

IoT Based Intelligent Dustbin Monitoring System

A Project Submitted in Partial Fulfillment of the Requirements for
the Degree of Bachelor of Science in Computer Science and
Engineering of the University of Asia Pacific
by

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DECLARATION

We, hereby, declare that the work presented in this Project is the outcome of the investigation performed by us under the supervision of Shammi Akhtar, Assistant Professor, Department of Computer Science, University of Asia Pacific. We also declare that no part of this Thesis and thereof has been or is being submitted elsewhere for the award of any degree or Diploma.

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ACKNOWLEDGEMENT

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ABSTRACT

A healthy environment is a vital part of living in a healthy and happy community. The major goal of this project is to create an intelligent dustbin that will keep our environment clean and environmentally friendly. For a smart lifestyle, Cleaning is necessary, and cleanliness comes with an Intelligent dustbin. The idea of an Intelligent dustbin is designed for use in buildings, colleges, and hospitals. Intelligent Dustbin therefore thought is an improvement over the normal Dustbin by raising it to become intelligent through the use of sensors and logic. It's a new concept that uses ultrasonic sensors to detect garbage levels and then sends a message to the garbage collector via the GSM module, updating the bin's status. With the help of technology, we have implemented IoT-based intelligent bin management solutions and initiatives that reduce the amount of time and energy required, to send an SMS immediately when the dustbin is full. Due to a number of factors such as the socio-economic environment, developing countries are unable to implement existing solutions. So in this project, we focused our thinking on developing an IoT-based intelligent garbage monitoring system for developing countries like Bangladesh.

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Chapter-1

Introduction

1.1 Garbage Monitoring System

As the world's nations develop, so do their concerns and accountability for a healthier and more sustainable environment are also increasing. Developed countries are inventing and implementing smart garbage management solutions, which are having a huge positive impact [1]. While developed countries can manage and treat different types of garbage materials of different categories, developing countries such as Bangladesh struggle with the collection and proper disposal of common household garbage. The majority of the time, we see images of garbage bins that are overflowing with garbage. As a result, it leads to an increase in diseases caused by a large number of insects and mosquitoes [2]. Due to a variety of factors such as socioeconomic environment and unplanned infrastructural issues, implementing existing smart solutions for garbage management systems in developing countries such as Bangladesh is a far greater challenge.

1.2 Motivation

Garbage management is a major issue in poor developing countries, as waste is strewn across the road as a result of improper collection and disposal methods, polluting the environment. This creates ugliness as well as some serious diseases. At the same time, the foul odor spreads and it also degrades the valuation of that area. Existing intelligent solutions are incompatible in developing countries like Bangladesh Due to many factors, including socioeconomic and cultural constraints. There are fundamental issues with waste management's primary tasks, such as proper disposal, collection, sorting, recycling, and so on [1]. To avoid this, we developed an Intelligent dustbin monitoring system, which is a GSM-based waste and garbage collection bins overflow indicator system for Smart cities, offices, and supermarkets, among other places.

1.3 Problem Statement

The most significant problem regarding garbage management in developing countries begins at the very starting point of the process. Due to the lack of proper systems for disposal and collections, wastes and garbage end up on the roads and surroundings. Most waste bins on the market are manually operated, and they use leg and hand to open the lid of the dustbin, allowing a person to dispose of the trash. People can't dispose of their trash without touching the dustbin, so it's not a user-friendly system. Sometimes, we can see the trash overload in cities, but the garbage cleanup team cleanup is slow to take action for the collected trash. The cleaner does not accept any

instructions or information about the overflowing trash inside the dustbin. In this age, monitoring the dustbin is still a time-consuming and inefficient process, so this project was created to make cleaning work faster and easier. Another issue is that many people are not interested in using dustbins for littering because they are not interested in coming near the dustbin. As a result, this project can attract people's attention to the use of dustbins because it is a very efficient and modern system.



Fig 1. Unhealthy Garbage Management

Chapter-2

Related Works

2.1 Literature Review

Since smart cities have become a center of attraction for developing countries' advancement, and without the removal or solution to the garbage problem, these cities will lose their attraction. As a result, a large number of projects and research are being developed in the field of smart garbage for smart cities, and these projects are being implemented below:

1. Sinha et al. (2015) proposed that Smart Dustbins can significantly reduce garbage along the roadside, thereby limiting the spread of various diseases. Both of these issues can be avoided by preventing pollution and the consumption of garbage spread by street animals. This smart bin can make a significant contribution to maintaining a clean and sanitary environment. in building a smart city. [3]
2. To effectively control municipal solid waste, Issac et al. (2013) suggested a system known as SVASTHA (a Sanskrit word that means healthy and hygienic). In this RFID and GPS-based system, data is collected via an RFID reader through Bluetooth and stored on a central server.[4]

3. Priya A. et al. (2018) suggested a "smart garbage monitoring and collection system using IoT. A smart garbage monitoring and collection system using the internet of things (IoT) is described in this paper as an innovative system. It is controlled by an Arduino board, and two dustbins were used for dry and wet garbage. The moisture sensor will detect these two types of garbage, and the dustbin will open or close automatically. To detect the level of garbage, an infrared sensor is placed inside the dustbin. When a garbage level reaches a certain threshold, it will send a call and a message to the garbage collection person using the GSM module, and the level will be displayed on a web server using an IoT module.[5]
4. Sharma et al. (2018) proposed a smart dustbin management system that uses IoT devices and the ionic framework to ensure that dustbins are cleaned when garbage levels reach their maximum levels. If the dustbin is not cleaned by a certain time, the record is forwarded to a higher authority, in this case, the admin, who can take appropriate action against the concerned employee. This system also includes a PIR sensor, an IR sensor, and an APR module. The servo motor opens the West dustbin gate when the PIR sensor detects motion, and the APR module feeds it information for at least 30 seconds when the PIR detects motion. [6]

5. Nagaraju et al. (2017) In the last few decades, the rate of Urbanization has increased tremendously. At the same time, phase waste production has increased. Management of waste has been a crucial issue to consider. The purpose of this paper is to help accomplish this noble goal. Arduino Uno Microcontroller and a GSM modem with an ultrasonic sensor are used to construct a smart bin in this paper. On top of the dustbin is an ultrasonic sensor that measures its height. The height of the threshold is set at 10 cm. [7]

2.2 Proposed System

Now a days dustbin is overflowing, the proposed system will help in reducing the overflow of dustbin because mosquitoes and houseflies reproduce primarily in the garbage, which is a major cause of many diseases such as malaria, dengue fever, and chikungunya, among others. As a result, headaches and stress levels increase. It will provide real-time data on the level of the garbage. when the intelligent dustbin is full, It will send the message quickly. Dustbin deployment based on actual requirements. This system is budget-friendly and easy to implement. Reduces bad smell and makes cities cleaner, which improves environmental quality. It is open automatically without the need to touch the lid. It is maintained in order to keep the environment clean.

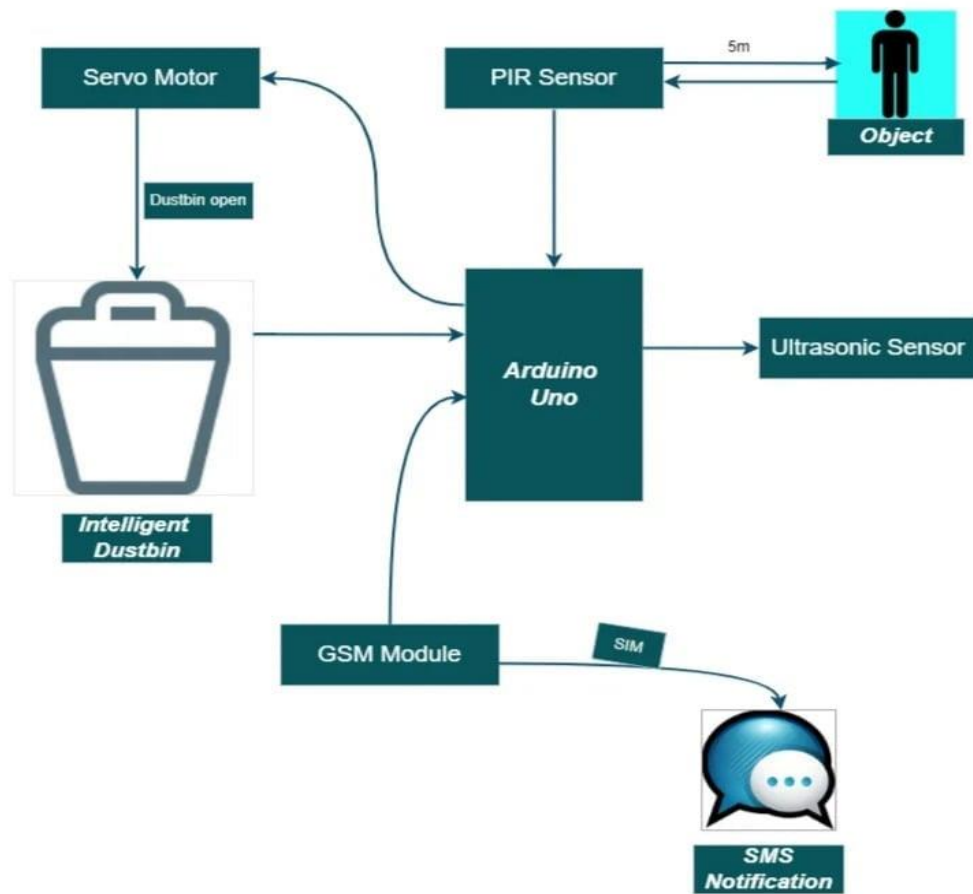


Fig 2. Proposed system model

Chapter-3

Methodology

An IoT-based project using Arduino is an intelligent dustbin. We use a Microcontroller when executing the code. We used an ultrasonic sensor to open the lid and wait a few moments for detection. Everything is being improved by intelligent technology for the benefit of humans. So this helps to keep the environment clean using technology. It is a sensor-based dustbin to be easy that anyone of any age can use.

3.1 Working Procedure

when the system is running, Arduino keeps monitoring for all things approaching the sensor within a certain range. At First, The Ultrasonic Sensor and Servo Motor are first connected to the Arduino's respective pins. This completes the build process of the Intelligent Dustbin. Code has been submitted to Arduino, along with all hardware and software connections to the dustbin. We will run the dustbin, wait for it to work or not.

When the PIR sensor detects an object such as a hand or others, Arduino calculates its distance here. The servo motor is turned on first if it is less than a predefined value, and the extended arm supports the lid [15]. The lid will open for a set amount of time then it will automatically close.

After completion of the entire process, GSM is attached inside the intelligent dustbin. A GSM module will be controlled by a microcontroller board to send an SMS Notification containing an intelligent dustbin and an alert message to a predefined

phone number when the intelligent dustbin's distance detector sensor indicates that it is full

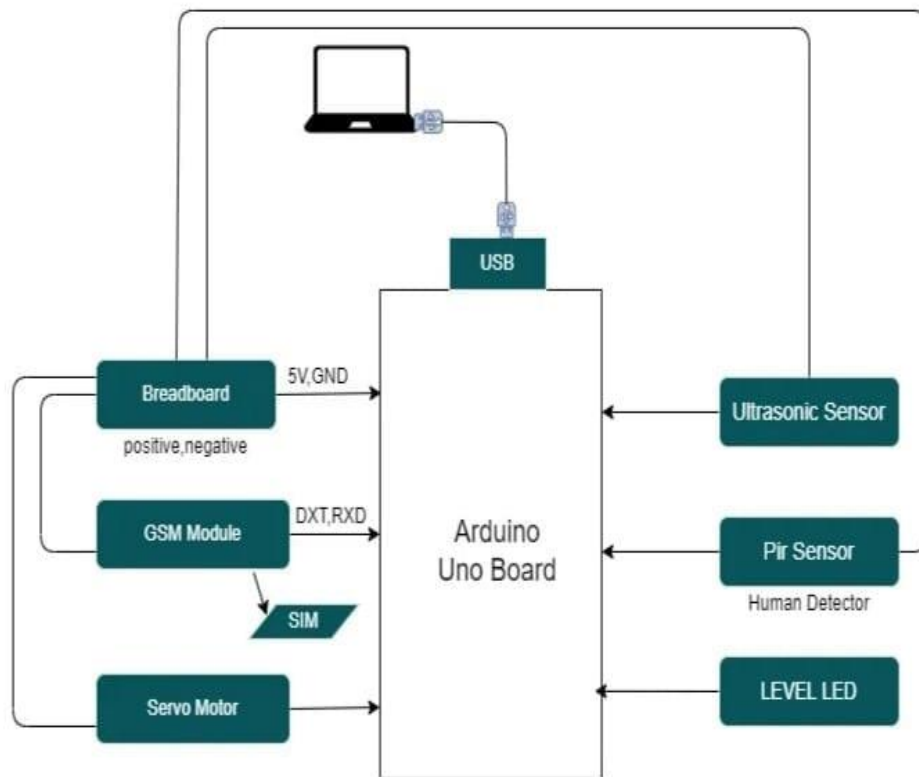


Fig 3. Working procedure process

3.2 Comparison with others system

To lead a healthy life, a hygienic environment is essential. Based on this concept, we have designed an intelligent dustbin that reduces air pollution and makes our environment more hygienic. Nowadays lots of smart dustbins are being made by conscious people but among them, hardly very few dustbins are organized and the rest of them are very simple which can't take efficient impact also can't catch user attraction. The system we propose here has an exceptional quality that not only reduces air pollution but also attracts users and increases their curiosity to use our intelligent dustbin. Like there are lots of dustbins where user need to use hand for opening and closing the gate of dustbin but in our proposed system user don't need to use hand for opening and closing the gate of the dustbin. Hereby using the sensor in a certain range the gate will automatically open and close, that's why people can easily put the garbage inside the dustbin. After the dustbin becoming full to notify the garbage collector is an issue so here we have used GSM Module which will help to generate a notification message then this message will be sent via SMS to the garbage collector.

Chapter-4

Components

4.1 Arduino Uno Board

Arduino is a company that makes open-source hardware and software for electronic projects. Various microprocessors and microcontrollers are used on the Arduino board. The Arduino board consists of a set of digital and analog input/output pins. Among the Arduino family, the Uno is the most popular. Uno represented Italy and was chosen for the Arduino Software release (IDE). These systems provide digital and analog I/O pins that interact with various expansion boards (called shields) and other circuits. To load programs from personal computers, the boards have serial communication interfaces, including the Universal Serial Bus (USB) on some models. The Arduino project provides an embedded development environment (IDE) based on the Processing programming language, which supports C and C++ for microcontroller programming.[8]



Fig 4. Arduino Uno Board

4.2 Ultrasonic Sensor

Ultrasonic sensors, as the name suggests, use ultrasonic waves to measure distance. The sensor head emits an ultrasonic wave, which the target reflects. Ultrasonic sensors calculate the distance to the target by measuring the time between transmit and receive. The optical sensor uses a transmitter and receiver, whereas the ultrasonic sensor uses one ultrasonic element for both emission and reception. In an ultrasonic sensor reflective model, there is only one oscillator that emits and receives alternating ultrasonic waves. As a result, the sensor head can be made smaller.[9]



Fig 5. Ultrasonic Sensor

4.3 GSM Module

GSM (Global System for Mobile Telecommunications) is a digital cellular technology that allows mobile voice and data services to be communicated. GSM differs from first-generation wireless systems in that it executes digital technology and transmission methods known as Time Division Multiple Access (TDMA). Every 200 kHz channel is divided

into eight 25 kHz slots by the GSM circuit switching system. In Europe, GSM uses the 900 MHz and 1.8GHz bands, while in the United States, it uses the 1.9GHz and 850 MHz bands. In Australia, Canada, and many South American countries, the 850MHz band is also used for GSM and 3GSM. It supports data transfer rates of up to 9.6 kilobits per second, allowing for the transmission of critical data services like SMS (Short Message Service). Another significant advantage is its international roaming capability, which allows users to use the same services they would at home while traveling abroad. This provides consumers with continuous and same-number connectivity in more places.[10]



Fig 6. GSM Module

4.4 Servo Motor

A servo is a system that uses error-sensing feedback control to improve its performance. A complex controller, which is typically a specific servomotor module, is also required. A servo motor is a DC motor that can precisely control angular position. These are DC motors with gears that gradually reduce the motor's speed. Servomotors are typically turned off between 90 and 180 degrees. On some servomotors, a 360° or more revolution cut-off is also available. Servo motors, on the other hand, do not rotate indefinitely. Their rotation is restricted to predetermined angles. [11]



Fig 7. Servo Motor

4.5 PIR Sensor

A passive infrared sensor (PIR sensor) is an electronics sensor that measures the amount of infrared light (IR) emitted by objects in their field of view. PIR motion sensors use them the most. PIR sensors are commonly used in security and automatic lighting systems. PIR sensors detect movement in general but don't tell you who or what moved. In order to do so, you'll need an imaging infrared sensor. PIR (passive infrared detector) sensors are also known as "PIR" or "PID." The term "passive" refers to the fact that PIR detectors do not emit any energy in order to detect something. They detect infrared radiation (radiant heat) that is emitted or reflected entirely by objects. [12]



Fig 8. PIR Sensor

4.6 Garbage Container

A Dustbin is just a garbage container used to store garbage and is manufactured from metal or plastic or anything complicated to store waste materials. They hold in different kinds of renewable and non-renewable materials and help keep the environment clean.



Fig 9. Garbage Container

4.7 Jumper Wires

Jumper wires are used in a circuit to connect two points. Jumper wires are frequently used with breadboards and other prototyping tools to facilitate circuit change when necessary, and All Electronics stocks them in a variety of lengths and assortments. Male jumpers are designed to plug securely into the holes on the breadboard. Male header posts and pin terminals on components are connected using female jumpers. Female-female, male-male, and male-female jumper combinations are available.[13]



Fig 10. Jumper Wires

4.8 LED

A light-emitting diode (LED) is a light-emitting semiconductor device. The energy is released as photons as the electrons in the semiconductor recombine with electron holes. The energy required for electrons to pass across the semiconductor's bandwidth determines the color of light. More than one semiconductor or a layer of phosphors emitting light on the semiconductor device are used to produce white light. [14]



Fig 11. LED

4.9 Breadboard

Electronic circuits are prototyped on breadboards. It used to be a breadboard, a polished piece of wood for slicing bread. Because it does not need to be soldered, the solderless breadboard is reusable. As a result, circuit design prototyping and experimentation are simple. Solderless breadboards are becoming more popular among students and in technological education as a result. This property was not available in older breadboard types. Stripboards (Vero boards) and other

prototyping printed circuit boards, which are used to construct semi-permanent prototypes, are difficult to reuse. Breadboards can be used to create digital and analog circuits, as well as complete central processing units, in addition to prototyping electronic systems (CPUs) [16]

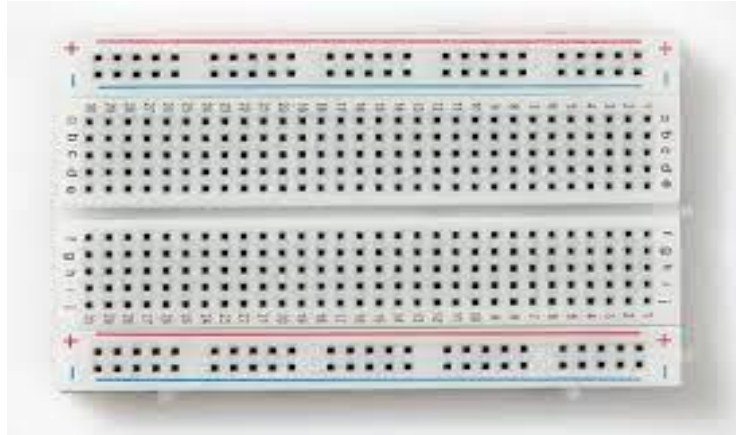


Fig 12. Breadboard

4.10 Arduino IDE

The Arduino project enables the development of the Arduino Environment (IDE), a Java-based cross-platform program. It comes from the IDE for the Processing and Wiring programming languages. Its goal is to teach artists and other newcomers who aren't familiar with software development how to program. It comes with a code editor that includes syntax highlighting, brace mapping, and automatic indentation, among other things. It allows you to compile and load programs to an Arduino board with a single click. A "sketch"

is a program created with the Arduino IDE. The Arduino IDE supports C and C++ by organizing the code with special rules.[2]

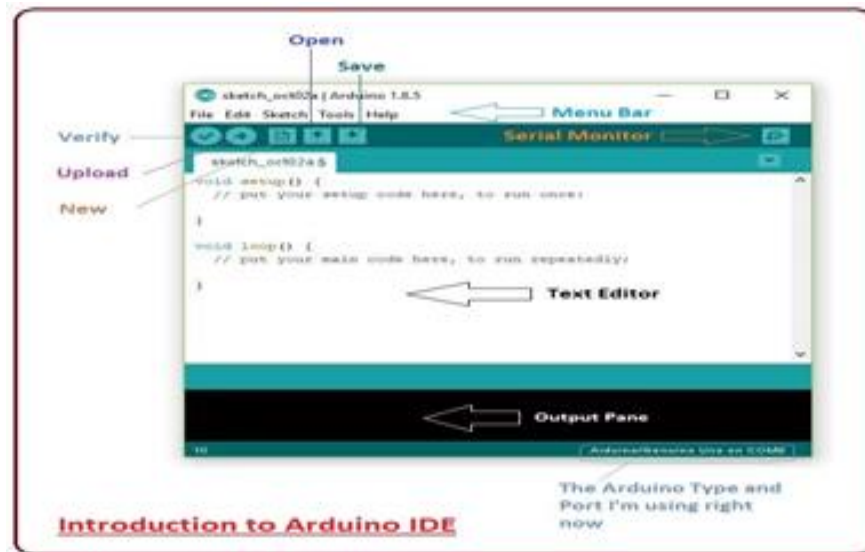


Fig 13. Arduino IDE

Chapter-5

Result Analysis

5.1 Experimental Results

After wiring and connecting all of the devices and setting up to the Intelligent Dustbin, check all of the important setups to see if anything is missing. After the connection has been established, the next step is to upload/submit code to Arduino and supply power to the circuit. When the system is powered on, Arduino monitors any things that come within a certain range of the sensor. If a person approaches the dustbin within 5 meters, the PIR sensor detects the object, Arduino calculates its distance, and if it is less than a predefined value, the servo motor is activated first, and the lid will open for a given time then it will automatically close after the 30s. We measure the garbage level with an ultrasonic sensor placed over the bins and compare it to the depth of the garbage. In the initial stage when the lid is open, the green led will be ON. when the garbage level is to be 50% then the yellow led will be ON. when the garbage level is to be 100% the red led will be ON. Finally, when the dustbin is filled with garbage, the GSM module will send a small message to the phone that "Dustbin is Full"



Fig 14. Initially the dustbin lid is closed

When dustbin power is off, it's will be look like that.



Fig 15. Dustbin lid is open & green led on

In the initial stage when the lid is open, the green led will be ON.



Fig 16. Lower half of dustbin is full & yellow led on
when the garbage level is to be 50% then the yellow led will be ON.



Fig 17. Dustbin is full & red led on
when the garbage level is to be 100% the red led will be ON.



Fig 18. Dustbin is full & message has received

Finally, when the dustbin is filled with garbage, the GSM module will send a small message to the phone that "Dustbin is Full"

Chapter-6

6.1 Conclusion

When these Intelligent dustbins are designed, various features such as sustainability, affordability, damage prevention, and maintenance issues are addressed. In building a smart city, this Intelligent Dustbin can make a significant contribution to a clean and hygienic environment. Bangladesh's population is growing at a rapid rate, and waste is being produced at a similar rate, but the waste management system has not improved in comparison to waste production. The goal of making Bangladesh Digital is to use modern technology to create a more sustainable human settlement and improve people's quality of life. We have presented our model Intelligent Dustbin which uses technology to provide a more eco-friendly approach to waste management systems. As a result, the above IoT-based Intelligent Dustbin Monitoring System can be a very effective waste management system for Dhaka City and other Bangladeshi cities. This model will digitalize and modernize the cities by applying the IoT-based Intelligent Dustbin monitoring system of Bangladesh.

6.2 Future Scope

This intelligent dustbin concept system is useful to make our environment clean and reduce air pollution. Our proposed smart dustbin system is very much organized and effective. But in the future, we can develop it better by adding more functionality. We will use an extra sensor so that the Entering of rainwater or any water inside or touching outside of the

dustbin couldn't harm the intelligent dustbin Also, for lazy and luxurious people here, we will add a wheel under the Intelligent dustbin and use a sensor so that the user can access the mobile Bluetooth device, and the user can control the dustbin by mobile Bluetooth device, so the user doesn't need to move towards the dustbin. Now when the user wishes they can use the Bluetooth functionality when the user uses it the dustbin will come towards the user. The gate of the dustbin will automatically open when the user puts waste into it, then the gate will automatically close, and the dustbin will move to its place where it was before.

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Appendix A: Source Code

```
#include<SoftwareSerial.h>
#include<Servo.h>

Servo S1;

int pirPin = 2;    //Define PIR pin
int pirStat = 0;

const int EchoPin = 10; //Define ultrasonic pin
const int TrigPin = 8;

int led1 = 11;    // Define leds
int led2 = 12;
int led3 = 13;

SoftwareSerial mySerial(7,6);
bool once = false;

void setup()
{
  S1.attach(9);

  pinMode(TrigPin, OUTPUT);
  pinMode(EchoPin, INPUT);

  pinMode(led1, OUTPUT);
  pinMode(led2, OUTPUT);
  pinMode(led3, OUTPUT);

  mySerial.begin(9600);
  Serial.begin(9600);
  Serial.println("Initializing...");
  delay(500);

  mySerial.println("AT"); // Sends an attention command, reply should be ok
  maincode();
  mySerial.println("AT+CMGF=1"); // Configuration for sending SMS
  maincode();
  mySerial.println("AT+CNMI=1,2,0,0,0"); // Configuration for receiving SMS
  maincode();
}
long Duration, Distance;
```

```

void loop()
{
  maincode();
}

void maincode()
{

  pirStat = digitalRead(pirPin);
  if (pirStat == HIGH) {          //Human detection
    S1.attach(9);
    Serial.println("Human Detected, Dustbin open...");
    S1.write(0);
  }
  if(pirStat == LOW)
  {
    S1.write(500);
    Serial.println("Dustbin close...");
  }

  //Ultrasonic value measuring
  digitalWrite(TrigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(TrigPin, HIGH);
  delayMicroseconds(5);
  digitalWrite(TrigPin, LOW);
  Duration = pulseIn(EchoPin, HIGH);
  Distance = ((Duration*0.034)/2);

  if ( Distance>=0 && Distance <= 5){

    digitalWrite(led1, HIGH);
    digitalWrite(led2, HIGH);
    digitalWrite(led3, HIGH);
    Serial.println("Dustbin is full");
    // Sending SMS
    if (once == false)
    {
      Serial.println("Sending SMS.....");
      sendSMS();
      Serial.println("SMS sent....");
      once = true;
    }
  }
}

```

```

}

if(Distance>6 && Distance <=15){

    digitalWrite(led1, HIGH);
    digitalWrite(led2, HIGH);
    digitalWrite(led3, LOW);
    Serial.println("Dustbin is 50% full");

}

if(Distance>15 && Distance <=30){
    digitalWrite(led1, HIGH);
    digitalWrite(led2, LOW);
    digitalWrite(led3, LOW);
    Serial.println("Dustbin is Empty");

}

}

void sendSMS(){ //SMS sending function
S1.detach();
mySerial.println("AT+CMGF=1");
delay(500);

mySerial.println("AT+CMGS=\"01793192906\\r\"); // Number where SMS will send

delay(500);
mySerial.print("Dustbin is full!");
delay(500);
mySerial.write(26);
S1.attach(9);
}

```

Appendix B: CEP Mapping

How P's are addressed through the project and mapping
among Ps, COs, and POs

Ps	Attribute	How P's are addressed through the project	COs	POs
P2	Wide-Ranging	<ul style="list-style-type: none"> Due to improper methods of garbage collection & dumping thus polluting the environment & also creating ugliness and some serious diseases, at the same time the bad smell is also spread and it also degrades the valuation of that area. This is a real-life problem. Our main aim was to design an Intelligent Dustbin by detecting and leveling, to keep our environment clean and eco-friendly and we have developed that. 	1	l
P1	Depth of Knowledge Requirement:	<ul style="list-style-type: none"> The project involves looking at existing models with similar objectives. Intelligent dustbin control has been performed and implemented using various sensors. 	2	b c
P4	Finance	<ul style="list-style-type: none"> To implement the Intelligent dustbin project, we have purchased hardware components. 	3	k
P3	Obvious solution	<ul style="list-style-type: none"> We have built a system called Intelligent dustbin based on IoT. After completing this project we have found that it is working very smoothly. it is very easy to maintain and also very much helpful to keep surroundings hygienic. More importantly it is very much sustainable. 	4	g
P6	Diverse Groups	<ul style="list-style-type: none"> Here to build this sort of project technological sense must be required. We can take it professionally by making these kinds of projects more and more and selling them to people. It will make our surroundings clean and also create 	5	f h

		<p>consciousness among people to use it for a healthy environment that has a social impact. Here our responsibilities are to use it, maintain it and encourage others to use it only for the purpose of making our environment clean and hygienic.</p> <ul style="list-style-type: none"> • People of all ages and classes can use the Intelligent dustbin. 		
P7	Many components	<ul style="list-style-type: none"> • We have read multiple papers individually to find the problem. • The hardware components were collected with the team. 	6	i
P5	Development and Tools	<ul style="list-style-type: none"> • We have made this project very systematically with messaging and levelling systems. We also used a sensor that is for automatically on/off the lid of the Intelligent dustbin. • We haven't faced much problem creating this project without in messaging system, firstly we haven't got the power supply in the GSM module but at the end of the day, we have solved all our problems. • Arduino IDE, Arduino Uno, Ultrasonic sensor, PIR Sensor, Servo Motor, GSM Module, LED. 	7	c d e
P8	Present Design	<ul style="list-style-type: none"> • Report prepared and presenting by team. 	8	j

How A's are addressed through the project

A's	Attribute	How A's are addressed through the project
A1	Range of resources	The project has to make use of various resources including money, information, electronic components such as Arduino Uno, PIR Sensor, Servo Motor, Ultrasonic Sensor and GSM module.
A2	Level of interaction	The level of interaction among the members of the group was very high during the creation of the architectural design of our project.
A3	Degree of innovation	Knowledge of innovation was required to develop the Intelligent dustbin monitoring system based on IoT.
A4	Consequences For the environment	The intelligent dustbin plays an important role in achieving a clean and hygienic environment.
A5	Familiarity	The project aims to encourage people to put their household garbage into an intelligent dustbin.