD, Mechanical Engineering Department)
(Jadavpur University)

Prof. Himadri Chattopadhyay
(Conference Secretary)

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