# Ultrasonic Sensor Equipped Automatic Object Sensing Smart Dustbin

## Submitted By


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Graduation Exercise Submitted to the Department of Mechanical Engineering in Partial Fulfillment of the Requirements for the Degree ofBachelor of Science in Mechanical Engineering


DEPARTMENT OF MECHANICAL ENGINEERING
SONARGAON UNIVERSITY
DHAKA, BANGLADESH

20 September, 2023

# DECLARATION

We hereby declare that this thesis is our own work and to the best of our knowledge it contains no materials previously published or written by another person, or have been accepted for the award of any other degree or diploma at Sonargaon University or any other educational institution. We also declare that the intellectual content of this thesis is the product of our own work and any contribution made to the research by others, with whom I have worked at Sonargaon University or elsewhere, is explicitly acknowledged.

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# CERTIFICATION OF APPROVAL

The thesis title "Arduino Based Automatic Object Sensing Smart Dustbin with auto filled pre-indication system." submitted by Md.Akram Hossain(BME1902018068),Md Sabbir Hosen Akash(BME2001020496), MD Shahanur Rahman (BME2001020498), Md. Ariful Islam (BME2001020429), Md.Al amin (BME2001020118) Has been accepted as satisfactory partial fulfillment of the requirement for the degree of bachelor of science in mechanical engineering on 20 September, 2023.

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# ABSTRACT

The main objective of the project is to design a smart dustbin which will help in keeping our environment clean and also eco friendly. Nowadays technologies are getting smarter day-by-day so, as to clean the environment we are designing a smart dustbin by using Arduino. This smart dustbin management system is built on the microcontroller-based system having ultrasonic sensors on the dustbin. If dustbin is not maintained than these can cause an unhealthy environment and can cause pollute that affect our health. In this proposed technology we have designed a smart dustbin using ARDUINO UNO, along with ultrasonic sensor, servo motor, and battery jumper wire. To implement a smart bin built on a microcontroller-based platform Arduino Uno board which is interfaced with inferred sensor that alarmed bin waste level & Ultrasonic sensor which senses object and open and closed bin cover through servo motor. It's properly running or not. For social it will help toward health and hygiene, for business for we try to make it affordable to many as many possible. So that normal people to rich people can take benefit from it.

# Table of Contents

# List of Figures

# Chapter 1
# Introduction

## 1.1 Overview:

Dustbins (or Garbage bins, Trash Cans, whatever you call them) are small plastic (or metal) containers that are used to store trash (or waste) on a temporary basis. They are often used in homes, offices, streets, parks etc. to collect the waste. In some places, littering is a serious offence and hence public waste containers are the only way to dispose small waste. Usually, it is a common practice to use separate bins for collecting wet or dry, recyclable or non-recyclable waste.

In this project, I have designed a simple system called Smart Dustbin using Arduino, Ultrasonic Sensor, and Servo Motor, where the lid of the dustbin will automatically open itself upon detection of human hand. The **smart dustbin** is a carefully designed solution that solves the social issue of waste disposal; the **smart dustbin** identifies the kind of material being thrown inside it and segregates it into bio or non-biodegradable.

## 1.2 Objectives:

1.To ensure protection of the environment through effective waste management.

2.To protect the health and wellbeing of people by providing an affordable waste collection service.

3.Ensure separation at source in all metropolitan and local municipalities

4.Increase thermal treatment and conversion of waste to energy

5.Preventing pollution and ecological degradation

6.It uses green energy

# Chapter 2
# Literature Review

The advent of smart cities and growing environmental concerns have catalyzed innovative waste management solutions. One such innovation is the integration of ultrasonic sensors into waste bins, leading to the development of smart waste bins. This paper presents a thorough literature review of ultrasonic sensor-based smart waste bins, elucidating their operational principles, advantages, challenges, and prospects for future development.

## 2.1 Introduction of Literature Review

The concept of smart waste bins, equipped with ultrasonic sensors for fill-level detection, is gaining prominence in modern waste management systems. These sensors employ high-frequency sound waves to measure the level of waste within a bin. The data generated is transmitted to a centralized management system, enabling real-time monitoring and efficient waste collection [1] [2].

## 2. Operational Advantages of Ultrasonic Sensor-Based Smart Waste Bins

### 2.1. Enhanced Waste Collection Efficiency

Ultrasonic sensor-based systems offer a substantial enhancement in waste collection efficiency. They enable waste management entities to optimize collection routes and schedules based on real-time data, thereby reducing operational expenses and minimizing fuel consumption [3].

### 2.2. Environmental Impact Reduction

Through optimized collection routes, smart waste bins diminish the number of waste collection vehicles on the road, resulting in reduced greenhouse gas emissions. Furthermore, they prevent overflows, mitigating litter and environmental contamination [4].

### 2.3. Cost Savings

Municipalities and waste management organizations can significantly reduce costs related to unnecessary collections and cleanup operations. This economic advantage further strengthens the case for deploying ultrasonic sensor-based systems [5].

### 2.4. Improved Public Health and Hygiene

By preventing overflows that can attract pests and promote the spread of diseases, smart waste bins contribute to maintaining public health and hygiene [6].

### 2.5 Challenges and Limitations

#### Initial Costs

The initial investment required for the implementation of ultrasonic sensor-based systems, including sensors, communication infrastructure, and software, can be substantial, which may pose challenges for smaller municipalities and organizations [7].

#### Maintenance

Ultrasonic sensors are sensitive to environmental factors such as dust, moisture, and temperature fluctuations. Consequently, regular maintenance is essential to ensure the accuracy of fill-level readings [8].

#### Data Security and Privacy

Concerns regarding data security and privacy arise as smart waste bins collect data on waste generation patterns. Proper measures must be implemented to safeguard sensitive information [9].

#### Integration with Existing Infrastructure

Retrofitting existing waste bins with ultrasonic sensors can be complex due to compatibility issues and the need for infrastructure upgrades [10].

#### Prospects for Future Development

#### IoT Integration:

Integrating ultrasonic sensor-based waste bins into the Internet of Things (IoT) ecosystem has the potential to enhance their functionality. This may include real-time data analytics, predictive maintenance, and dynamic route optimization [11].

**Sensor Miniaturization**

Ongoing research aims to reduce the size and cost of ultrasonic sensors while maintaining their accuracy. Smaller, more affordable sensors could pave the way for wider adoption of this technology [12].

**Energy Efficiency**

Innovations in sensor technology may lead to more energy-efficient ultrasonic sensors, reducing power consumption and extending sensor battery life [13].

**Smart Sorting**

Future iterations of smart waste bins may incorporate sorting mechanisms to separate recyclables from general waste, further enhancing waste management processes [14].

Ultrasonic sensor-based smart waste bins represent a promising advancement in waste management systems, offering enhanced efficiency, reduced environmental impact, cost savings, and improved public health and hygiene. While challenges such as initial costs, maintenance, data security, and integration persist, ongoing developments in IoT integration, sensor miniaturization, energy efficiency, and smart sorting hold the potential to address these challenges and further propel the adoption of this technology.

# Chapter 3

# Components and Working Procedures

3.1 **Components Required -**

**1**. Arduino UNO

2. Power Source (Battery)

3. Battery Connecting Wire

4.Ultrasonic Sensor

5.Servo motor

6. Inferred Sensor

7. Red LED indicator

8. Dust Bin

9. Male to female Jumper wire

10.Female to male jumper wire

**3.2 Working procedure**

To implement a smart bin built on a microcontroller-based platform Arduino Uno board which is interfaced with inferred sensor that alarmed bin waste level & Ultrasonic sensor which senses object and open and closed bin cover through servo motor.

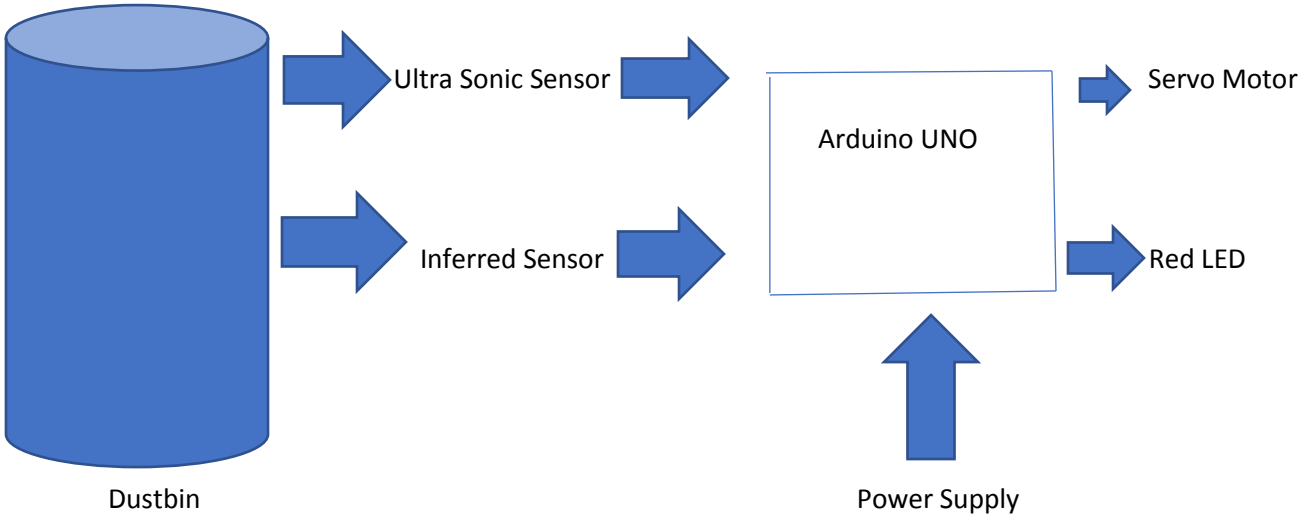



Figure:1 Circuit diagram of smart dustbin

Constituent:

Arduino UNO:

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous

programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board — you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.

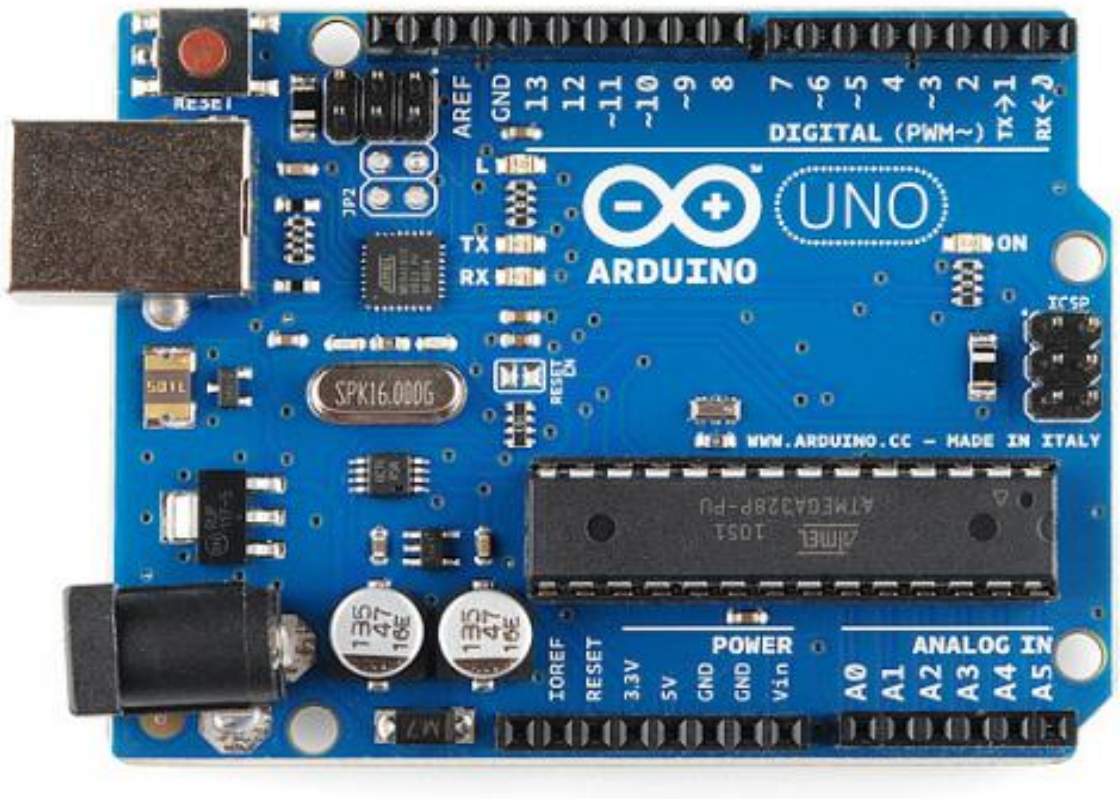



Figure-2: Arduino Uni

The Uno is one of the more popular boards in the Arduino family and a great choice for beginners. The Arduino hardware and software was designed for artists, designers, hobbyists, hackers, newbies, and anyone interested in creating interactive objects or environments. Arduino can interact with buttons, LEDs, motors, speakers, GPS units, cameras, the internet, and even your smart-phone or you're TV! This flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has led to a large community of users who have contributed code and released instructions for **a huge** variety of Arduino-based projects.

Arduino coding can be found in the Appendix-A of this book.

Advantage of Arduino:

- Not much knowledge required to get started
- Fairly low cost, depending on shields you need
- Lots of sketches and shields available
- No external programmer or power supply needed

Disadvantage:

- No understanding of the AVR microcontroller
- Sketches and shields can be difficult to modify
- No debugger included for checking scripts
- You get no experience of C or professional development tools.

Power Source (Battery):

A battery is a device that stores electric power in the form of chemical energy. When necessary, the energy is again released as electric power for DC consumers such as lighting and starter motors. A battery consists of several galvanic cells with a voltage of 2 volt each. For a 12-volt battery, six cells are linked in series and fitted inside a single casing. To achieve 24 volt, two 12-volt batteries are linked in series. Each cell has positive oxidized lead plates and negative lead metal plates, and has an electrolyte consisting of water and sulphuric acid. During discharging, the lead oxide on the lead plates is converted into lead. The acid content decreases because sulphuric acid is required for this process.

**Applications of Batteries:**

The small essential components that can operate many devices are the batteries. It has become one of the key components in our everyday lives. There are some batteries which can be recharged and are used in mostly each and every sector. Some of the applications of the batteries are given below.

- House
- Health Instruments
- Medical
- Logistics and construction
- Firefighting and Emergency
- Military

**Uses of Batteries**

**Battery Use in Home**

We depend on batteries for several gadgets that we use in our house. Devices like remote controls and torches are powered by disposable batteries. Mobile phones, handheld video game consoles, digital cameras, and many other devices use rechargeable batteries, such as alkaline

batteries. Appliances that consume too much power, such as laptops and other devices, are powered by advanced batteries like lithium batteries.

Battery Use in Health Instruments:

There are multiple uses of batteries in different health instruments. Artificial limbs, insulin pumps, hearing aids, and valve assistance devices are some instruments that use batteries to function. Mercury batteries are useful for photographic light metres and electronic devices such as real-time clocks in appliances.

**Battery Use in Medical Sector:**

'Batteries are used in the medical sector to a great extent. ECG heart monitor is connected to a battery so that it can be moved with the patient and is always ON for showing the patient's vitals. Rechargeable batteries like lithium-ion and nickel-cadmium batteries are frequently utilised in hospitals.

**Battery Uses in Logistics and Construction:**

Heavy-duty batteries are employed to power equipment such as forklifts because exhaust fumes and carbon monoxide are generated while combustion can be dangerous in confined workspaces. Batteries used in automobiles are lead-acid batteries.

**Battery Use in Firefighting and Emergency Response:**

Batteries are used in radios, which are crucial for emergency response. Large batteries are required for these radios to store large charges. Batteries are used in ECGs, flashlights, and even metal and fire detectors. These tools save lives daily.

**Batteries Uses in Military Operations:**

The batteries which offer both high energy and power density are widely used in military operations. Batteries are used in radios which are used to communicate. Even infrared goggles and different field devices are powered by batteries. Lithium batteries provide a much longer life to devices, and silver oxide batteries are used in missiles and submarines.

.

| percentage charged | battery voltage | specific gravity | percentage discharged |
|---|---|---|---|
| 0 % | 11.64 V | 1.100 | ± 100 % |
| 20 % | 11.88 V | 1.140 | ± 80 % |
| 40 % | 12.09 V | 1.175 | ± 60 % |
| 60 % | 12.30 V | 1.210 | ± 40 % |
| 80 % | 12.51 V | 1.245 | ± 20 % |
| 100 % | 12.72 V | 1.280 | 0 % |

Figure-3: Battery voltage and Specific gravity relations

Ultrasonic Sensor:

Ultrasonic sensors are used around the world, indoors and outdoors in the harshest conditions, for a variety of applications. Our ultrasonic sensors, made with piezoelectric crystals, use high frequency sound waves to resonate a desired frequency and convert electric energy into acoustic energy, and vice versa. Sound waves are transmitted to and reflected from the target back to the transducer. Targets can have any reflective form, even round. Certain variables, such as target surface angle, changes in temperature and humidity, and reflective surface roughness, can affect the operation of the sensors**.**

**There are two types of ultrasonic sensors:**

**Proximity Detection:** An object passing within the preset range will be detected and generate an output signal. The detect point is independent of target size, material or reflectivity.

**Ranging Measurement:** Precise distance(s) of an object moving to and from the sensor are measured via time intervals between transmitted and reflected bursts of ultrasonic sound. Distance change is continuously calculated and outputted.

As shown in Figure 1 Ultrasonic sensors work 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. Our ultrasonic sensors, like many others, use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse. Figure 2 shows the pin configuration for ultrasonic sensor module (HC-SRO4) which includes.

- Vcc (5 volt Supply )

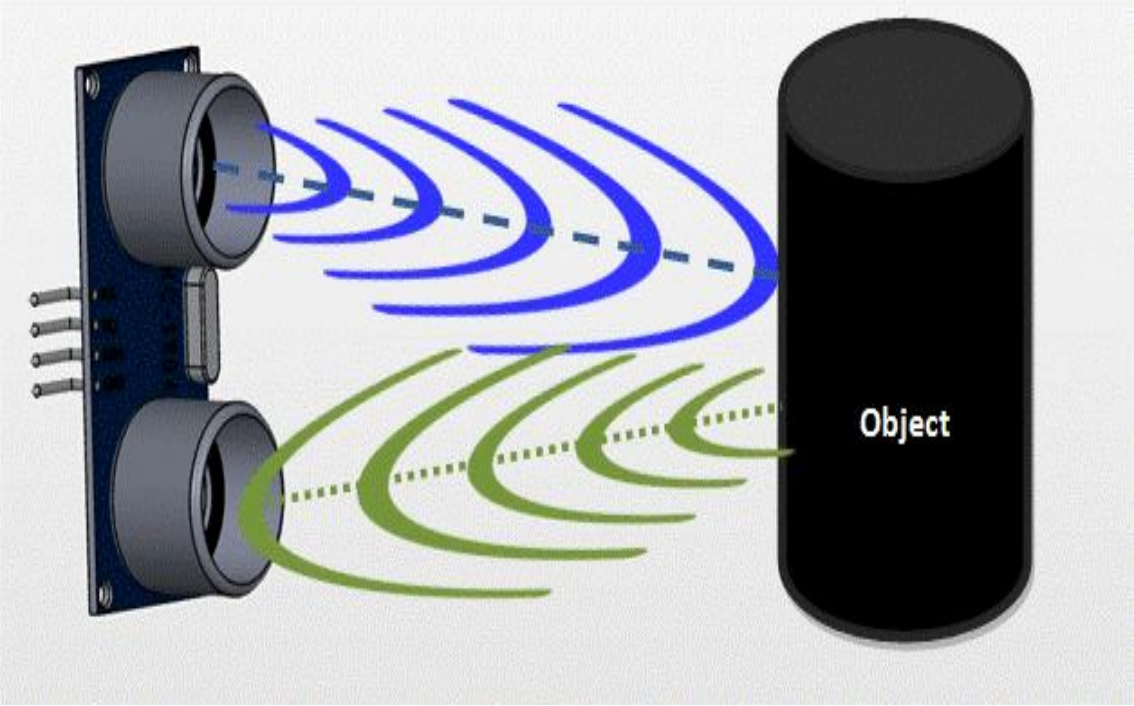
- Trigger pin
- Echo pin
- Gnd (0volt)
- 


Figure 4: Ultrasonic Sensor

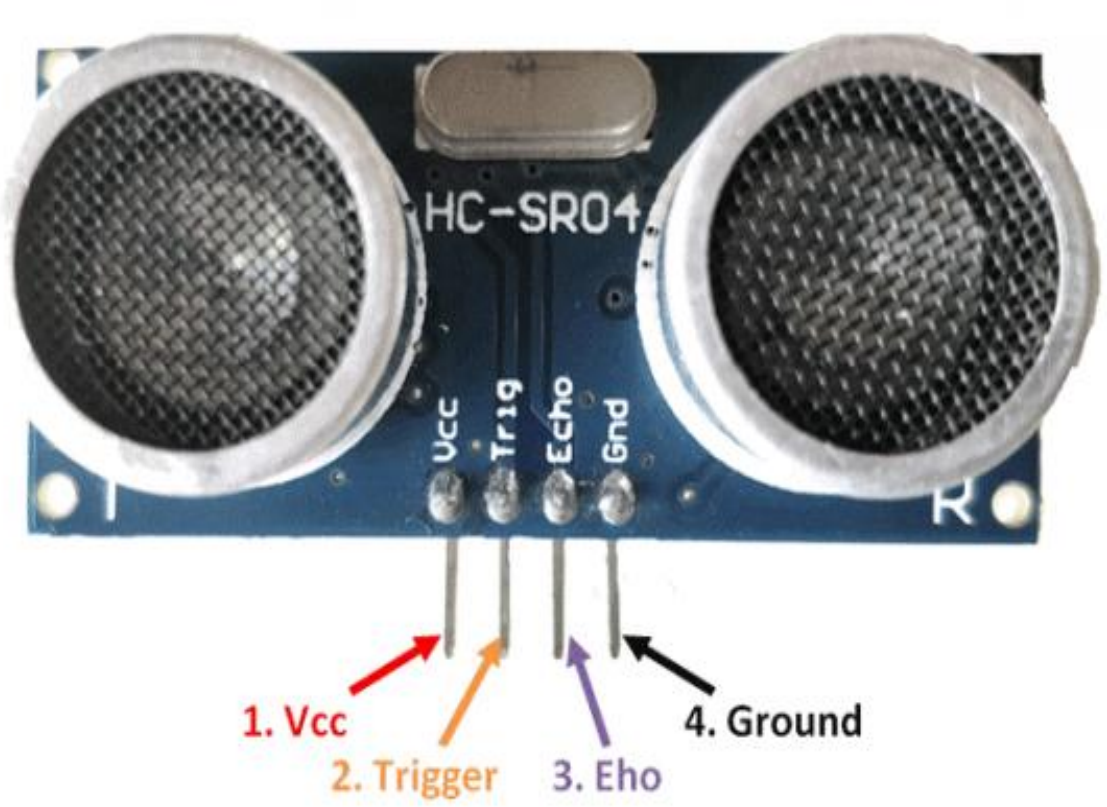



Figure 5: Ultrasonic Sensor

Ultrasonic Sensor Specifications:

- Length: 4.5 cm (1 ¾ in)
- Width: 2.0 cm (¾ in)
- Height: 1.4 cm (½ in)
- Typical price: Around $4
- Supply voltage: 5V
- Operating voltages: 3V or 5V (trigger), 5V all other I/O ports
- Working current: 15mA
- Operating range: 2 cm to 400 cm (1 in – 13 ft)
- Claimed precision: 0.3cm, more realistically: 1cm
- Measuring angle: 15 degrees
- Quiescent Current : : <2mA
- Working Current: 15mA
- Effectual Angle: <15°
- Ranging Distance : 2cm – 400 cm/1″ 13ft
- Resolution : 0.3 cm
- Measuring Angle: 30 degree
- Trigger Input Pulse width: 10Us

- **Applications of Ultrasonic Sensors:**

- Loop control
- Roll diameter, tension control, winding and unwind
- Liquid level control
- Thru beam detection for high-speed counting
- Full detection
- Thread or wire break detection
- Robotic sensing
- 45° Deflection; inkwell level detection; hard to get at places
  - People detection for counting
  - Contouring or profiling using ultrasonic systems
  -
  - **Servo Motor:**
    servo motor is an electrical device which can push or rotate an object with great precision. If you want to rotate an object at some specific angles or distance, then you use servo motor. It is just made up of simple motor which run

Figure 6:Servo Motor

through servo mechanism. If motor is used is DC powered then it is called DC servo motor, and if it is AC powered motor then it is called AC servo motor. We can get a very high torque servo motor in a small and light weight packages. Due to these features they are being used in many applications like toy cars, RC helicopters and planes, Robotics, Machine etc.

- Figure 3 displaying the internal infrastructure of the servo motor and figure 4 shows the angular rotation of the servo motor that how it will perform its angular rotations when a signal will be provided by microcontroller.


Figure 7: Servo Motor

Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.

Micro Servo 9G Specifications:

- Weight: 9 g
- Dimension: 22.2 x 11.8 x 31 mm approx.
- Stall torque: 1.8 kgf·cm
- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Dead band width: 10 µs
- Temperature range: 0 ºC – 55 ºC Position “0” (1.5 ms pulse) is middle, “90” (~2ms pulse) is all the way to the left. ms pulse) is all the way to the right, “”-90″ (~1ms pulse) is all the way to the left.

**Basic Information Modulation:**

- Analog Torque: 4.8V: 25.0 oz-in (1.80 kg-cm)
- Speed: 4.8V: 0.10 sec/60°
- Weight: 0.32 oz (9.0 g)
- Dimensions: Length: 0.91 in (23.1 mm)

- Width: 0.48 in (12.2 mm)
- Height:1.14 in (29.0 mm)
- Motor Type: 3-pole Gear Type: Plastic
- Rotation/Support: Bushing

**Additional Specifications:**

- Rotational Range: 180°
- Pulse Cycle: ca. 20 ms
- Pulse Width: 500-2400 µs

A servo motor consists of three main components:

- A motor: This can be either a DC motor or an AC motor depending on the power source and the application requirements. The motor provides the mechanical power to rotate or move the output shaft.
- A sensor: This can be either a potentiometer, an enco der, a resolver, or another device that measures the position, speed, or torque of the output shaft and sends feedback signals to the controller.
- A controller: This can be either an analog or a digital circuit that compares the feedback signals from the sensor with the desired setpoint signals from an external source (such as a computer or a joystick) and generates control signals to adjust the motor's voltage or current accordingly.

**Applications of Servo Motors:**

Servo motors have a wide range of applications in various fields and industries. Some of the common applications are:

- Robotics: Servo motors are used to provide precise motion and force for robotic arms, legs, joints, grippers, etc. They enable robots to perform tasks such as picking, placing, welding, assembling, etc.
- CNC machinery: Servo motors are used to drive the axes of CNC machines such as lathes, mills, routers, etc. They enable CNC machines to perform accurate and complex machining operations such as cutting, drilling, engraving, etc.
- Automated manufacturing: Servo motors are used to control the movement and position of various components and devices in automated manufacturing systems, such as conveyors, feeders, loaders, unloaders, etc. They enable automated manufacturing systems to achieve high productivity and quality.
- Medical equipment: Servo motors are used to operate various medical devices and instruments such as surgical robots, scanners, pumps, ventilators, etc. They enable medical equipment to perform precise and safe operations and treatments.

Inferred Sensor:

IR sensor is an electronic device, that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the **infrared spectrum**, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.

Figure 8: Inferred Sensor

The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode . Photodiode is sensitive to IR light of the same wavelength which is emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the IR light received.

There are five basic elements used in a typical infrared detection system: an infrared source, a transmission medium, optical component, infrared detectors or receivers and signal processing. Infrared lasers and Infrared LED's of specific wavelength used as infrared sources.

**IR Sensor Circuit Diagram:**

An infrared sensor circuit is one of the basic and popular sensor modules in an electronic device. This sensor is analogous to human's visionary senses, which can be used to detect obstacles and it is one of the common applications in real-time. This circuit comprises the following components

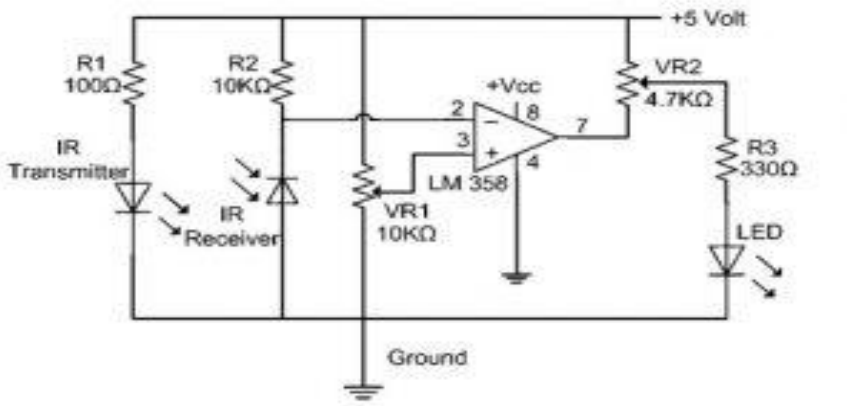
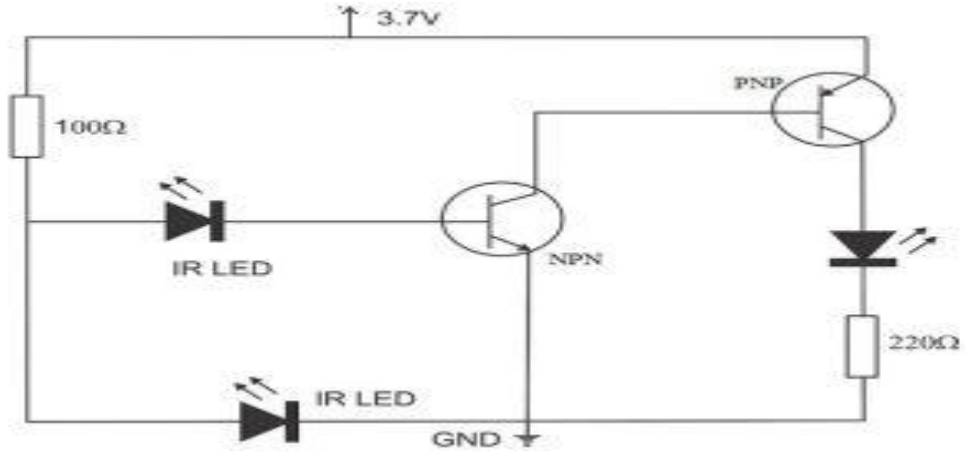



Figure 9:IR Sensor Circuit Diagram

- LM358 IC 2 IR transmitter and receiver pair
- Resistors of the range of kilo-ohms.
- Variable resistors.
- LED (Light Emitting Diode).

**IR Sensor Circuit using Transistor:**

**The circuit diagram of the IR sensor using transistors namely obstacle detection using two transistors is shown below. This circuit is mainly used for obstacle detection using an IR LED. So, this circuit can be built with two transistors like NPN and PNP. For NPN, BC547 transistor is used whereas, for PNP, BC557 transistor is used. The pinout of these transistors is the same.**




**Figur 10:**IR Sensor Circuit using Transistor

**Types of IR Sensor:**
There are two types of IR sensors are available and they are,

- Active Infrared Sensor
- Passive Infrared Sensor

**Active Infrared Sensor:**

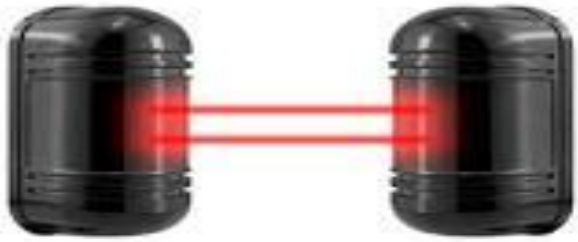


Figure 11:Active Infrared Sensor

Active infrared sensors consist of two elements: infrared source and infrared detector. Infrared sources include the LED or infrared laser diode. Infrared detectors include photodiodes or phototransistors. The energy emitted by the infrared source is reflected by an object and falls on the infrared detector.

**Passive Infrared Sensor:**

**Figure 12: Passive Infrared Sensor**

Passive infrared **sensors** are basically Infrared detectors. Passive infrared sensors do not use any infrared source and detector. They are of two types: quantum and thermal. Thermal infrared sensors use infrared energy as the source of heat. **Thermocouples**, pyroelectric detectors and

bolometers are the common types of thermal infrared detectors. Quantum type infrared sensors offer higher detection performance. It is faster than thermal type infrared detectors. The photo sensitivity of quantum type detectors is wavelength dependent.

**IR Sensor Working Principle:**

There are different types of infrared transmitters depending on their wavelengths, output power and response time. An IR sensor consists of an IR LED and an IR Photodiode, together they are called as PhotoCoupler or OptoCoupler.

**IR Transmitter or IR LED:**

Infrared Transmitter is a light emitting diode (LED) which emits infrared radiations called as IR LED's. Even though an IR LED looks like a normal LED, the radiation emitted by it is invisible to the human eye.

**Advantages of Infrared Sensor**

The advantages of Infrared Sensor are:

- Their low power requirements make them suitable for most electronic devices such as laptops, telephones, PDAs.
- They are capable of detecting motion in presence/ absence of light almost with same reliability.
- They do not require contact with object to for detection.
- There is no leakage of data due to beam directionality IR radiation.
- They are not affected by corrosion or oxidation.
- They have very strong noise immunity.

Disadvantages of Infrared Sensor

The disadvantages of Infrared Sensor are:

- Required Line of sight.
- Get blocked by common objects.
- Limited range.
- Can be affected by Environmental conditions such as rain, fog, dust, pollution.

Red LED indicator:

A red LED light typically indicates that there is an error or problem with the device or system. The specific meaning of. Per Westermark**.**

Figure 13:Red LED indicator

Male to female Jumper wire:

ale to female jumper wires are used for easy and convenient interconnection between components in electronic prototyping and testing projects, without the need for soldering. They come in groups or cables with connectors or pins at each end and can connect FRC pins, Header pins, Berg pins, and other components.

Figure 14: Jumper Wire

### 3.3 Overview of our project:


Figure 15: Power switch


Figure 16:Ultrasonic sensor, Infrred Sensor & Red LED


Figure 17:Servo Motor

**Power Switch:** A Power Switch provides an electrical connection from a voltage source or ground to a load. It saves power across multiple voltage rails and protects subsystems from damage.

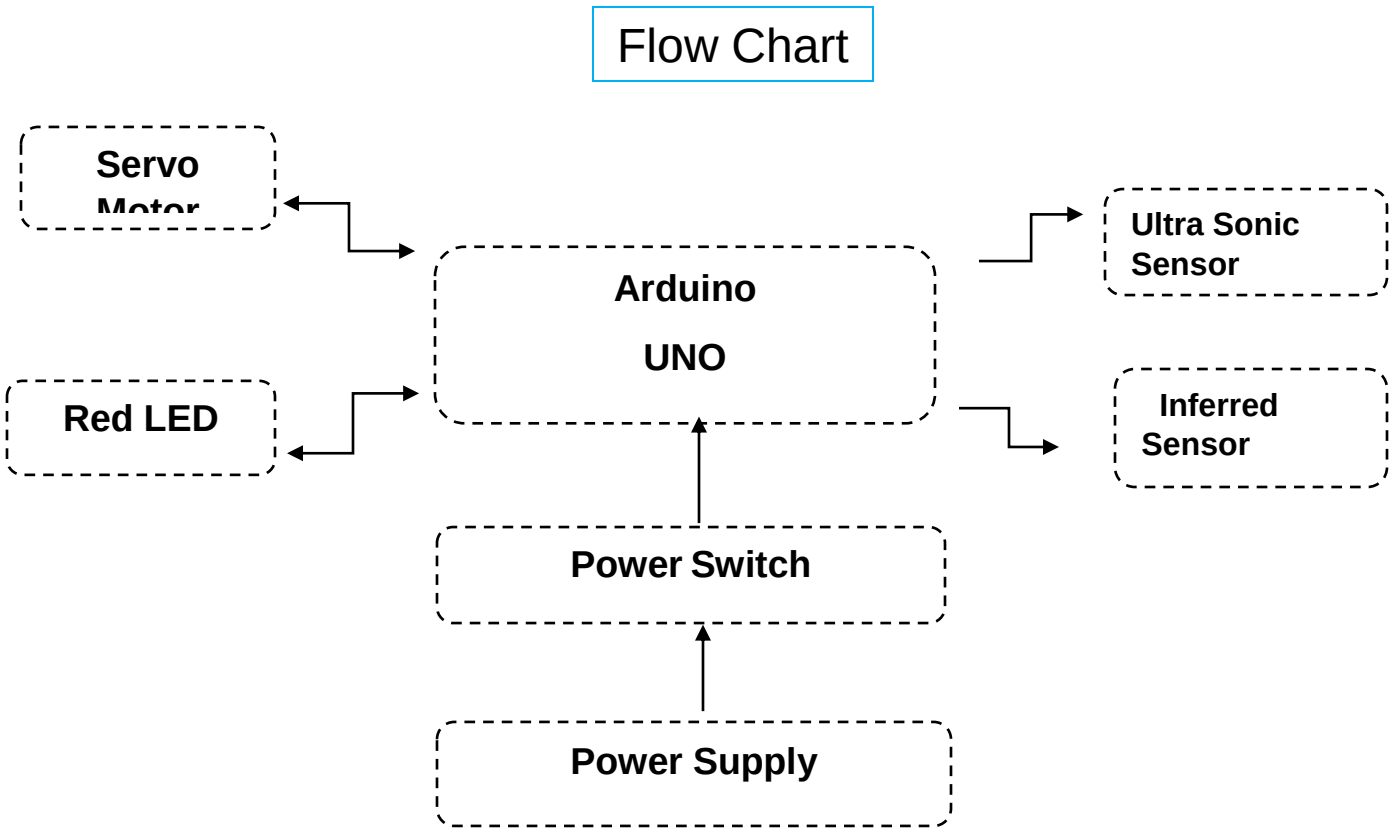
**Ultrasonic sensor:** An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. It's getting the sense and open or close the mouth of the bin.

**Infrred Sensor:** The IR transmitter continuously emits the IR light and the IR receiver keeps on checking for the reflected light.It's Indicated the level of rust inside the bin.

**Red LED:**When the bin is full by the rust,the Red LED is became on as a singnal.

**Servo Motor:**Servo Motor Helps to Open or Close the mouth of the Bin**.**

### 3.4 flow chart



# Chapter 4
# Results and Discussion

[to be added]

# Chapter 5
# Recommendation and Future Scope

The authors are continuously working to upgrade the Smart dustbin so as to address a wide number of current shortcomings. The problems of foul odour and manual controlled mobility calls for the future scope which includes the odour control mechanism to get rid of foul smell of organic garbage. Also, realising the requirement of an autonomous dustbin, GPS module can be implemented for path planning combined with ultrasonic sensor for obstacle avoidance.

**1. Continuous Improvement of Smart Dustbin:**

The authors are consistently engaged in enhancing the functionality of the Smart dustbin to overcome several existing limitations.

**2. Addressing Foul Odor Issue:**

One of the key shortcomings being addressed is the problem of foul odors emanating from organic garbage. To mitigate this issue, a future scope involves the implementation of an odour control mechanism.

**3. Autonomous Mobility:**

In order to make the dustbin more autonomous in its operations, there is a need to address manual control. To achieve this, the future scope includes the incorporation of a GPS (Global Positioning System) module for path planning.

**4. Path Planning:**

The GPS module will be used to facilitate efficient path planning for the smart dustbin, ensuring it follows optimal routes during waste collection.

**5. Obstacle Avoidance:**

To enhance safety and efficiency further, an ultrasonic sensor will also be integrated into the system. This sensor will enable the dustbin to detect and avoid obstacles in its path autonomously.

# Chapter 6

# Conclusion

his smart dustbin system was implemented using Ultrasonic sensor, SIM800l, servo motor, and PIR sensor integrated in an Atmega328p, SIM800l. This system assures the efficient cleaning of dustbins when the garbage level reaches threshold level. When the dustbin gets filled, the ultrasonic sensor senses this; the atmega328p uses SIM800l to update the status of the dustbin online and to send message to the truck drivers in charge of disposing the garbage. As a result, the total number of waste collection truck trips is reduced, and the overall cost of rubbish collection is reduced. On delaying the disposal of the waste, the dustbin cannot be made used of because the lid would not open. This will prevent spilling of the garbage on the ground. Smart. The necessity for the web-based waste management application is increasing day by day due to the population and less maintenance in the disposal of waste. A waste management agency can use this type of system to monitor the waste collection status in real time environment and measure the performance of truck rivers, thereby reducing the manual process of monitoring and verification. In the future, an extension to this system can be the integration of a mapping system that will help in navigation issues to the location of the dustbin whose content needs to be disposed by the management agents.

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# Appendix-A

Arduino coding for the smart dustbin-

**Arduino Programming:**

```
// Download Servo Library
//https://www.electroniclinic.com/arduino-libraries-download-and-projects-they-are-used-in-project-codes/
#include <Servo.h>
// Defines Tirg and Echo pins of the Ultrasonic Sensor
const int trigPin = 6;
const int echoPin = 7;
// Variables for the duration and the distance
long duration;
int distance;
Servo myServo; // Creates a servo object for controlling the servo motor
void setup() {
  pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
  pinMode(echoPin, INPUT); // Sets the echoPin as an Input
  Serial.begin(9600);
  myServo.attach(9); // Defines on which pin is the servo motor attached
}
void loop() {
  // rotates the servo motor from 15 to 165 degrees
  for (int i = 15; i<= 165; i++) {
    myServo.write(i);
    delay(30);
    distance = calculateDistance();// Calls a function for calculating the distance measured by the Ultrasonic sensor for each degree

    Serial.print(i); // Sends the current degree into the Serial Port
    Serial.print(","); // Sends addition character right next to the previous value needed later in the Processing IDE for indexing
    Serial.print(distance); // Sends the distance value into the Serial Port
    Serial.print("."); // Sends addition character right next to the previous value needed later in the Processing IDE for indexing
  }
  // Repeats the previous lines from 165 to 15 degrees
```

```
  for (int i = 165; i> 15; i--) {
    myServo.write(i);
    delay(30);
    distance = calculateDistance();
    Serial.print(i);
    Serial.print(",");
    Serial.print(distance);
    Serial.print(".");
  }
}
// Function for calculating the distance measured by the Ultrasonic sensor
int calculateDistance() {

  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin on HIGH state for 10 micro seconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH); // Reads the echoPin, returns the sound wave
travel time in microseconds
  distance = duration * 0.034 / 2;
  return distance;

}
```