SMART GARBAGE DISPOSAL SYSTEM

A Project Report
Submitted in partial fulfilment of the Requirements for the
award of the Degree of
BACHELOR OF SCIENCE (INFORMATION TECHNOLOGY)
By

Aditi Bhosale

&

Nihal Padwal

Under the esteemed guidance of

Asst. Prof. Ansa Jovel

DEPARTMENT OF INFORMATION TECHNOLOGY

KERALEEYA SAMAJAM (REGD.) DOMBIVLI'S

MODEL COLLEGE (AUTONOMOUS)

(Affiliated to University of Mumbai)

DOMBIVLI, 421201 MAHARASHTRA April 2021

INDEX

TABLE OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND STUDY:

The garbage collection system includes the traditional manual collection of garbage which has many drawbacks. Due to manually doing this work it becomes difficult to maintain and follow a proper system for collecting garbage.

The sight of an overflowing garbage bin at the street corners has become rather common nowadays, with the garbage clearance system losing its efficiency. Most of the garbage bins become full, sometimes even overflow with garbage since there is no proper and timely collection of garbage. In this modern world of technology, rather than using the traditional approach of garbage collection we can use technology for our benefit and create a cleaner and smarter environment.

Table 1.1 The previous year papers on Smart Bins

Sr.No	**Title**	**Date & Publisher**	**Sensors and Microcontroller**	**Advantages**	**Disadvantages**
1	A New Model for Smart Garbage Monitoring	2017 (IJSRCSEIT) Data Transfer Nodes (DTN)	GSM Arduino UNO	1.The system will send messages about the garbage level at real time to the authorities	1.The system is very simple since it will only send the garbage level

2	Smart garbage monitoring system using sensors with RFID over internet of things	2017 Journal of Advanced Research in Dynamical and Control Systems	IR Sensor, Photoelectric Sensor, Radio Sensor, RFID, Weight Sensor	1.Because of the RFID scanner the person will know what waste he has thrown and as well as will receive a message	1.To use this system the user needs to to have an RFID card 2.It will not work if many people want to use bin at the same time.

3	Waste Management System Based On IoT	Mar-2018 International Research Journal of Engineering and Technology (IRJET)	Arduino UNO, Ultrasonic Sensor, GPS,GSM.	1.It will sense the garbage level 2.it will send an alert message	1.The following system is already in existence.
4	SPAMAST Smart Garbage Bin Monitoring System Using Wireless Sensor Network	06 August 2019 Journal of Engineering Research and Reports (JERR)	Arduino UNO, GSM Module, Laser sensors, nRF24L01, Ultrasonic sensor, Servomotor.	1.It will monitor the level of garbage 2.It will automatically open when the sensors detect the hand	

5	Smart City Waste Management System Using GSM	May – Jun 2017 International Journal of Computer Science Trends and Technology (IJCST)	GSM Module, Ultrasonic Sensor	1.The system will send an alert message to the authorities as soon as the bins will be 90% full	1.the alert message will be sent only when the bins are 90% full so this system is only useful only at places where the bins fill up quickly.
6	IoT: smart garbage monitoring using android and real time database	June 2019,	ultrasonic sensor, GPS module, GSM/GSM Modul SIM808 Arduino UNO microcontroller	1,Less garbage 2.Healthy Environment 3.Everything is obtained through a Smartphone	1.If it rains then the sensors might be damaged 2.Someone can steal the sensors and modules

7	Waste Management System Based On IoT	Mar-2018	ultrasonic sensor, GPS, GSM module ,Arduino UNO microcontroller, Buzzer alarm, Led	1.Alert using alarm Show garbage level using LEDS 2.Includes Email functionality	1.If it rains then the sensors might be damaged 2.Someone can steal the sensors and modules 3.LEDs might not work aftersome time.
8	Smart Garbage Monitoring Using IoT	28 Aug 2018	Arduino Uno, ESP8266 Wi-Fi Module, Ultrasonic	1.Dust bin can be Easily Monitored through	1.Servers might get crashed 2.Someone can steal the sensors and

			Sensors, Servo Motor, RC-A-524 Metal Detector Sensor Module, IR Motion Sensor, OV7670 image sensor	Webpages. 2.The system can be used to minimize the Cost and Time. Day to Day monitoring and cleaning can be o keep the pollution minimal	modules 3.Sensor nodes used in the dustbins have limited memory size
9	IOT Based Smart Garbage alert system using Arduino UNO	09 February 2017	Arduino UNO R3, Ultrasonic Sensor, ESP8266 Wi-Fi	1.Reduce human monitoring process 2.System Database can be accessed at any time from anywhere	1.Someone can steal the sensors and modules 2.If it rains then the sensors might be damaged
10	Efficient IOT Based Smart Bin for Clean Environment	April 5, 2018	HTML and embedded C language, Infrared Sensor, Rain sensor Arduino IDE,	1.System is used to indicate the level of wastages filled. 2.Entering of Rain water in to the bin is prevented.	1.Wireless technologies used in the system such as zigbee and wifi have shorter range and lower data speed 2. In RFID based systems, RFID tags are affected by surrounding metal objects (if any)

Table 1.2 Functions of existing and proposed system

	EXISTING SYSTEM	PROPOSED SYSTEM
MICROCONTROLLER	Arduino uno	Arduino uno
SENSORS	Ultrasonic sensors, metal detector sensor, RFID, Rain sensor, Photoelectric sensor, Weight sensor	Ultrasonic Sensor

FUNCTION	1.Will sense the weight of garbage bin 2.Will notify the garbage level of the bin to the authority 3.sense whether it is raining or not 4.Will send the information regarding the garbage level of the bin in real time. 5.Will alert the authority when the bins will be full.	1.Will sense the garbage level in real time. 2.It will send an alert message to the authority that the garbage bin is full. 3.It will send the location of the bin that is full and needs to be cleaned. 4.The bin will display in how much time the authority will come and clean the bins. 5. If bins are cleaned before the timer runs out ten the LCD on the bins will display "bins are cleaned" 6. Else the bins will send a complaint to the higher authority that the bins have not yet been cleaned.

ADDITIONAL FUNCTIONS		The proposed system will display in how much time the bins will be cleaned. So, people who want to throw the garbage can discard the garbage in the bins before the bins are cleaned. It System will also send complaint message to Higher authority if bins not cleaned.

1.2 OBJECTIVE:

The main objective of this project is to create and follow a more systematic procedure for the collection of garbage by incorporating technology into it and thereby getting one step closer to our dream of creating our city a **Smart city** .

In this project we will design and build smart garbage bins that will be capable of sending alert messages in the form of GPS address to the garbage collection team, so that they can clean the bins when full. When the garbage will reach the maximum level, a message will be sent to the cleaning team, on receiving the alert message they will reply within how much time the garbage will be collected. This project will provide a smart solution for waste management system resulting in healthy and clean environment.

1.3 PURPOSE:

This project will stop the problem of overflowing dustbins along roadsides and localities as these smart bins are managed at real time therefore creating empty and clean dustbins available to common people.

This project will be useful for both the locals as well as to the garbage collection team since the team would know at which location the dustbins are full therefore saving their time and it

will benefit people since the bins will be cleaned within a time-frame when bins will be full providing cleaner and healthier environment.

1.4 SCOPE:

This project will be used to create smart waste management system which will be compatible mainly with concept of smart cities. One of the big challenges in urban cities is solid waste management not only in India but in most of the cities around the world.

Therefore this project is very useful in such urban cities since these cities have high population the garbage bins are mostly filled and there is no proper system used to clean the bins .The above idea can be implemented for smart cities where the residents would be busy enough with their hectic schedule and wouldn't have enough time for managing waste.

Everyone wants to live in a clean and healthy place but overflowing waste bins are an ideal breeding ground for bacteria and insects therefore creating unhealthy living environment. The smart bins will provide real time data to the garbage collection team by sending the location of the bin when they are full and need to be cleaned. It will help overcome the problem of garbage overflowing therefore providing an healthy living atmosphere.

1.5 APPLICABILITY

The Smart garbage bins will help us create a better and cleaner environment. Today main issue for pollution is Garbage Overflow. Public waste bins are filling up faster than ever and inevitably many of the bins end up overflowing before collected, causing not only cluttered streets and bad odours but also negative health and environmental impacts. Using this project we can stop the problem of overflowing dustbins since the bins will be cleaned as soon as they are full therefore providing us with healthy and clean surroundings.

This project gives us one of the most efficient ways to keep our environment green and clean. With the help of Internet-Of- Things (IOT) it is possible to achieve a more efficient system than the one currently existing.

CHAPTER 2:SURVEY OF TECHNOLOGIES

In recent decades, urbanization has increased tremendously and so has the waste production. Waste management has been a crucial issue to be considered.

India is turning into a big garbage dump. When it comes to waste management in India, nothing is quite right. If we don't take this seriously then India will never get itself out of dump. There is literally no space remaining to accommodate fresh garbage waste

Garbage if not managed properly can result in various types of health issues, bad odour, and overall bad reputation of the area in which Garbage is not cleaned. Around 10 million tons of garbage is generated in just cities alone like Delhi, Mumbai, Chennai, Hyderabad, Bangalore and Kolkata.

In this project we will use an Ultrasonic sensor which will be placed under the dustbin lid which will detect the garbage level. When the dustbin will be almost full the sensors will detect it and send a message about the location of the bin informing the authorities that dustbins are full and need to be cleaned. **Disadvantages:**

- **Health issues**

Improper management of garbage can affect the health of people living nearby the polluted area or landfill causing skin irritations, blood infections, respiratory problems, growth problems, and even reproductive issues.

- **Contamination:**

Soil contamination: Soil contamination is the No. 1 problem caused by improper waste removal and disposal. Some wastes that end up in landfills excrete hazardous chemicals that leak into the soil.

Air contamination: Some papers and plastics are burned in landfills, emitting gas and chemicals that hurt the ozone layer. Waste that releases dioxins are also dangerous and pose a health risk when they diffuse into the air that we breathe. Add to that the methane gases that

decomposing wastes release. Landfill gas produced by the decomposing wastes, can be explosive and can harm nearby communities

Water contamination: Hazardous wastes in the environment leech into the ground, and ultimately, into ground water. This water is used for many things, from watering the local fields to drinking. Toxic liquid chemicals from waste can also seep into water streams and bodies of water.

- ## Bad Reputation:

No one wants to live in an area where garbage is overflowing has a bad odour. A smelly city with poor sanitation and trash all over the place does not attract people or tourists, let alone investments.

CHAPTER 3: REQUIREMENT ANALYSIS

3.1 PROBLEM DEFINITION:

In India there is no proper system to manage the Waste. There are various problems people have to face such as Bad odour, Health problems etc when the garbage is not managed properly.

To eliminate this problem government has installed dustbins in every area and appointed respective authorities but this solution is flawed as those people don't follow a proper system and the garbage keeps piling up.

India is turning into one big garbage dump. The problem is assuming gigantic proportions and the numbers are staggering. Urban India is the world's 3rd largest garbage generator and by 2050 waste is expected to rise to 436 million tons.

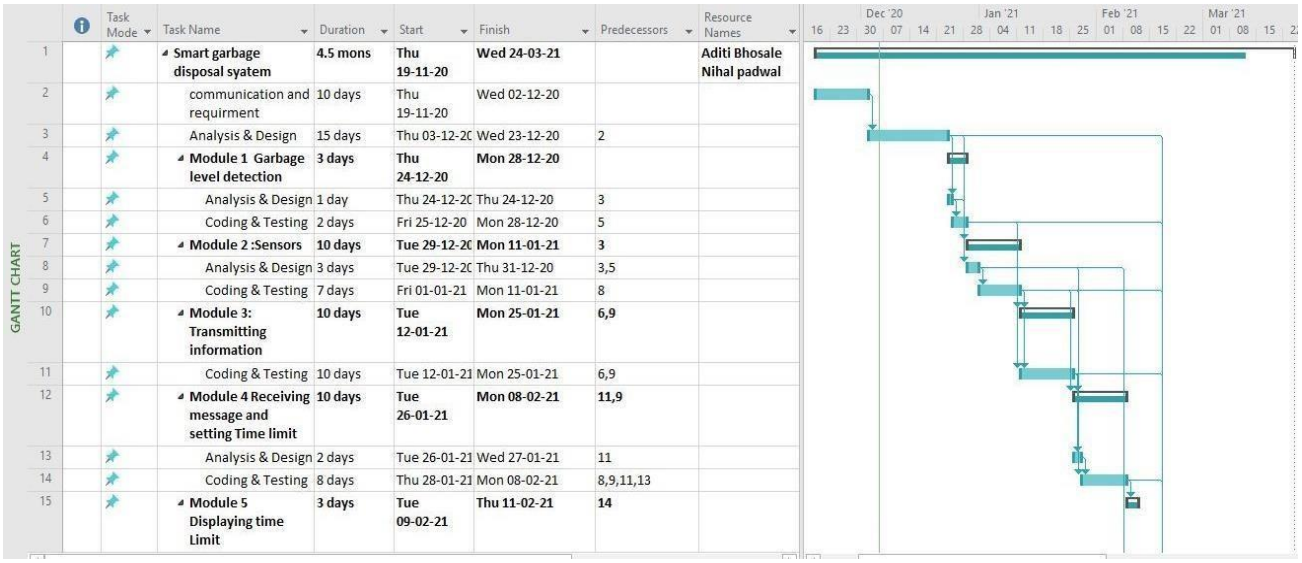
The increase in waste generation as a by-product of economic development has led to various subordinate legislations for regulating the manner of disposal and dealing with generated waste are made under the umbrella law of Environment Protection Act, 1986 (EPA**)** .

According to a study done by scientists at the School of Environmental Sciences in Jawaharlal Nehru University, high levels of nickel, zinc, arsenic, lead, chromium and other metals are part of the solid waste at landfills in many metro cities. Nearly 20% of methane gas emissions in India is caused by landfills. The trash dumped in the landfills are prone to catching fire due to the heat generated by the decomposition of waste.

3.2 REQUIREMENT SPECIFICATION:

The system includes bins that have sensors which detect the garbage level. The system will sense the garbage level in Real Time. Once the garbage will reach to its maximum limit (For our system we have taken the threshold as 90%) the bins will send messages in form of location to the garbage collection team. The team will then reply with the time required to come and clean the bin, which will be displayed using the LCD display fitted on the bin. Once the bins will be cleaned the LCD will display "bins are cleaned". And if the bins are not cleaned before the timer exceeds a compliant would be send to the higher authority.

3.3 PLANNING AND SCHEDULING:

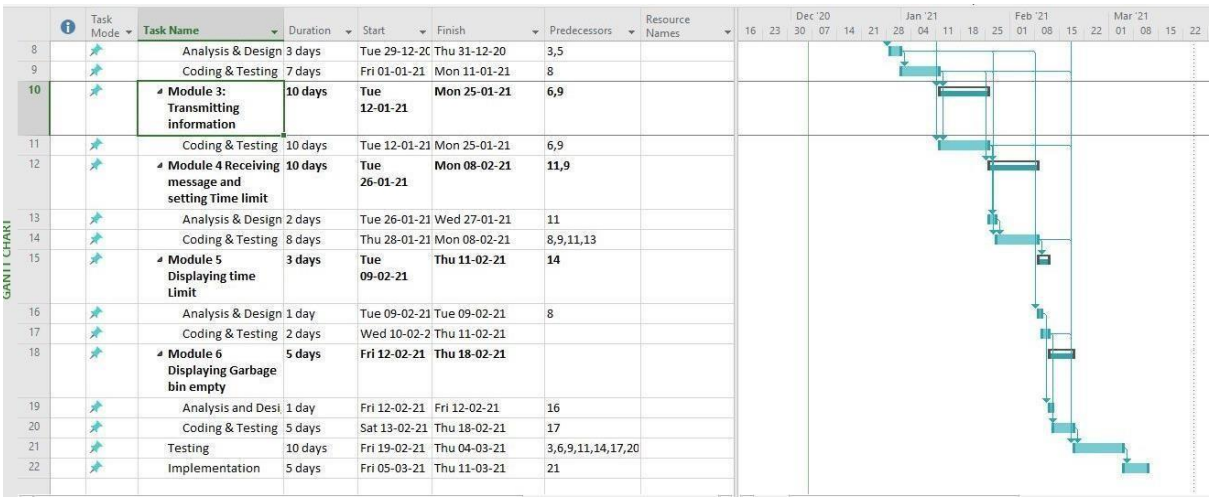


	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		**Smart garbage disposal syatem**	**4.5 mons**	**Thu 19-11-20**	**Wed 24-03-21**		**Aditi Bhosale Nihal padwal**
2		communication and requirment	10 days	Thu 19-11-20	Wed 02-12-20		
3		Analysis & Design	15 days	Thu 03-12-20	Wed 23-12-20	2	
4		**Module 1 Garbage level detection**	**3 days**	**Thu 24-12-20**	**Mon 28-12-20**		
5		Analysis & Design	1 day	Thu 24-12-20	Thu 24-12-20	3	
6		Coding & Testing	2 days	Fri 25-12-20	Mon 28-12-20	5	
7		**Module 2 :Sensors**	**10 days**	**Tue 29-12-20**	**Mon 11-01-21**	**3**	
8		Analysis & Design	3 days	Tue 29-12-20	Thu 31-12-20	3,5	
9		Coding & Testing	7 days	Fri 01-01-21	Mon 11-01-21	8	
10		**Module 3: Transmitting information**	**10 days**	**Tue 12-01-21**	**Mon 25-01-21**	**6,9**	
11		Coding & Testing	10 days	Tue 12-01-21	Mon 25-01-21	6,9	
12		**Module 4 Receiving message and setting Time limit**	**10 days**	**Tue 26-01-21**	**Mon 08-02-21**	**11,9**	
13		Analysis & Design	2 days	Tue 26-01-21	Wed 27-01-21	11	
14		Coding & Testing	8 days	Thu 28-01-21	Mon 08-02-21	8,9,11,13	
15		**Module 5 Displaying time Limit**	**3 days**	**Tue 09-02-21**	**Thu 11-02-21**	**14**	

GANTT CHART

Dec '20 | Jan '21 | Feb '21 | Mar '21

Fig.3.1 Gantt chart 1

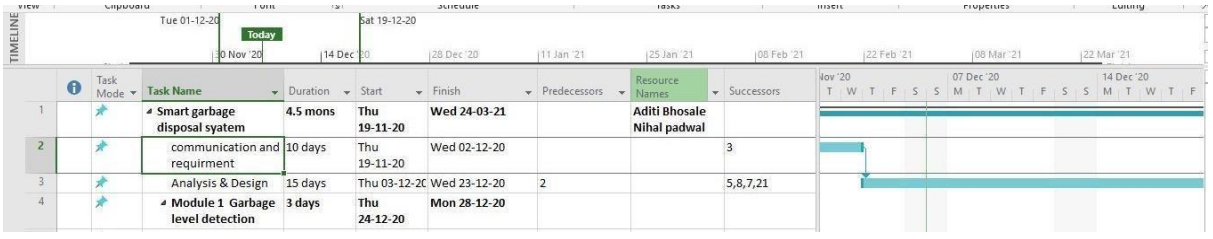


	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
8		Analysis & Design	3 days	Tue 29-12-20	Thu 31-12-20	3,5	
9		Coding & Testing	7 days	Fri 01-01-21	Mon 11-01-21	8	
10		**Module 3: Transmitting information**	**10 days**	**Tue 12-01-21**	**Mon 25-01-21**	**6,9**	
11		Coding & Testing	10 days	Tue 12-01-21	Mon 25-01-21	6,9	
12		**Module 4 Receiving message and setting Time limit**	**10 days**	**Tue 26-01-21**	**Mon 08-02-21**	**11,9**	
13		Analysis & Design	2 days	Tue 26-01-21	Wed 27-01-21	11	
14		Coding & Testing	8 days	Thu 28-01-21	Mon 08-02-21	8,9,11,13	
15		**Module 5 Displaying time Limit**	**3 days**	**Tue 09-02-21**	**Thu 11-02-21**	**14**	
16		Analysis & Design	1 day	Tue 09-02-21	Tue 09-02-21	8	
17		Coding & Testing	2 days	Wed 10-02-21	Thu 11-02-21		
18		**Module 6 Displaying Garbage bin empty**	**5 days**	**Fri 12-02-21**	**Thu 18-02-21**		
19		Analysis and Desi	1 day	Fri 12-02-21	Fri 12-02-21	16	
20		Coding & Testing	5 days	Sat 13-02-21	Thu 18-02-21	17	
21		Testing	10 days	Fri 19-02-21	Thu 04-03-21	3,6,9,11,14,17,20	
22		Implementation	5 days	Fri 05-03-21	Thu 11-03-21	21	

GANTT CHART

Dec '20 | Jan '21 | Feb '21 | Mar '21

Fig 3.2 Gantt chart 2



TIMELINE

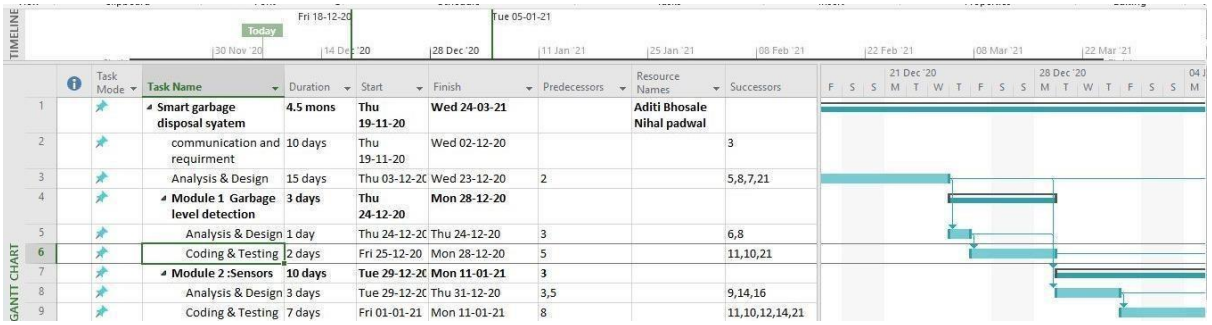
Tue 01-12-20 | Today | Sat 19-12-20

30 Nov '20 | 14 Dec '20 | 28 Dec '20 | 11 Jan '21 | 25 Jan '21 | 08 Feb '21 | 22 Feb '21 | 08 Mar '21 | 22 Mar '21

	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	Successors
1		**Smart garbage disposal syatem**	**4.5 mons**	**Thu 19-11-20**	**Wed 24-03-21**		**Aditi Bhosale Nihal padwal**	
2		communication and requirment	10 days	Thu 19-11-20	Wed 02-12-20			3
3		Analysis & Design	15 days	Thu 03-12-20	Wed 23-12-20	2		5,8,7,21
4		**Module 1 Garbage level detection**	**3 days**	**Thu 24-12-20**	**Mon 28-12-20**			

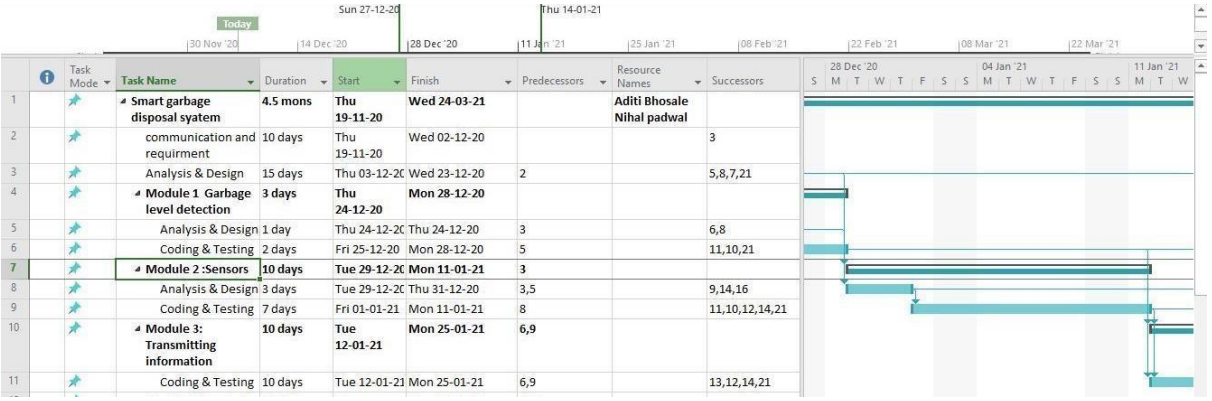
Nov '20 | 07 Dec '20 | 14 Dec '20

Fig 3.3 Gantt chart of requirement and analysis



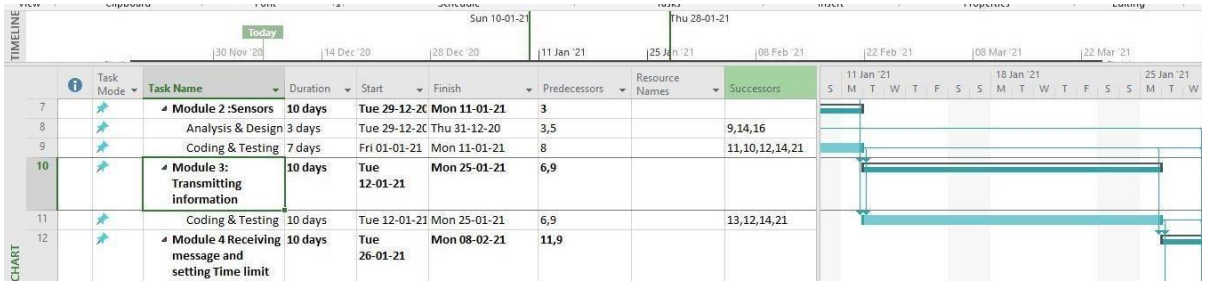
	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	Successors
1		**Smart garbage disposal syatem**	**4.5 mons**	**Thu 19-11-20**	**Wed 24-03-21**		**Aditi Bhosale Nihal padwal**	
2		communication and requirment	10 days	Thu 19-11-20	Wed 02-12-20			3
3		Analysis & Design	15 days	Thu 03-12-20	Wed 23-12-20	2		5,8,7,21
4		**Module 1 Garbage level detection**	**3 days**	**Thu 24-12-20**	**Mon 28-12-20**			
5		Analysis & Design	1 day	Thu 24-12-20	Thu 24-12-20	3		6,8
6		Coding & Testing	2 days	Fri 25-12-20	Mon 28-12-20	5		11,10,21
7		**Module 2 :Sensors**	**10 days**	**Tue 29-12-20**	**Mon 11-01-21**	**3**		
8		Analysis & Design	3 days	Tue 29-12-20	Thu 31-12-20	3,5		9,14,16
9		Coding & Testing	7 days	Fri 01-01-21	Mon 11-01-21	8		11,10,12,14,21

Fig 3.4 Gantt chart of Module 1



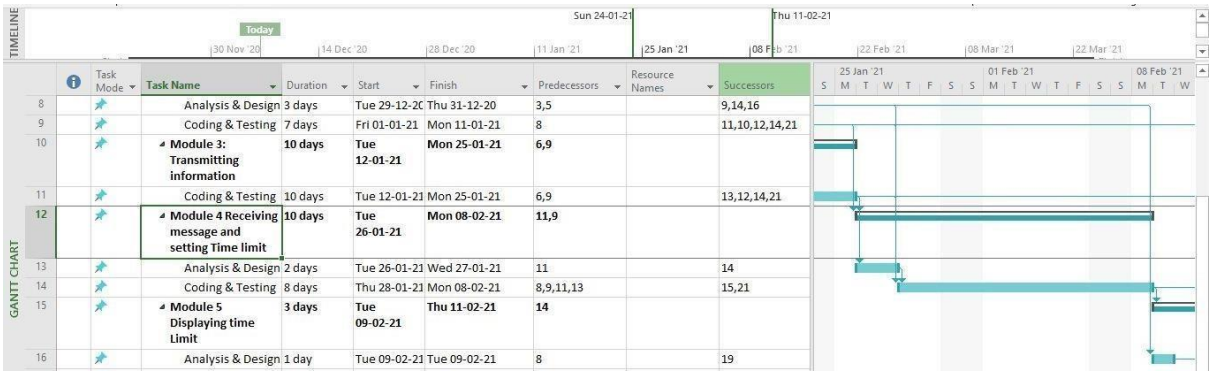
	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	Successors
1		**Smart garbage disposal syatem**	**4.5 mons**	**Thu 19-11-20**	**Wed 24-03-21**		**Aditi Bhosale Nihal padwal**	
2		communication and requirment	10 days	Thu 19-11-20	Wed 02-12-20			3
3		Analysis & Design	15 days	Thu 03-12-20	Wed 23-12-20	2		5,8,7,21
4		**Module 1 Garbage level detection**	**3 days**	**Thu 24-12-20**	**Mon 28-12-20**			
5		Analysis & Design	1 day	Thu 24-12-20	Thu 24-12-20	3		6,8
6		Coding & Testing	2 days	Fri 25-12-20	Mon 28-12-20	5		11,10,21
7		**Module 2 :Sensors**	**10 days**	**Tue 29-12-20**	**Mon 11-01-21**	**3**		
8		Analysis & Design	3 days	Tue 29-12-20	Thu 31-12-20	3,5		9,14,16
9		Coding & Testing	7 days	Fri 01-01-21	Mon 11-01-21	8		11,10,12,14,21
10		**Module 3: Transmitting information**	**10 days**	**Tue 12-01-21**	**Mon 25-01-21**	**6,9**		
11		Coding & Testing	10 days	Tue 12-01-21	Mon 25-01-21	6,9		13,12,14,21

Fig 3.5 Gantt chart of Module 2



	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	Successors
7		**Module 2 :Sensors**	**10 days**	**Tue 29-12-20**	**Mon 11-01-21**	**3**		
8		Analysis & Design	3 days	Tue 29-12-20	Thu 31-12-20	3,5		9,14,16
9		Coding & Testing	7 days	Fri 01-01-21	Mon 11-01-21	8		11,10,12,14,21
10		**Module 3: Transmitting information**	**10 days**	**Tue 12-01-21**	**Mon 25-01-21**	**6,9**		
11		Coding & Testing	10 days	Tue 12-01-21	Mon 25-01-21	6,9		13,12,14,21
12		**Module 4 Receiving message and setting Time limit**	**10 days**	**Tue 26-01-21**	**Mon 08-02-21**	**11,9**		

Fig 3.6 Gantt chart of Module 3



	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	Successors
8		Analysis & Design	3 days	Tue 29-12-20	Thu 31-12-20	3,5		9,14,16
9		Coding & Testing	7 days	Fri 01-01-21	Mon 11-01-21	8		11,10,12,14,21
10		**Module 3: Transmitting information**	**10 days**	**Tue 12-01-21**	**Mon 25-01-21**	**6,9**		
11		Coding & Testing	10 days	Tue 12-01-21	Mon 25-01-21	6,9		13,12,14,21
12		**Module 4 Receiving message and setting Time limit**	**10 days**	**Tue 26-01-21**	**Mon 08-02-21**	**11,9**		
13		Analysis & Design	2 days	Tue 26-01-21	Wed 27-01-21	11		14
14		Coding & Testing	8 days	Thu 28-01-21	Mon 08-02-21	8,9,11,13		15,21
15		**Module 5 Displaying time Limit**	**3 days**	**Tue 09-02-21**	**Thu 11-02-21**	**14**		
16		Analysis & Design	1 day	Tue 09-02-21	Tue 09-02-21	8		19

Fig 3.7 Gantt chart of Module 4

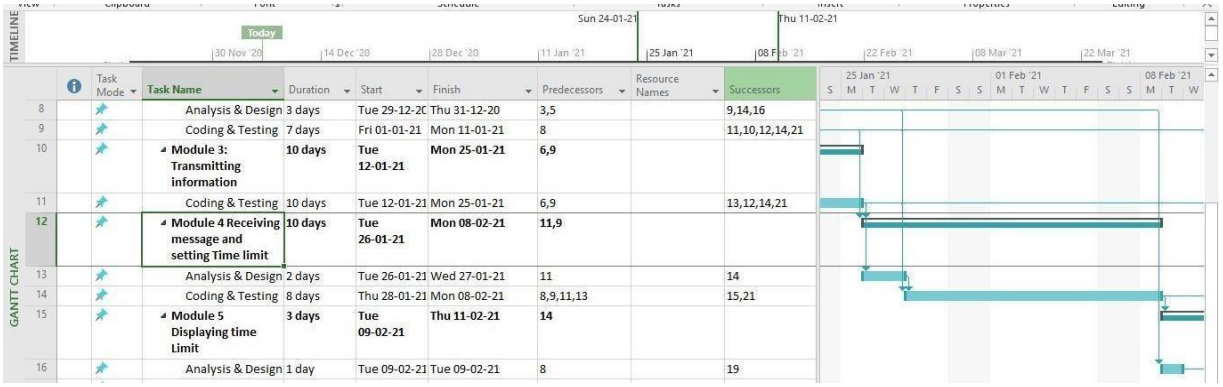


Fig 3.8 Gantt chart of module 5

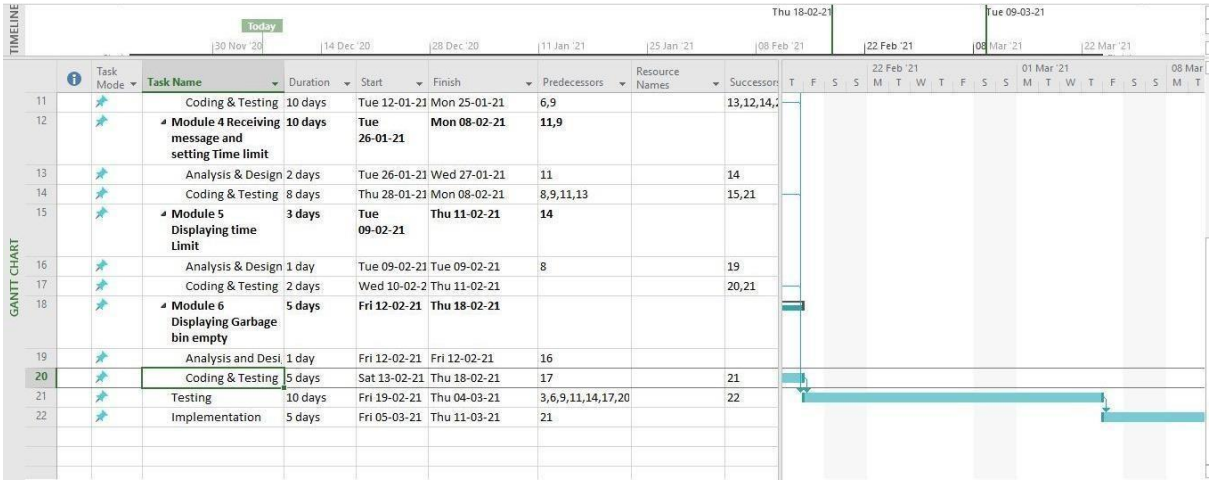


Fig 3.9 Gantt chart of module 6 & Testing and Implementation

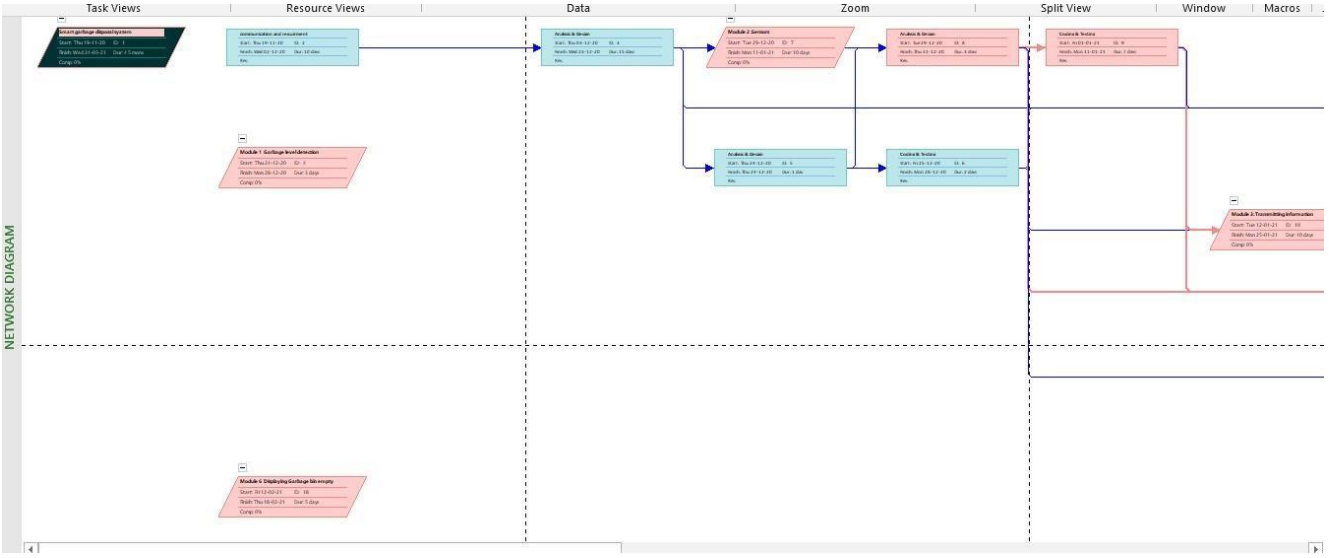


Fig 3.10 Network diagram 1

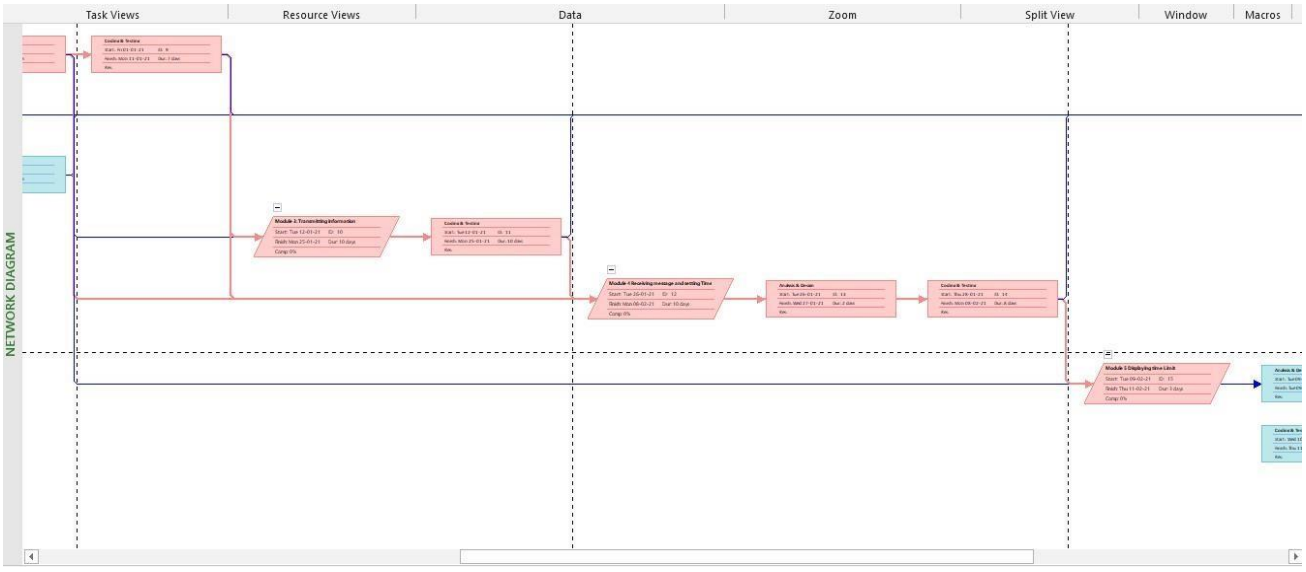


Fig 3.11 network diagram 2

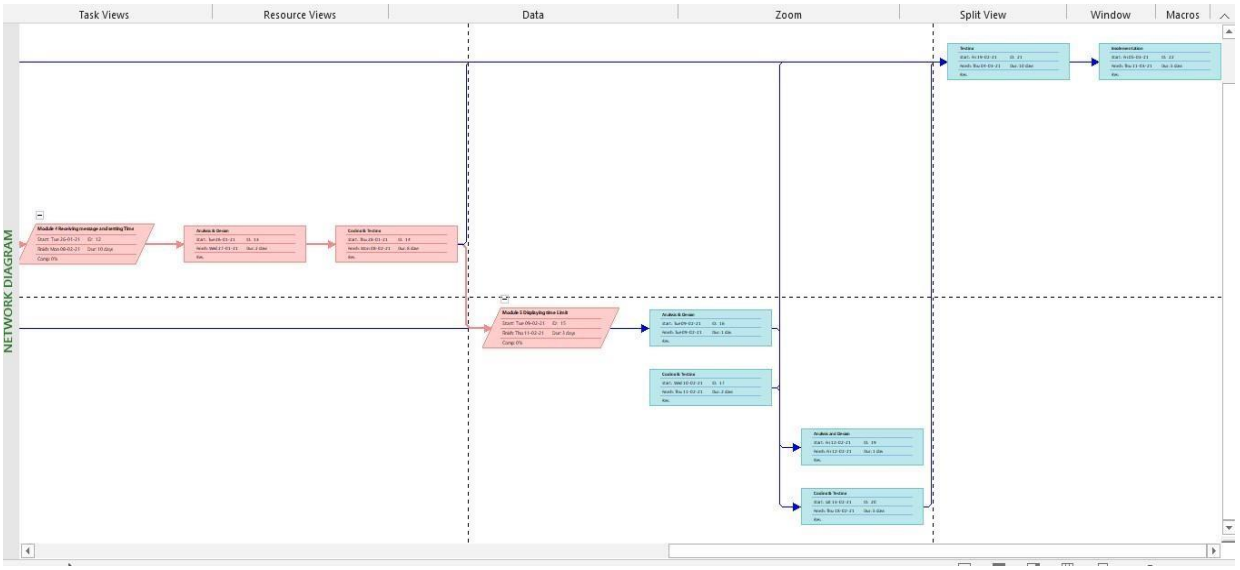


Fig 3.12 Network diagram 3

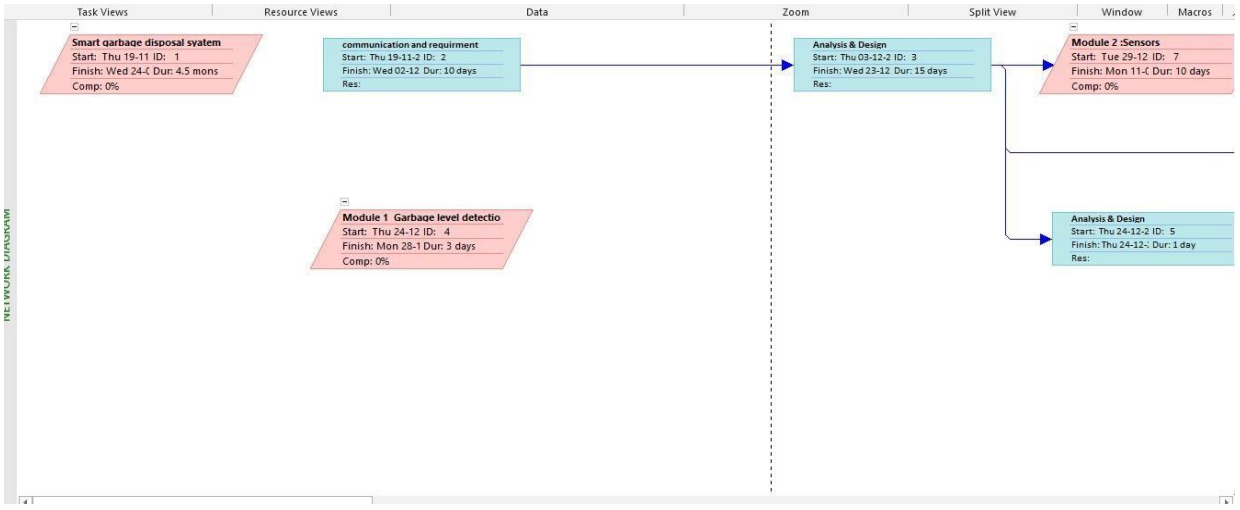


Fig 3.13 Network diagram of Module 1

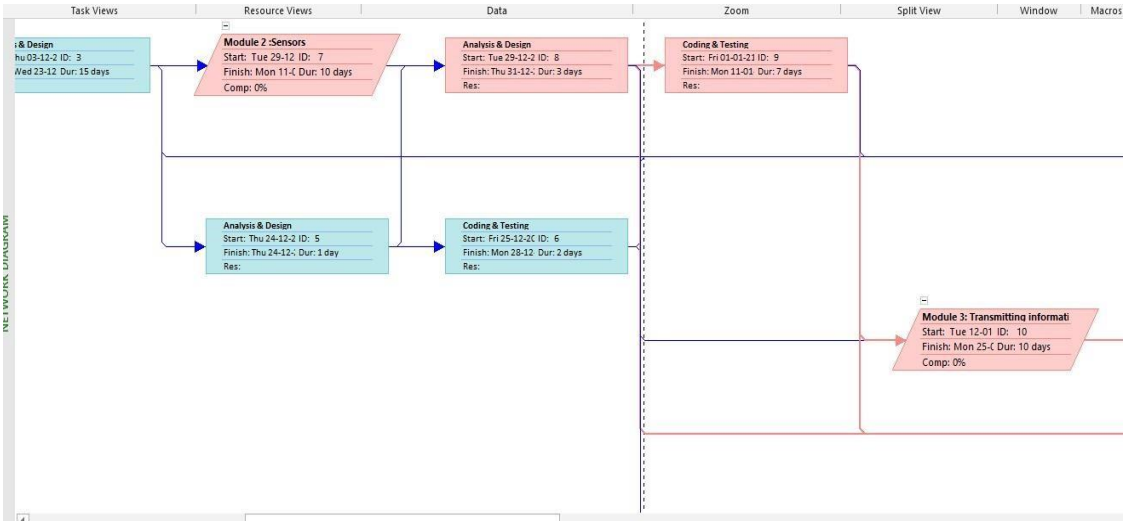


Fig 3.14 Network diagram of Module 2

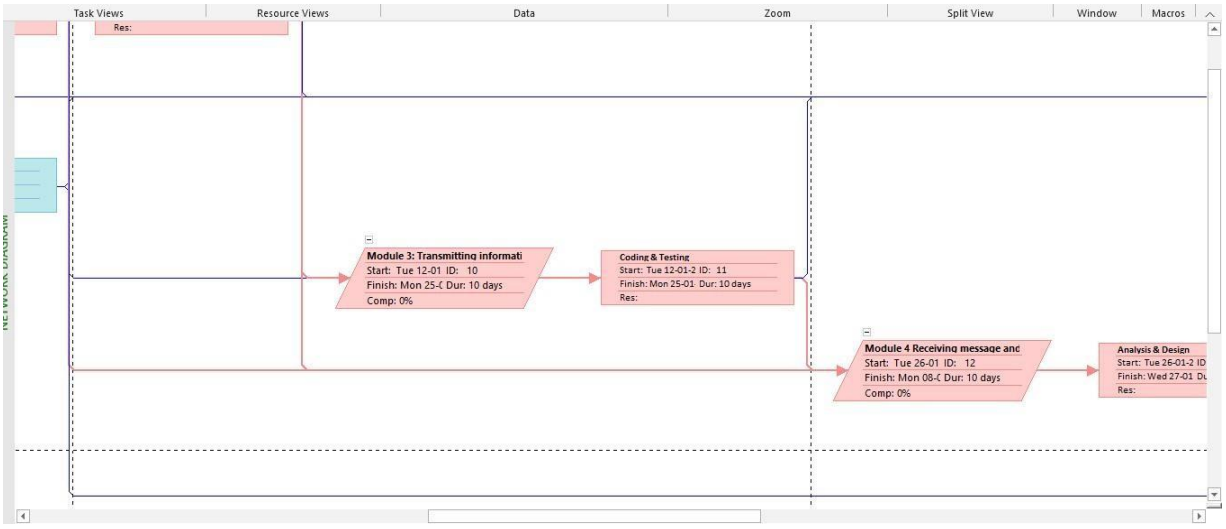


Fig 3.15 Network diagram of Module 3

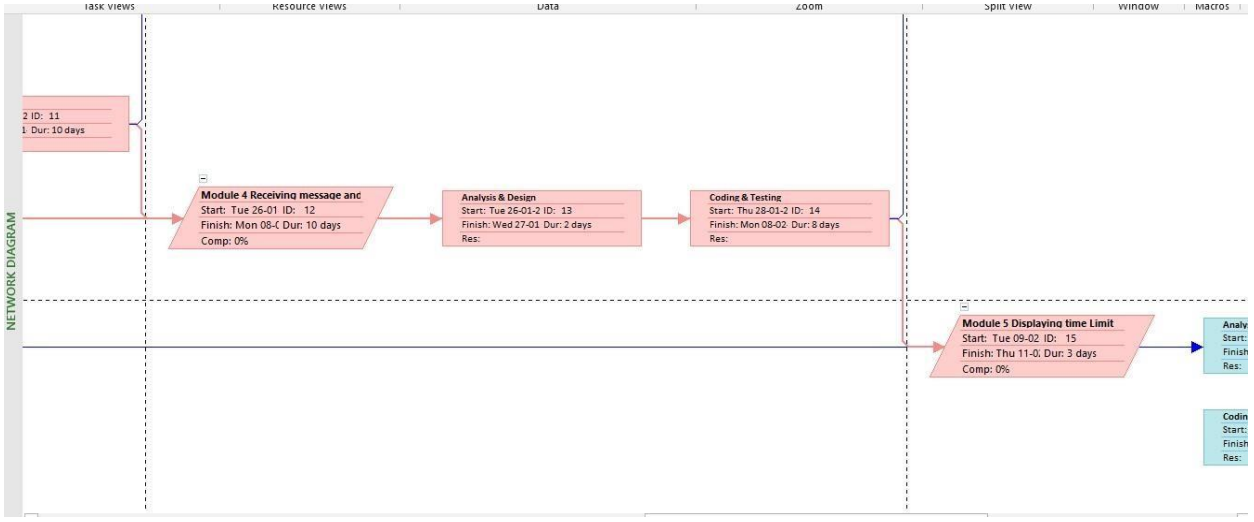


Fig 3.16 Network diagram of Module 4

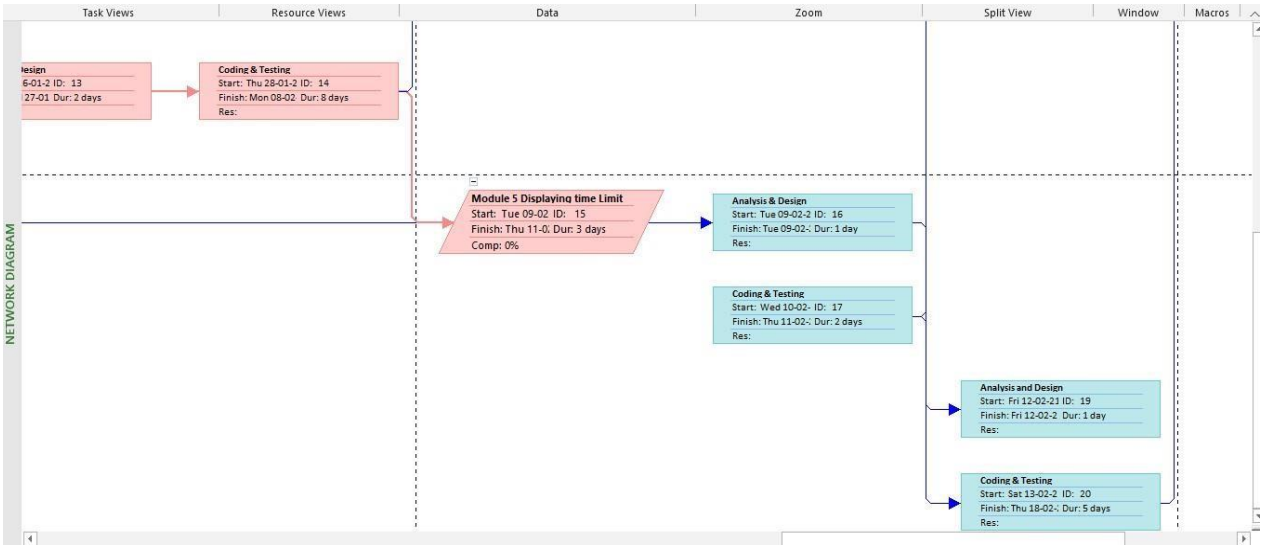


Fig 3.17 Network diagram of module 5

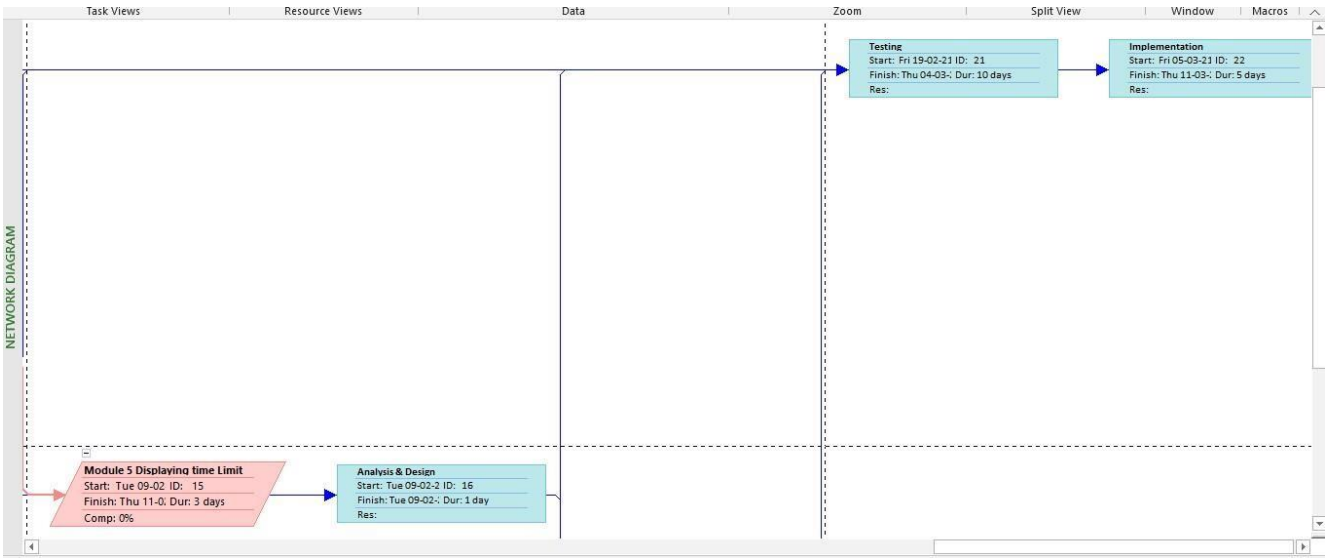


Fig 3.18 Network diagram of Testing &Implementation

3.4 HARDWARE AND SOFTWARE REQUIREMENT

Hardware requirement:

- Arduino UNO
- Ultrasonic Sensor
- GSM Module (SIM800L GPRS GSM Module)
- LCD display
- Bin
- External 3.7V Battery
- Capacitor- 25V
- Connecting wires
- Breadboard

Software requirement:

- Arduino IDE

3.5 PRELIMINARY PRODUCT DESCRIPTION

The motive of this project is to provide a better and efficient way of handling garbage. With this system the sensors will sense automatically the garbage level and alert the Garbage collection team/vans when the bins will be full, providing a more efficient method of disposal and collection of garbage. On receiving alert, the Collection team reply with the amount of time required to come and clean the bins which when received will be displayed on the LCD present on the bins, making it informative to the nearby residents. If cleaned the bins will again go back to sensing the garbage level else the system will send complaint to the higher authority.

3.6 CONCEPTUAL MODEL

STEP1: Start

STEP2: Sense the garbage level.

STEP3: Wait until garbage level reaches maximum limit.

STEP4: Send location of bin accessed to the garbage collection vans using GSM module

STEP5: Wait for receiving the time limit.

STEP6: Display the time limit and start the countdown timer.

STEP7: If bins cleaned display message “Bins are cleaned”.

STEP8: Else send complaint to the higher authority that bins are not yet been cleaned.

Flowchart**:**

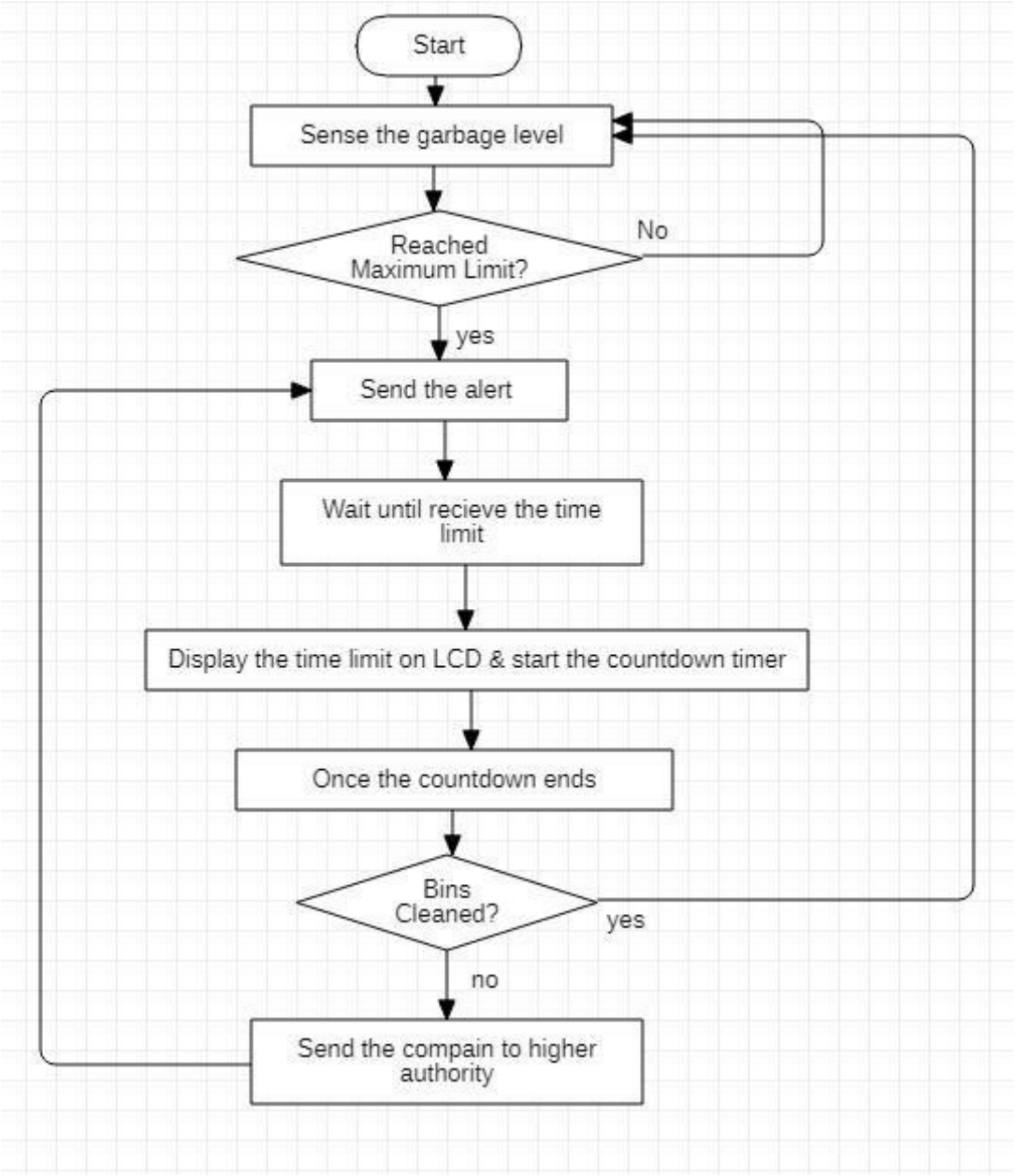


Fig. 3.19 Flowchart of system

CHAPTER 4: SYSTEM DESIGN

4.1. BASIC MODULES

- **Ultrasonic distance Sensor(HC-SR04) module:**

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. It works by sending out a sound wave at a frequency above the range of human hearing. The transducer of the sensor acts as a microphone to receive and send the ultrasonic sound. The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse.

Fig 4.1 Ultrasonic Sensor HC-SR04

- **GSM Module(SIM800L GPRS GSM Module):**

A GSM/GPRS modem is a class of wireless modem, designed for communication over the GSM and GPRS network. It requires a SIM (Subscriber Identity Module) card just like mobile phones to activate communication with the network. Also, they have IMEI (International Mobile Equipment Identity) number similar to mobile phones for their identification. At the heart of the module is a SIM800L GSM cellular chip from SimCom. The operating voltage of the chip is from 3.4V to 4.4V, which makes it an ideal candidate for direct LiPo battery supply. This makes it a good choice for embedding into projects without a lot of space.

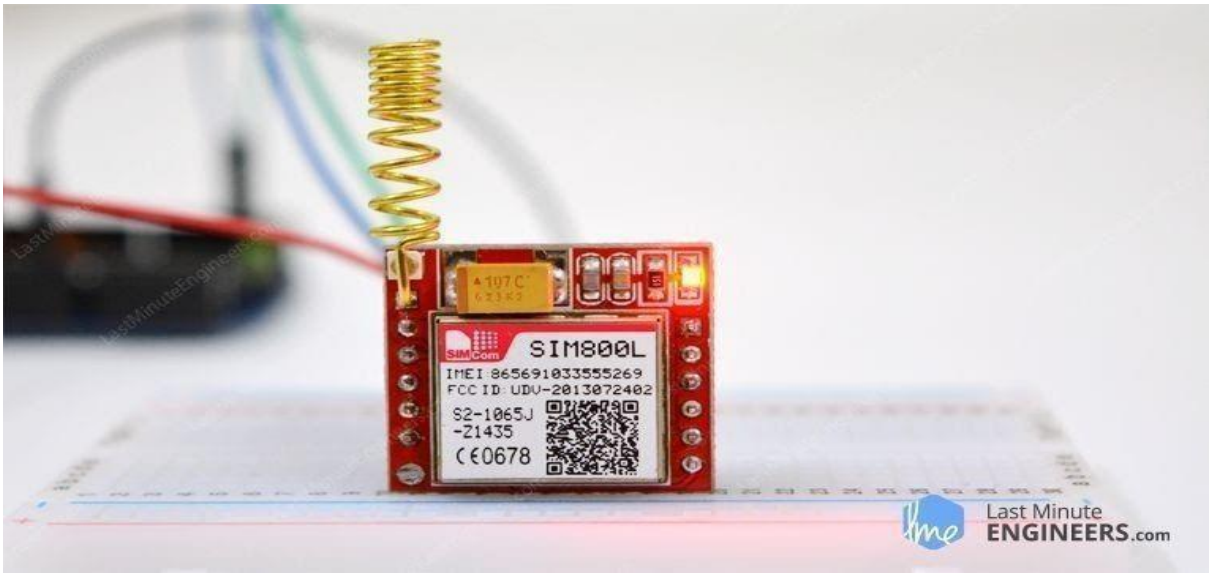


Fig 4.2 SIM800L GPRS GSM Module

- **LCD display:**

The lcd display will be used to display the messages on the bins.

Fig 4.3 LCD display

- **Arduino uno:**

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.

Fig 4.4 Arduino UNO

4.2 PROCEDURAL DESIGN

4.2.1 Algorithm Design:

Step 1: Start

Step 2: Sense the garbage level.

Step 3: Wait until garbage level reaches maximum limit.

Step 4: Send location of bin accessed to the Garbage collection team using GSM module.

Step 5: Wait for receiving the time limit.

Step 6: Display the time limit and start the countdown timer.

Step 7: When cleaned display message “Bins are cleaned”.

Step 8: If not cleaned before timer exceeds send complaint to higher authority.

Step 9: Stop.

4.2.2 Logical Design:

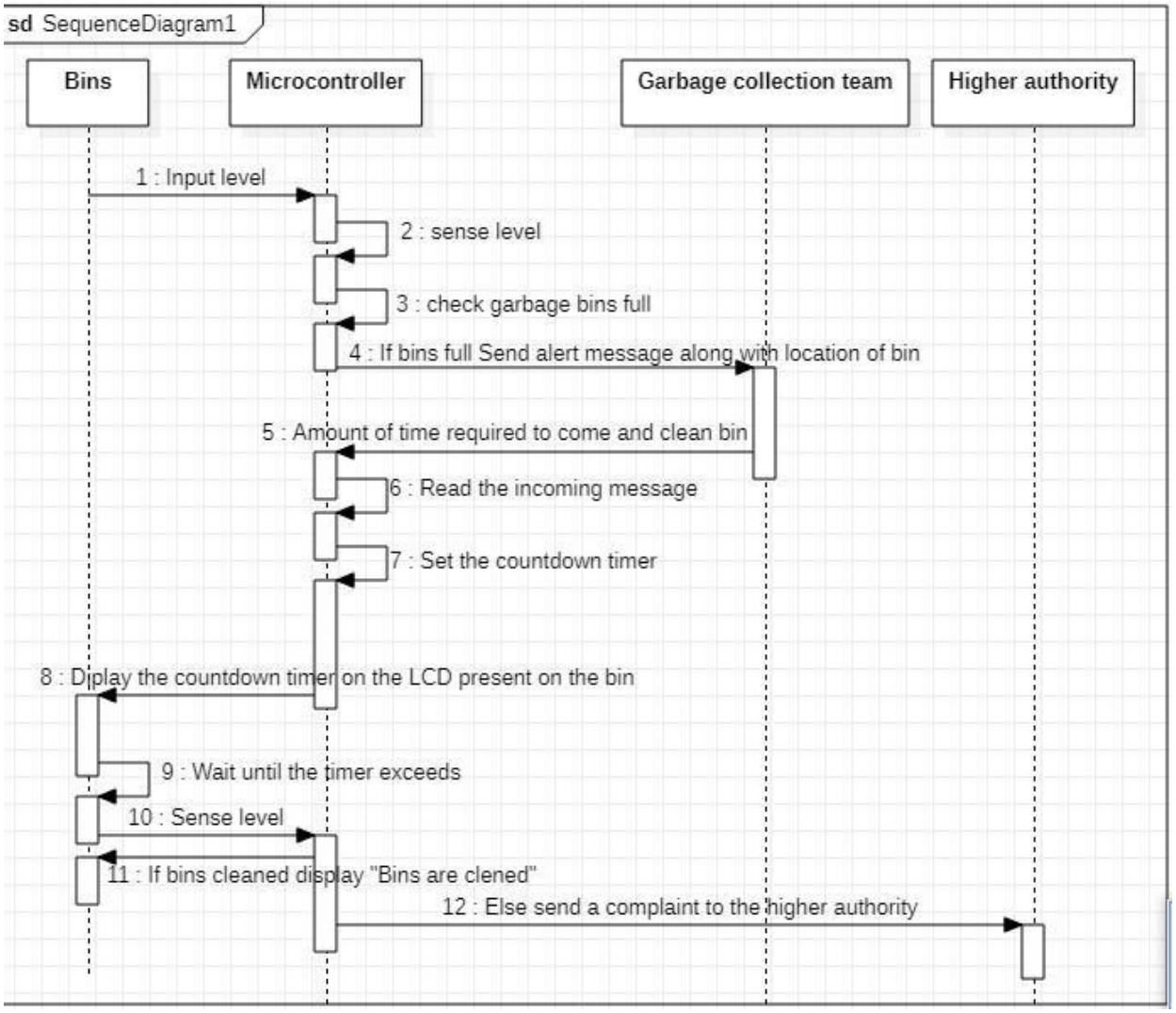


Fig 4.5 Sequence diagram of the system

4.3 USER INTERFACE DESIGN:

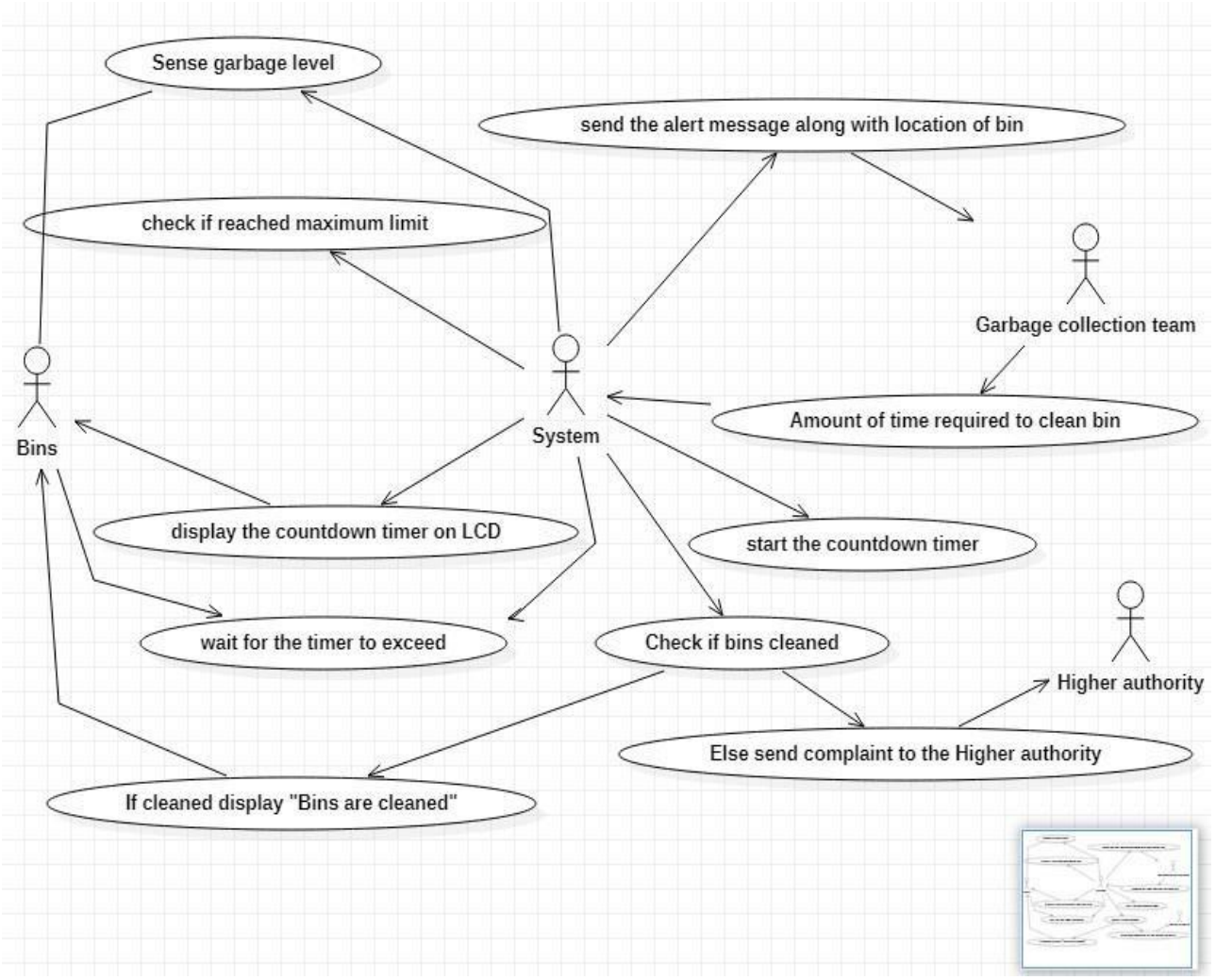


Fig 4.6 Use case diagram of the system

4.4 SECURITY ISSUES:

- **Connectivity issues:**

Since the system will send messages through GSM Module there are chances that during the transmission of messages there can occur connectivity issues.

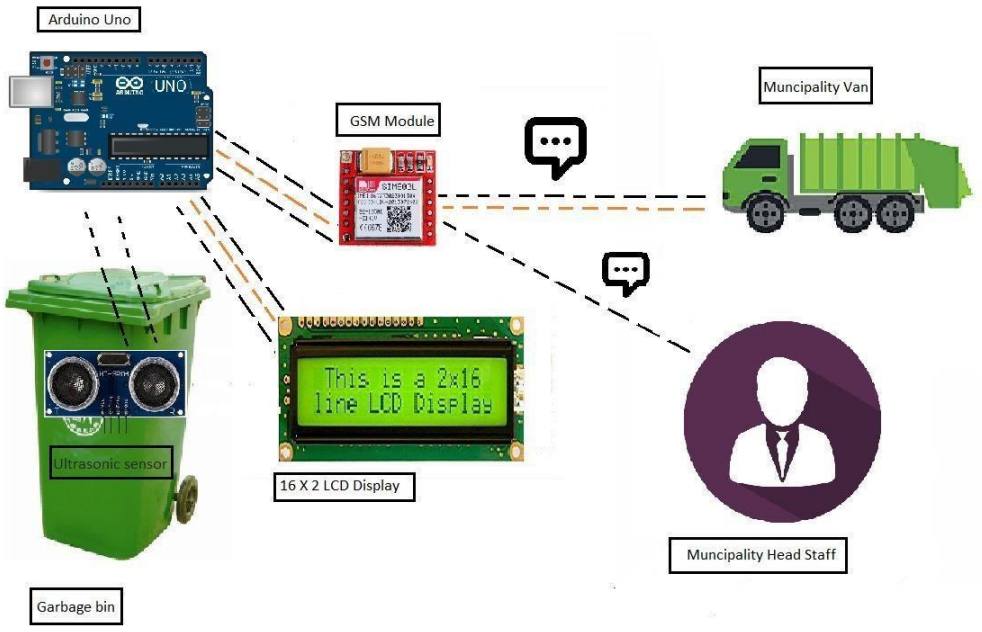


Fig 4.7 Prototype of the system

- **Loose wires:**

The system will be connected to the microcontroller using wires.So there are chances of having a loose wire which may result in errors.

- **Climate:**

Since the system will be set up in a local area there are chances that during cloudy or rainy season the components may get damaged or could develop rust which may hamper its performance.

4.5 TESTING:

IOT testing is a type of testing to check IOT devices. With the growing technology, there is an increasing need to deliver better and faster services. There is a huge demand to create, access, use and share data from any device at any given time. The thrust is to provide greater insight and control, over various interconnected IOT devices. Hence, IOT testing framework is important. IOT testing is a key to ensuring that these IOT devices work accurately for the intended environment. Apart from this, in a functioning IOT environment, when more devices are deployed, it may be difficult to replicate a real-time environment for testing as there may be lots of devices that have to be tested on the platform. IOT is a connection of identifiable embedded devices with the existing Internet infrastructure. Testing for IOT devices broadly revolves around Security, Analytics, Device, Networks, Processors, Operating Systems, Platforms and Standards. Performance testing is important to create a strategic approach for developing and implementing an IOT testing plan.

CHAPTER 5: IMPLEMENTATION AND TESTING

5.1 IMPLEMENTATION:

```
#include <SoftwareSerial.h>
#include <LiquidCrystal_I2C.h>
#include <Wire.h>
LiquidCrystal_I2C lcd(0x27,16,2);  // set the LCD address to 0x3F for a 16 chars and 2 line display
SoftwareSerial mySerial(8, 7); //SIM800L Tx & Rx is connected to Arduino #8 & #7

const int trigPin = 9;   const int echoPin = 10;  //Defining
variable int
dist1,sms=0,rec=0,alert=0,distance,counter=0,x,clean; long
duration; String msg="";

void setup() {
  // put your setup code here, to run once:   //setup for the
ultrasonic sensor pinMode(trigPin, OUTPUT); // Sets the trigPin
as an Output pinMode(echoPin, INPUT); // Sets the echoPin as
an Input

//setup for the lcd display   lcd.init();   lcd.clear();
lcd.backlight();      // Make sure backlight is on   lcd.setCursor(0,0);
//Set cursor to character 2 on line 0   lcd.print("Hello world");

//Begin serial communication with Arduino and Arduino IDE (Serial Monitor)
Serial.begin(9600);

  //Begin serial communication with Arduino and
SIM800L   mySerial.begin(9600);   delay(1000);
  Serial.println("Setup complete !");
mySerial.println("AT+CSMP=17,167,0,0\r\n");   updateSerial();
}
```

```
void loop() {
  // put your main code here, to run repeatedly:
sense_level();
if(sms==1)
  {    lcd.setCursor(0,0);
lcd.print("alert sent!");
recv_sms();
delay(10000);
while(rec==1)
  {
if(mySerial.available())
  {
    msg = mySerial.readString();
Serial.println(msg);     int len=msg.length();
    Serial.println(len);    String
msg1;    int n=51;    char
inChar;    counter+=1;
Serial.println("counter:");
   Serial.println(counter);
   //Serial.println("mesage and length printed");    //Serial.println(n);    while(n<(len-2))
   {
    inChar=msg.charAt(n);
msg1+=inChar;     n++;
   }
   if(counter==2)     {
x=msg1.toInt();
Serial.println(x);
countdown(x);
clean=check_cleaned();     if(clean==0)
    {       send_alert();       delay(30000);
lcd.clear();       lcd.setCursor(0,0);
```

```
lcd.print("complain filled");
delay(30000);

Reset();
}      else
    {       lcd.setCursor(0,0);
lcd.print("bins are cleaned");
lcd.setCursor(0,1);
lcd.print("Thank you!!");
delay(50000);
      Reset();
     }
}
else
   {
   Serial.println(msg1);
    }
   }
  }
 }
}

int ultrasonic()
{
  // Clears the trigPin digitalWrite(trigPin,
LOW); delayMicroseconds(2);
// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH); delayMicroseconds(10); digitalWrite(trigPin,
LOW);
// Reads the echoPin, returns the sound wave travel time in microseconds
duration = pulseIn(echoPin, HIGH); // Calculating the distance
distance= duration*0.034/2;
// Prints the distance on the Serial Monitor
```

```
//Serial.print("Distance: ");
Serial.println(distance); return
distance;
}

void send_sms()
{   mySerial.println("AT+CMGF=1"); // Configuring TEXT mode
updateSerial();
mySerial.println("AT+CMGS=\"8104066652\"\r\n");   //change
ZZ with country code and xxxxxxxxxxx with phone number to
sms  updateSerial();   mySerial.println("HELLO bins are full at
||
https://maps.app.goo.gl/sWHZG3zcFERV5Nn99");   //text
content   delay(1000);   mySerial.println((char)26);   delay(1000);   Serial.println("sent");
sms=1;
  Serial.println(sms);
  Serial.println("exiting send sms");
 }

void recv_sms()
{   mySerial.println("AT+CNMI=1,2,0,0,0"); // Decides how newly arrived SMS messages
should be handled   delay(1000);   rec=1;
  }

void send_alert()
 {
  //mySerial.println("ATD+918104066652;"); //  change ZZ with country code
and xxxxxxxxxxx with phone number to dial   //updateSerial();
//delay(20000); // wait for 20 seconds...
  //mySerial.println("ATH"); //hang up
  //updateSerial();        mySerial.println("AT+CMGF=1");  //  Configuring  TEXT  mode
updateSerial();   mySerial.println("AT+CMGS=\"8104066652\"\r\n");  //change ZZ with
country code and xxxxxxxxxxx with phone number to sms
```

```
 updateSerial();    mySerial.println("The bins are
not yet cleaned at ||
https://maps.app.goo.gl/sWHZG3zcFERV5Nn99");   //text content
delay(1000);   mySerial.println((char)26);   delay(1000);   alert=1;
 }

int check_cleaned()  {
int dist2 =
ultrasonic(); int
cleaned;
if(dist2>=18)
  {
  cleaned=1;
  }   else
  {
  cleaned=0;
}  return
cleaned;
}

void sense_level()
{           dist1      =
ultrasonic();
if(dist1 <= 2)
  {
delay(15000);   if(dist1
<= 2)
  {
if(sms==0)
    {
    send_sms();     delay(10000);
//recv_sms();
    // delay(80000);
```

```
    }
   }
 }
}


void countdown(int mins) {
  int i,j;
  lcd.setCursor(0,0);   lcd.print("will
arrive in:");   for(i=mins;i>=0;i--)
  {
for(j=59;j>=0;j--)
    {
lcd.setCursor(0,1);
lcd.print(i);
lcd.print(":");
lcd.print(j);       delay(1000);
    }
  }
}


void Reset()
{   sms=0;
rec=0;
alert=0;
clean=0;
counter=0;
lcd.clear();
lcd.setCurs
or(0,0);
lcd.print("h
ello world");
```

```
}


void updateSerial()  {
delay(500);   while
(Serial.available())
  {
    mySerial.write(Serial.read());//Forward what Serial received to Software Serial Port
  }
while(mySerial.available())
  {
    Serial.write(mySerial.read());//Forward what Software Serial received to Serial Port


}
}
```

5.2 CODE EFFICIENCY:

COCOMO (Constructive Cost Model) is a regression model based on LOC, i.e. number of Lines of Code. It is a procedural cost estimate model for software projects and often used as a process of reliably predicting the various parameters associated with making a project such as size, effort, cost, time and quality. It was proposed by Barry Boehm in 1970 and is based on the study of 63 projects, which make it one of the best-documented models. The key parameters which define the quality of any software products, which are also an outcome of the Cocomo are primarily Effort & Schedule:

- **Effort:** Amount of labor that will be required to complete a task. It is measured in personmonths units.

• **Schedule:** Simply means the amount of time required for the completion of the job, which is, of course, proportional to the effort put. It is measured in the units of time such as weeks, months.

Different models of COCOMO have been proposed to predict the cost estimation at different levels, based on the amount of accuracy and correctness required. Based on the complexity of the project and the LOC of project it can be organic, semi-detached and embedded. As the complexity of our project is of low level it is considered as of organic type.

A software project is said to be an organic type if the team size required is adequately small, the problem is well understood and has been solved in the past and also the team members have a nominal experience regarding the problem.

The formula used for organic is as follows:

$a = 2.4$

$b = 1.05$

$$E = 2.4 (KLOC)^{1.05}$$

$$E = 2.4 (240)^{1.05}$$

$$E = 757.5879$$

5.3 TESTING:

5.3.1 COMPONENTS TESTING:

5.3.1.1 Arduino UNO Testing:

Arduino Uno is tested in this phase using a simple blink code

Test code:

```
// the setup function runs once when you press reset or power the board void setup()
{
// initialize digital pin LED_BUILTIN as an output. pinMode(LED_BUILTIN, OUTPUT);
}
```

```
// the loop function runs over and over again forever void loop() {
digitalWrite(LED_BUILTIN, HIGH);   // turn the LED on (HIGH is the voltage
level) delay(1000);                // wait for a second
digitalWrite(LED_BUILTIN, LOW);    // turn the LED off by making the voltage LOW
delay(1000);                       // wait for a second
}
```

Test images:

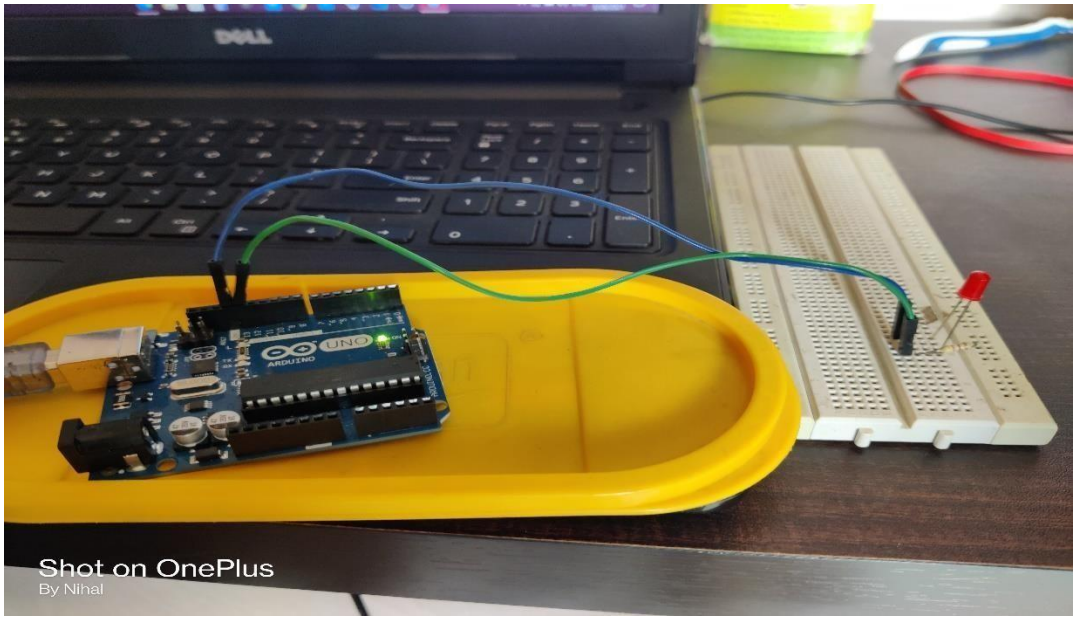


Fig 5.1 Before uploading the code

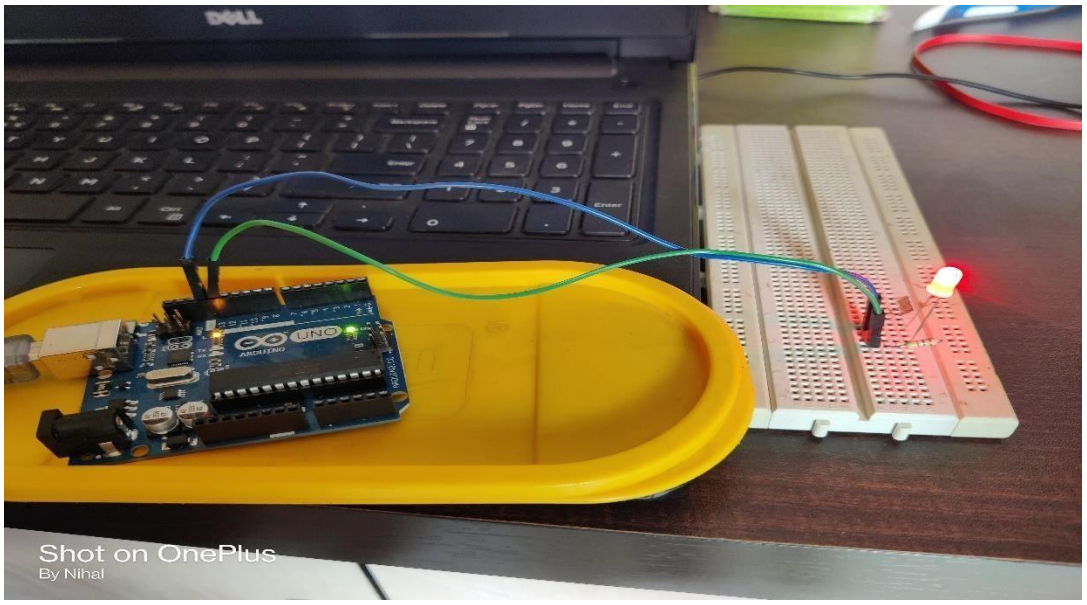


Fig 5.2 After uploading the code

5.3.1.2 GSM module SIM800L testing:

In this phase the GSM module SIM800L is tested by connecting a capacitor and supplying external power supply using 3.7V battery. The LED present on the module blinks every 3 seconds ensuring proper working of the GSM module**.**

Test Images:

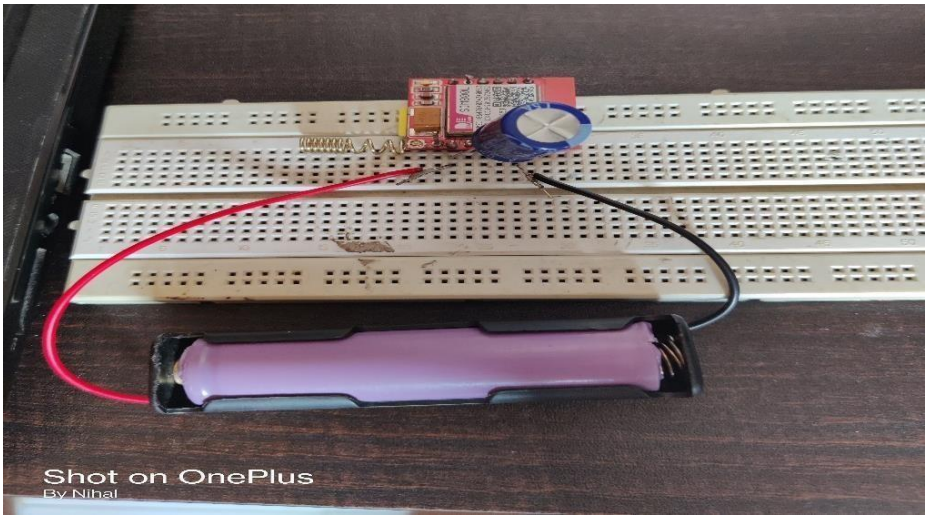


Fig 5.3 LED on GSM module blinking off

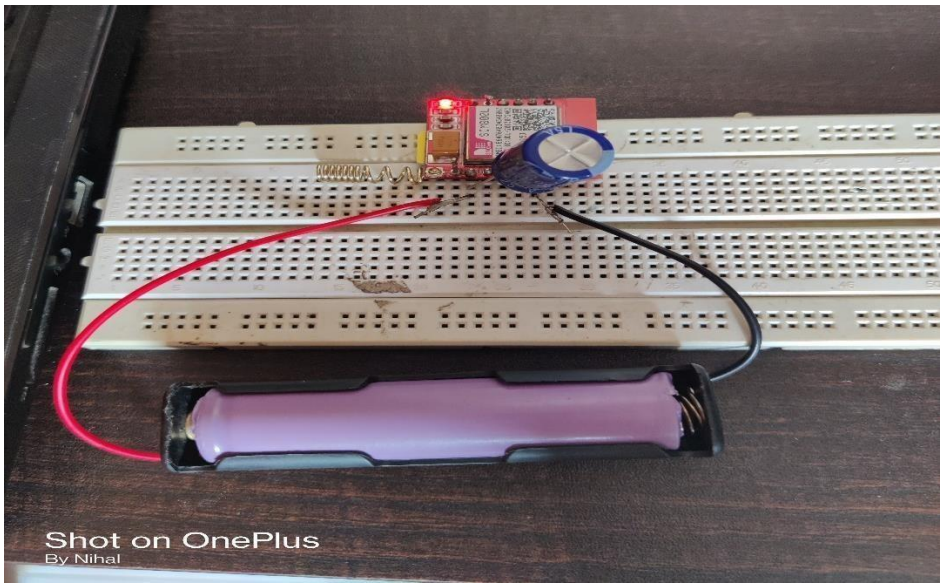


Fig 5.4 LED on GSM module blinking on

5.3.1.3 HC-SR04 Ultrasonic sensor testing:

The ultrasonic sensor is tested in this phase using the code that calculates the distance between an object and ultrasonic sensor.

Test Code:

```
const int trigPin = 9;
const int echoPin = 10;
long duration; int
distance; void setup()
{  Serial.begin(9600);
   //setup for the ultrasonic sensor pinMode(trigPin,
OUTPUT); // Sets the trigPin as an Output pinMode(echoPin,
INPUT); // Sets the echoPin as an Input
} void loop() {    // Clears the
trigPin digitalWrite(trigPin,
LOW);
delayMicroseconds(2);
```

```
// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH); delayMicroseconds(10); digitalWrite(trigPin,
LOW);
// Reads the echoPin, returns the sound wave travel time in microseconds duration
= pulseIn(echoPin, HIGH);  // Calculating the distance distance=
duration*0.034/2;
// Prints the distance on the Serial Monitor
Serial. Print("Distance: ");
Serial.println (distance);
}
```

Test Images:

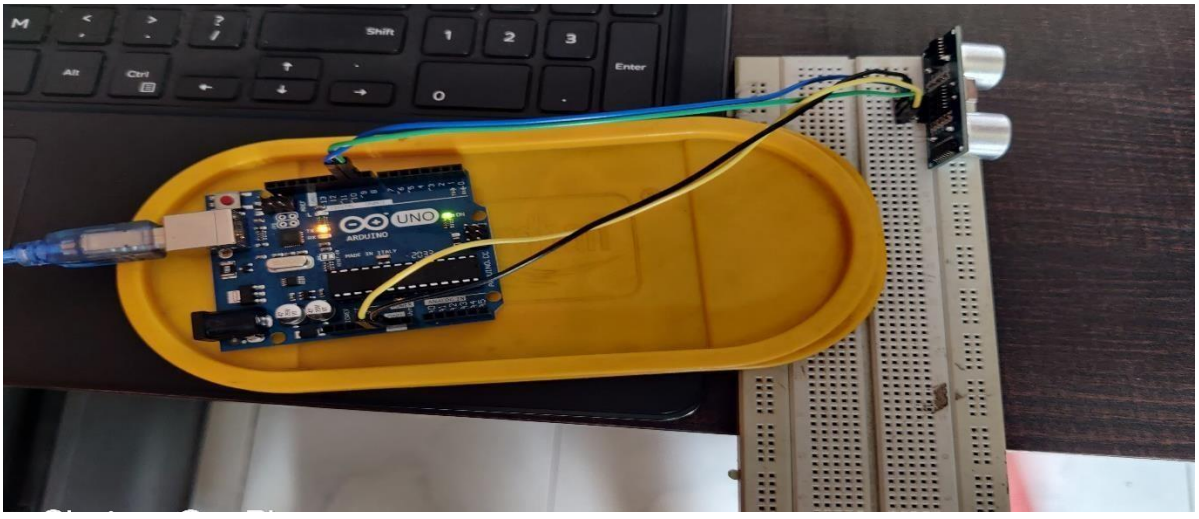


Fig 5.5 Ultrasonic sensor when no object in front of it

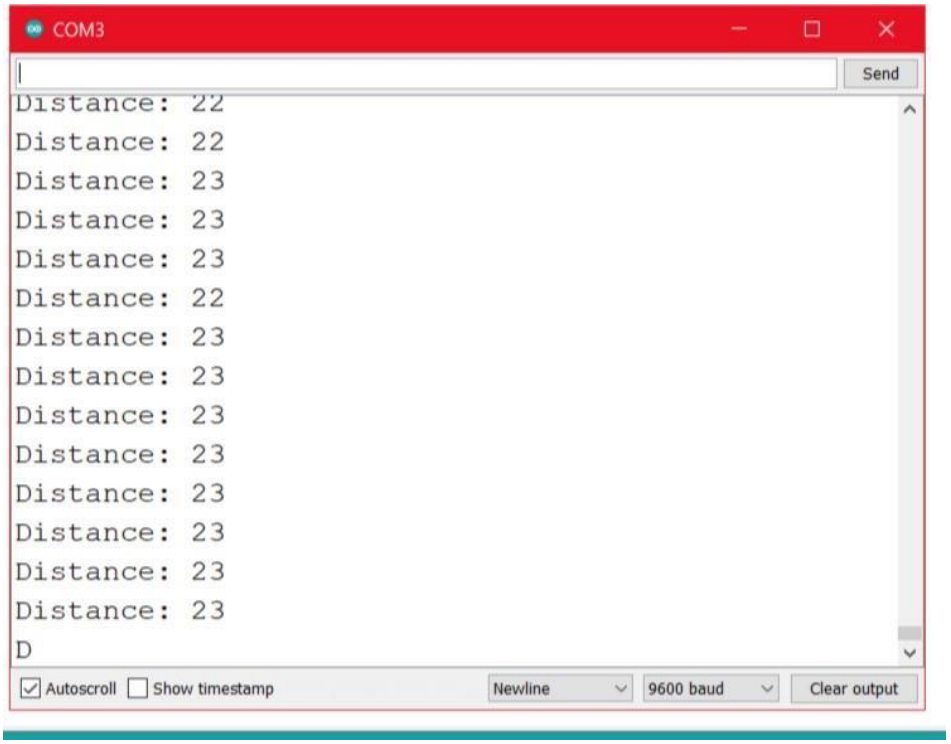


Fig 5.6 Ultrasonic sensor output when no object in front of it

Fig 5.7 Ultrasonic sensor when object in front of it.

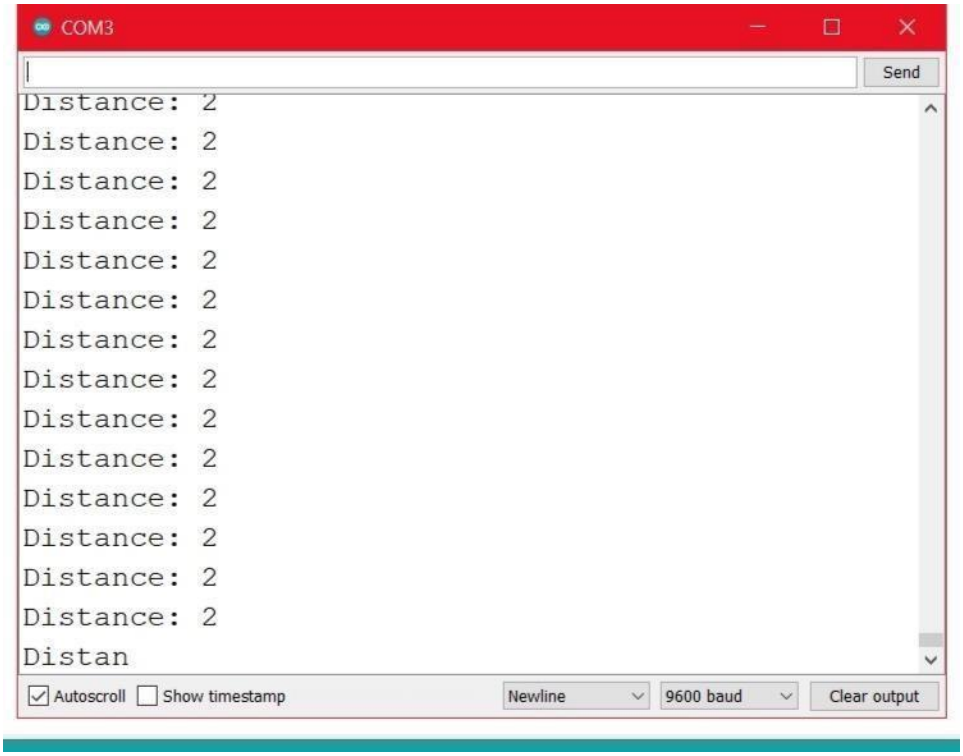


Fig 5.8 Ultrasonic sensor output when object in front of it.

5.3.1.4 LCD Display testing:

In this phase we are testing a 16X2 LCD display using a code that displays data on LCD.

Test Code:

```
#include <LiquidCrystal_I2C.h>
#include <Wire.h>
LiquidCrystal_I2C lcd(0x27,16,2);   // set the LCD address to 0x3F for a 16 chars and 2 line display

void setup() {    lcd.init();   lcd.clear();
lcd.backlight();      // Make sure backlight is
on
```

```
  // Print a message on both lines of the LCD.
  lcd.setCursor(0,0);   //Set cursor to character 2 on line 0
lcd.print("Hello world!");

  lcd.setCursor(0,1);   //Move cursor to character 2 on line 1
lcd.print("LCD working");
}

void loop() {
}
```

Test Images:

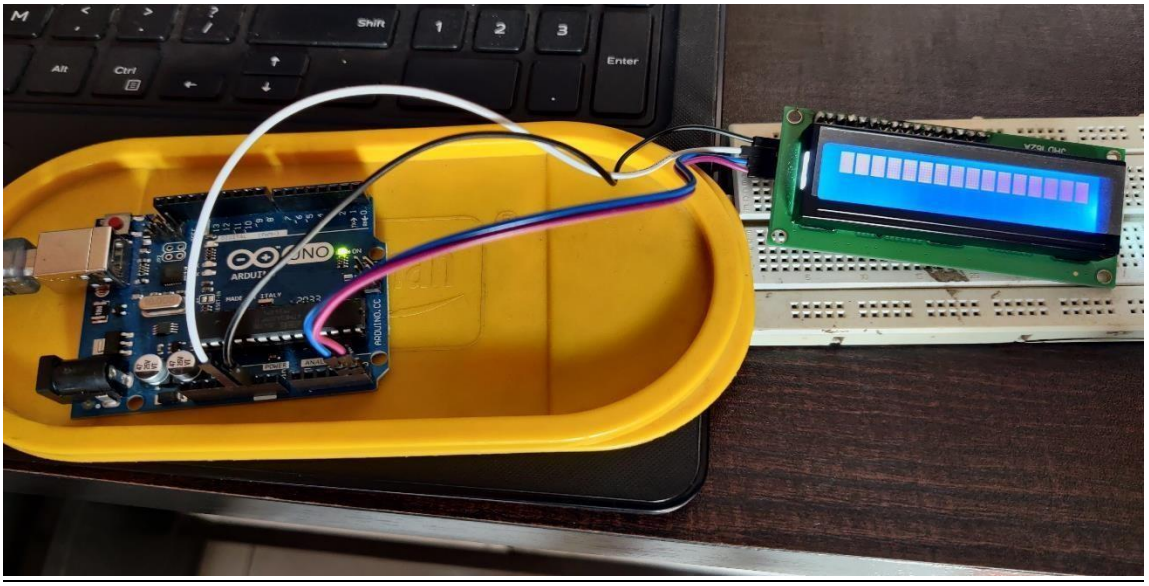


Fig 5.9 LCD powered on.

Fig 5.10 LCD displaying the message.

5.3.2 SYSTEM TESTING

This phase is for testing that the bins are sensing, sending message, receiving message, setting timer, and alerting the higher authority if bins not cleaned before timer exceeds, ensuring that the system is working properly.

Fig.5.11 Integrated system

Fig 5.12 Integrated system

- When bins are not full:

Fig 5.13 when bins are not full

- When bins are 90% full send alert:

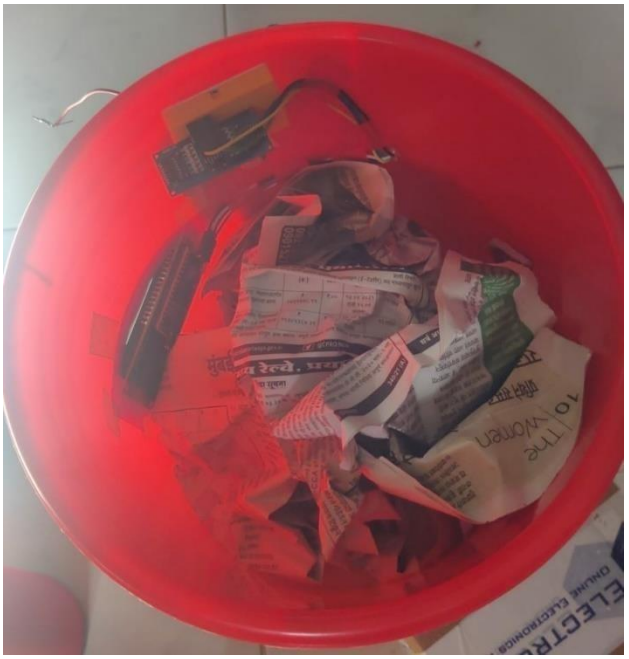


Fig 5.14 Bins are 90% full

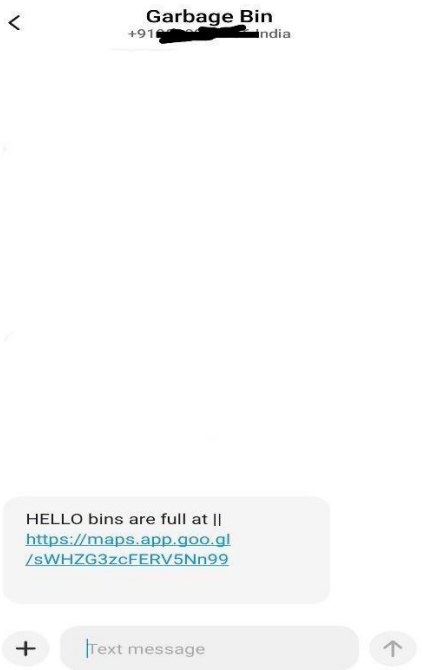


Fig 5.15 Alert message with Location

Fig 5.16 Displaying alert message sent

- Time required to clean the bins:

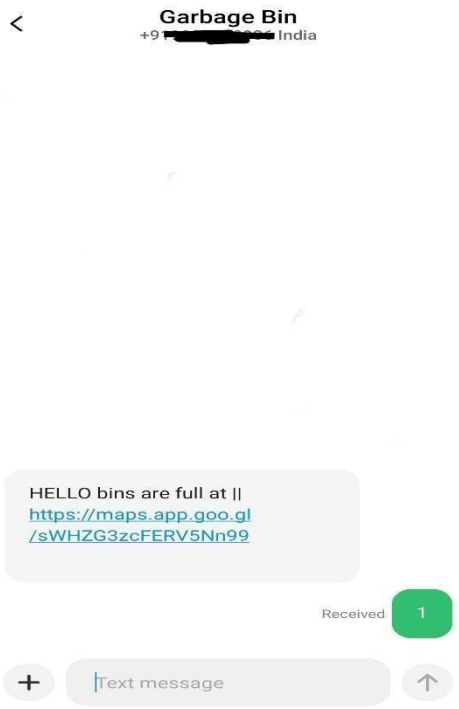


Fig 5.17 Replying the amount of time required to clean the Bins.

- Receiving message and starting the countdown Timer:

Fig 5.18 Starting the countdown timer.

- When countdown timer exceeds if bins cleaned:

Fig 5.19 Bins are cleaned

- When countdown exceeds bin not cleaned :

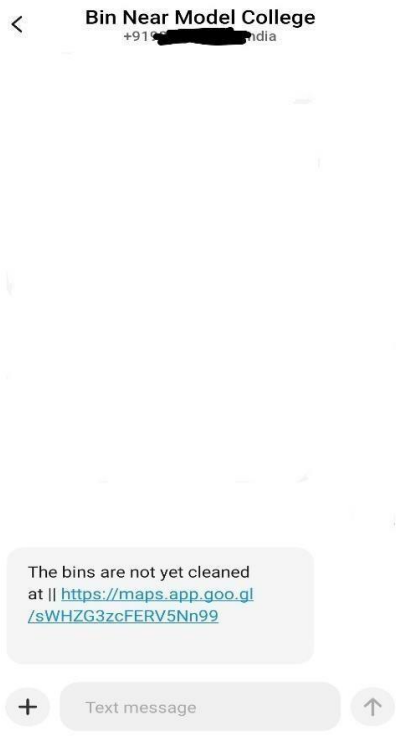


Fig 5.20 Complaint message to higher authority

CHAPTER 6: RESULT AND DISCUSSION

6.1 TEST CASE PLAN:

Table: 6.1 Test Cases

Test Case ID	Test Case Name	Test Description	Input	Expected Output	Actual Output	Result
TID01	Arduino UNO Testing	Evaluating proper working of Arduino UNO	Program	Blink LED	Blink LED	PASS
TID02	GSM Module Testing	Checking proper Connectivity of the GSM module SIM800L.	Sim-card, External 3.7V battery.	LED present on GSM module blinking every 3 seconds.	LED present on GSM module blinking every 3 seconds.	PASS
TID03	Ultrasonic sensor Testing	Calculating the distance between an object and ultrasonic sensor.	Program	The distance between the ultrasonic sensor and the object is calculated.	The distance between the ultrasonic sensor and the object is calculated.	PASS
TID04	LCD Display Testing	Checking the LCD display is working properly	Program	The LCD displaying the words.	The LCD displaying the words.	PASS
TID05	When Bins not full	When Bins are not full only Displaying the message on LCD.	Bins not full.	LCD displaying the message “Hello world”.	LCD displaying the message “Hello world”.	PASS
TID06	When bins 90% full, Send alert	When Bins reach their maximum limit send the alert messages to the Garbage collection team.	Bins 90% full	Message sent to the Garbage collection team and LCD displaying “Alert sent!”	Message sent to the Garbage collection team and LCD displaying “Alert sent!”	PASS

TID07	Time required to clean the Bins	The Garbage collection team will then reply with the	Sending the alert message.	Receiving the time required by the Garbage collection	Receiving the time required by the Garbage collection to	PASS
		amount of time required to come and clean the bins.		team to come and clean he bins.	come and clean he bins.	
TID08	Starting the Countdown Timer	Starting the countdown timer and displaying the timer on LCD.	The amount of time required for the Garbage collection team to come and clean the bins.	The LCD (present on the bin) will display the countdown timer.	The LCD (present on the bin) will display the countdown timer.	PASS
TID09	Countdown exceeds and bins cleaned.	When countdown timer exceeds, the ultrasonic sensor senses the garbage level and if the Bins are cleaned.	The Bins should be cleaned.	The LCD(present on the bin) displays “bins are cleaned”.	The LCD(present on the bin) displays “bins are cleaned”.	PASS
TID10	Countdown exceeds and bins not cleaned.	When the countdown timer exceeds, the ultrasonic sensor senses the garbage level and if the Bins are not yet been cleaned.	Bins have not yet been cleaned.	Complaint is sent to the higher authority that the bins have not yet been cleaned.	Complaint is sent to the higher authority that the bins have not yet been cleaned.	PASS

6.2 USER DOCUMENTATION:

- When bins are not full:

When the bins are not yet full to their maximum limit, the LCD display(present on the bins) displays the message ”hello world”, letting people know that they can discard their garbage in the bins.

Fig 6.1 and 6.2 The Bins are not yet full and LCD displaying the message.

- When bins are 90% Full send alert:

For our System we have keep the threshold as 90%. Therefore, once the bins reach the limit of 90% full, alert messages along with the location of the bins are sent by the system to the Garbage collection team/vans.

Fig 6.3 The bins are 90% full.

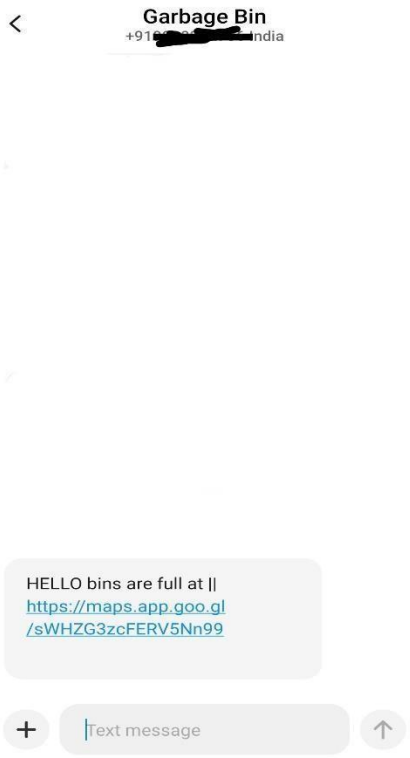


Fig 6.4 Alert message sent along with location of bin.

Fig 6.5 Bins displaying message "alert sent!"

- Time required to clean the bins:

  On receiving the alert message the Garbage collection team/vans will reply with the amount of time(in Minutes) required to come and clean the bins.

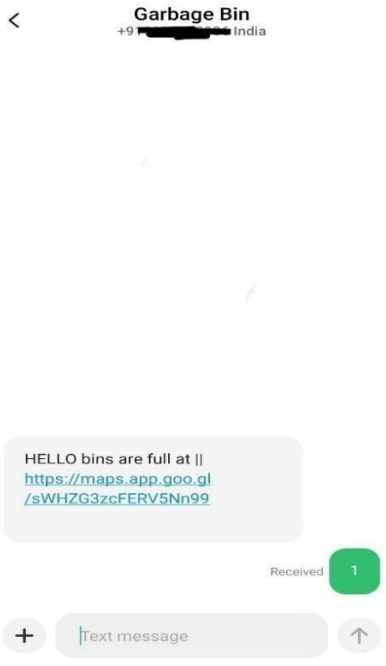


Fig 6.6 The amount of time required to come and clean the bins.

- Receiving message and starting the countdown Timer:

When the Garbage collection team will reply with the amount of time required (in minutes) to come and clean the bin, the System will read the message will start the countdown timer for the specified number of minutes and wait until the timer exceeds. e.g., If the Garbage collection team reply with 30 that means 30 minutes will be needed to come and clean the bins, on receiving the message the system will start the timer for 30 minutes and wait until the timer reaches 0.

Fig 6.7 Shows the LCD displaying the countdown timer.

- When countdown timer exceeds if bins cleaned:

  When the timer exceeds (i.e when the timer reaches 0) the ultrasonic sensor checks whether the bins are cleaned or not and if the bins are cleaned the LCD displays the message “Bins are cleaned” for some time , and, then again goes back to sensing the bins and waiting until it reaches 90% limit.

Fig 6.8 Bins are cleaned

- When countdown exceeds bin not cleaned :

  When the countdown timer exceeds(i.e when the timer reaches 0) the ultrasonic sensor checks whether the bins are cleaned or not. If the bins are not yet been cleaned the system sends complaint to the higher authority that the bins at this location have not yet been cleaned. The LCD present on the bins also displays “complaint filed” letting the residents know that complaint has been sent.

Fig 6.9 The complaint message sent to the higher authority

Fig 6.10 The LCD displaying "complaint filled"

CHAPTER 7: SUMMARY

7.1 CONCLUSION:

The system aims at creating a cleaner, greener and smarter environment by incorporating IOT in it. The bins will provide real time data to the garbage collection team by sending the location of the bin when the bins reach their maximum limit. It will help overcome the problem of garbage bins overflow therefore providing a healthy living atmosphere. As well as, since the bins will display the amount of time required by the garbage collection team to come and clean the bin, the residents would know within how much time the bins will be cleaned and ready to use. Since in the urban cities the residents are busy enough with their hectic schedule and don't have enough time for managing waste, this system is very useful since it will automatically send complaint message to the higher authority if the bins are not cleaned before the countdown timer exceeds.

The system will provide a better and efficient solution to the problem of waste monitoring and disposal, thereby, giving a solution for unsanitary environmental condition in a city. It creates and follows a more systematic procedure for the collection and disposal of garbage using technology. Using this system we will get one step closer to creating our city a SMART CITY.

7.2 LIMITATIONS:

- When cleaning the bins, the system may get damaged, which may led to errors like improper data being transmitted etc.
- If the sensors on the bins which are used to sense the garbage level are blocked or get damaged the system may misinterpret that to bins being full and send the alert messages.
- During rainy Season the rain water may damage the components present on the bin.eg LCD display will stop working if it comes in contact with water.
- Since the system contains electronic components and wires, there is a possibility of shortcircuit.
- Lack of security
- Since the communication between the bin and the garbage collection team and municipal authority happens using the SIM-Card present in the GSM Module, if the SIM-card has less/No range or if the SIM-Card stops working then, there will be problem in sending and receiving messages.
- The GSM module is powered by a 3.7V external battery, when battery expires,they must be changed otherwise the GSM will stop working.
- While programming, if wrong phone number is entered then alert will be sent to wrong people.

7.3 FUTURE SCOPE:

- The system can be made more convenient by creating an app that will show the bins which are not yet full, so in case bin is unavailable for disposing garbage, the residents would know which are the nearby bins available to dispose garbage.
- In future we can add the functionality of segregating the garbage into dry and wet
- The system can be updated to close the lids when the bins are full, therefore not allowing people to dump anymore garbage in it.
- The automatic lid can also be useful in rainy season, blocking the rain water from entering the bins.
- We can also create an app that will show the exact location and activity of the garbage collection van.
- To make the bins more informative we can also fit a pollution detector sensor on it, to detect the pollution level.
- A Database can be created for every bin in the area to monitor the frequency of bins getting full, which will be useful for sanitization team to know how soon the bin gets full.

REFERENCES:

1. Gaikwad Prajakta, Jadhav Kalyani , Machale Snehal," SMART GARBAGE COLLECTION SYSTEM IN RESIDENTIAL AREA" , IJRET: International Journal of Research in Engineering and Technology,March 2015.
2. Arebey M.Hannan, M.A. Basri, H. , Abdullah, H. "Solid waste monitoring and management using RFID, GIS",2014.
3. Insung Hong, Sunghoi Park, Beomseok Lee,Jaekeun Lee, Daebeom Jeong, and Sehyun Park, "IoT-Based Smart Garbage System for Efficient Food Waste Management", Volume 2014 ,Article ID 646953 ,28 August 2014.
4. Prof. Dr. Sandeep M. Chaware, Shriram Dighe, Akshay Joshi, Namrata Bajare, Rohini Korke "Smart Garbage Monitoring System using Internet of Things (IOT)", IJIREEICE International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, January 2017.
5. Shubham Thakker and R. Narayanamoorthi, "Smart and Wireless Waste Management", IEEE Sponsored 2nd International Conference on Innovations in Information Embedded and Communication Systems, 2015.
6. Abhay Shankar Bharadwaj, Rainer Rego and Anirban Chowdhury, "IoT Based Solid Waste Management System", Frugal Labs Tech Solutions Private Limited Bengaluru Karnataka India, 2016.
7. N. Sathish Kumar, B. Vijaylakshmi, R. Jenifer Prathana and A. Shankar, "IOT Based Smart Garbage alert system using Arduino UNO", IEEE, 2016.
8. Kanchan Mahajan and J.S. Chitode, "Waste Bin Monitoring System Using integrated Technologies", IJERT: International Journal of Innovative Research in Science Engineering and Technology, July 2014.
9. Minhaz UddinSohagAmit KumerPodder, "Smart garbage management system for a sustainable urban life: An IoT based application", Department of Electrical and Electronic Engineering, Khulna University of Engineering & Technology, Khulna 9203, Bangladesh, 5 July 2020.
10. V. Aswin Raaju; J. Mappilllai Meeran; M. Sasidharan; K. Premkumar , Manakula Vinayagar "IOT Based Smart Garbage Monitoring System Using ZigBee" Institute Of Technology, Kuppam, India, 24 October 2019.
11. Abhishek Dev, Maneesh Jasrotia, Muzammil Nadaf, Rushabh Shah, "IoT Based Smart Garbage Detection System", International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 12, December 2016