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Smart Dustbin

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I confirm that I understand my coursework needs to be submitted online via Google Classroom under the relevant module page before the deadline in order for my assignment to be accepted and marked. I am fully aware that late submissions will be treated as non-submission and a mark of zero will be awarded.

Acknowledgment

We like to express our gratitude to the module teachers Mr. Sugat Man Shakya and Mr. Sujil Maharjan, for giving us the opportunity to work on IOT project of the topic, Smart dustbin, which also helped us in doing much research and We learned a lot about circuit team management and real-world imprecation of clouds as well as IoT and increase our knowledge on the respective topic. Getting help on every step, makes the project successful. So, without dedication of mentors the project would have never got this shape. So, thank you for the opportunities of working in a team and also thank you mentors for making this successful.

Abstract

This report describes the development of a Smart Dustbin that uses sensor technologies and software to improve waste management. The objective of the project is to improve the shortcomings in the current waste management procedures, which can be labour-intensive and harmful to the environment. Phases of planning, design, resource collecting, and system development are all included in this project. The results show a fully functional Smart Dustbin that gives data on waste types and amounts and automatically sorts waste. It passed thorough testing to ensure its reliability and effectiveness. Findings indicate a significant improvement in waste management efficiency and user engagement. More advanced classification methods and scalability will be the main goals of future improvements. This project not only advances the field of smart waste management but also contributes to more sustainable environmental practices In terms of efficiency, impact on the environment, and user convenience, the Smart Dustbin project offers benefits and is a big step forward in promoting the integration of technology into waste management.

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1. Introduction

Devices can communicate with each other and the cloud by connecting to the internet through the Internet of Things (IoT). Due to affordable processors and fast transmission, billions of devices are now connected, enabling everyday devices to collect data from sensors and respond intelligently. By enabling real-time monitoring, analysis, and automation, this network of connected devices is changing traditional methods. From industrial devices to household appliances, can be connected to the digital environment because of sensors, actuators, and networking characteristics (AWS, 2024).

Nowadays, effective waste management has gained in importance as urbanization and population growth increases. Traditional waste disposal methods often face challenges such as irregular collection schedules and overflowing bins, leading to littering and unwanted surroundings. These problems hamper attempts to develop sustainable, environmentally friendly urban places and result in unhygienic conditions as well as serious health hazards for the general public. The idea of a smart dustbin arises at a connection of waste management techniques and Internet of Things (IoT) technology to address these issues. To maximize waste management, increase productivity, reducing environmental pollution and promoting cleaner, healthier communities, this project focuses on the set up of smart dustbins. This technological integration with sustainability represents a significant advancement toward more efficient and sustainable city waste management.

1.1 Current Scenario

The current scenario of waste management in Nepal presents a wide range of challenges that severely impact the efficiency and effectiveness of urban sanitation services. According to the Waste Management Baseline Survey of Nepal 2020 finds problems such as limited access to necessary equipment essential for modern waste management practices and inadequate controls over bad smells at transfer stations. Even though some municipalities have created waste management plans, oversight and accountability problems are highlighted by the absence of regular monitoring operations and evaluation of existing waste management processes. (Central Bureau of Statistics, 2021)

Nepal's waste management system relies on informal waste workers and traditional waste collection methods, which create major challenges that impact both environmental health and performance. These employees often do not receive proper training and are poorly prepared, risking their health and safety (Springer, 2023). In an effort to modernize this system, Kathmandu Metropolitan City's initiated a project to install smart dustbins, aiming to start a "smart era" in waste management with the goals of protecting the environment and addressing the pressing issues of efficiency and setting an example for other Nepalese cities to follow. (Ojha, 2019)

1.2 Problem Statement and Project as a solution

Problem Statement

Traditional dustbins have drawbacks like scheduled collections and manual maintenance making them inefficient and unable to handle the increasing urban waste generation. This results in overflowing bins, environmental pollution and serious problems to public health and cleanliness. The process of collecting waste from individual households is time-consuming, which increases the time and cost of waste collection, disrupting both collector’s schedules and resident’s daily lives.

The project to install smart solar dustbins didn't perform according to expectations, even with an investment of almost Rs 600,000 per bin and 60 units placed in important areas. Due to the way these bins are designed, with a focus on visual displays and the placement of the waste opening at the back, people often mistake them for advertising boards, according to a survey. The small and difficult to notice opening have resulted in poor utilization. The problems with these smart bins are mostly related to faulty technology, user-unfriendly design, and a lack of public awareness of proper usage techniques (Ojha, 2019).

Figure 1: Smart Solar Dustbin (Ojha, 2019).

Project as a solution

The Smart Dustbin system aims to solve the shortcomings found in traditional waste management systems by combining modern IoT sensors into urban waste bins. This method improves environmental health and urban cleanliness through several strategic improvements. Each smart dustbin is equipped with sensors to monitor waste levels in real time and reduce littering. The data collected by these bins are used to improve the routes of waste collection vehicles, which lowers costs and improves operating efficiency. The bins are designed to be user-friendly and clear markings that educate people on safe waste disposal methods, in an effort to increase public engagement. By making the containers easier to use and more accessible, these design improvements encourage proper disposal.

1.3 Aims and Objectives:

1.3.1 Aims

The aim of this project is to create the system that can monitor the smart dustbin and give the real time information about the level of waste filled and open when the human is near to human while throwing waste in dustbin.

1.3.2 Objectives

- This system is expected to monitor the waste level of the dustbin using sensors.
- By using the sensor, the system is expected to identify the level of dust.
- This system use sensor and open when the person is throwing waste in dustbin automatic.

2. Background

System Overview:

The proposed IoT system is a smart dustbin designed for waste management tasks. By employing technology such as ultrasonic sensors, it can detect the presence of waste and measure the level of accumulation within the dustbin. This ensures timely disposal, optimizing the efficiency of waste management processes. The innovative solution automates the opening of the dustbin lid when waste is detected, enhancing convenience, and contributing to maintaining cleanliness and hygiene in our surroundings.

In this project, the key component is the Arduino microcontroller, which serves as the brain of the system. When the ultrasonic sensor identifies waste, the Arduino triggers a servo motor to open the lid, facilitating easy disposal. The seamless integration of hardware components like the breadboard and jumper wires ensures a reliable connection while drawing power directly from a laptop enhances portability and convenience.

Overall, this project exemplifies the intersection of technology and practicality, offering a solution that not only enhances convenience but also contributes to a cleaner and healthier environment. By automating waste disposal processes and providing real-time information on waste accumulation, the smart dustbin represents a significant step forward in modern waste management practices.

Hardware Components:

Arduino UNO:

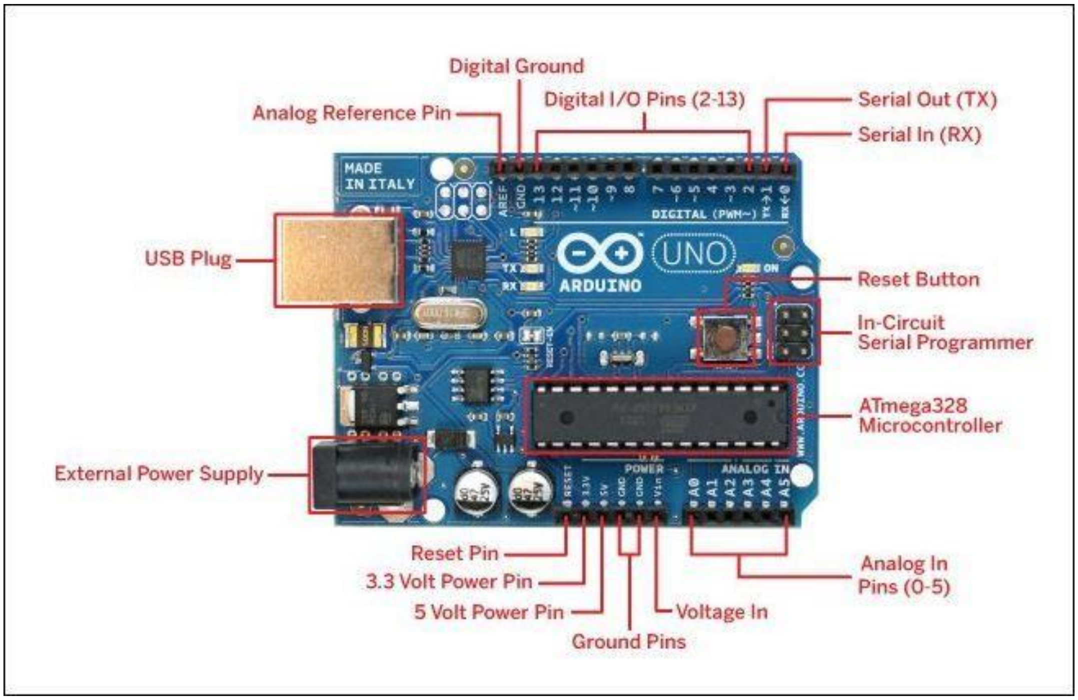

Figure 2: Arduino UNO (thenengprojects, 2018)

The Arduino UNO is a popular microcontroller board based on the ATmega328P chip. Uno is equipped with digital and analog input/output pins that can be used to interface with various sensors, actuators, and other electronic components. Which can be programmed using Arduino Integrated Development Environment (IDE) using C/C++ programming language making it accessible to beginner programmers. (Badamasi, 2014)

SG90 Servo motor:

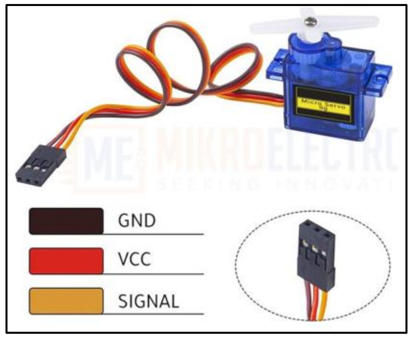

Figure 3: Servo Motor. (Waslleh, 2024)

The SG90 servo motor is a type of small, compact, and lightweight servo motor commonly used in robotics, model making, and other hobbyist projects. It is a digital servo motor that receives and processes PWM (Pulse Width Modulation) signal faster and better, allowing for precise control over its rotation. (Arduino Circuit, 2023)

Jumper Wire:

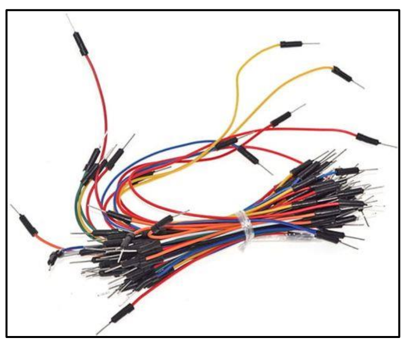

Figure 4: Jumper wire. (Wiltronics, 2022)

Jumper wires are essential components in electronics and prototyping. They are flexible wires with connectors at each end, typically used to create electrical connections between various components on a breadboard, circuit board, or other electronic platforms. (Hemmings, 2018)

Ultrasonic Sensor:

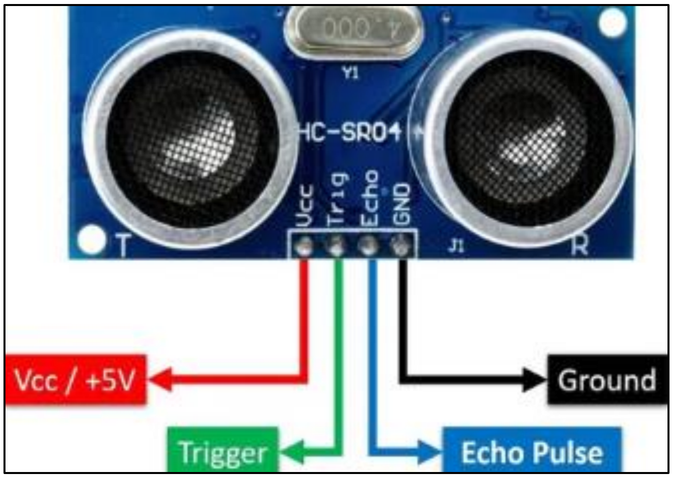

Figure 5: Ultrasonic Sensor. (Microcontorllerslab, 2024)

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. The distance between the sensor and the object is calculated using the period between emission and reception. (WatElectronics, 2022)

Breadboard:

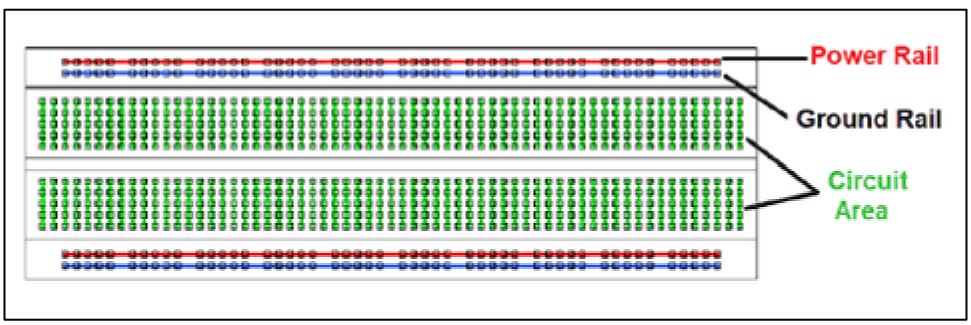

Figure 6: Breadboard. (Components, 2018)

A breadboard is an electronic tool used in electronics prototyping and experimentation. It is a solderless board where electronic components can be inserted and connected without the need for soldering. Breadboards typically consist of a plastic base with a grid of interconnected metal sockets, arranged in rows and columns. (CircuitBread, 2019)

Software:

Arduino IDE:

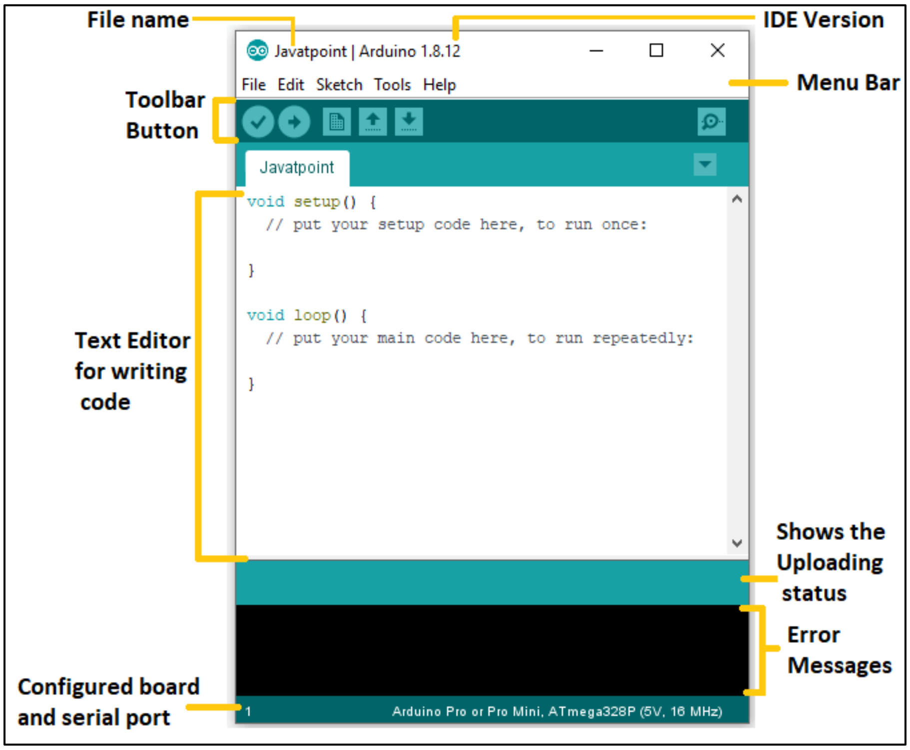

Figure 7: Arduino IDE. (javapoint, 2024)

The Arduino Integrated Development Environment (IDE) is a software platform designed to simplify the process of programming Arduino microcontroller boards. It provides an interface for writing, compiling, and uploading code to Arduino boards. (javapoint, 2024)

Draw.io:

Draw.io is a diagramming tool that allows users to create various types of diagrams, such as flowcharts, diagrams, mind maps, organization charts, and more. It offers a user-friendly interface and a vast library of pre-built shapes and templates, making it a versatile tool for various diagramming needs.

Design Diagram:

Block Diagram:

A block diagram is a graphical representation of a system that provides a functional view of a system and illustrates how the different elements of that system interlink (Freeman, 2024). Block diagrams provide a high-level, abstract overview of a system, making it easier to understand the overall structure and interactions between its various parts without diving into details.

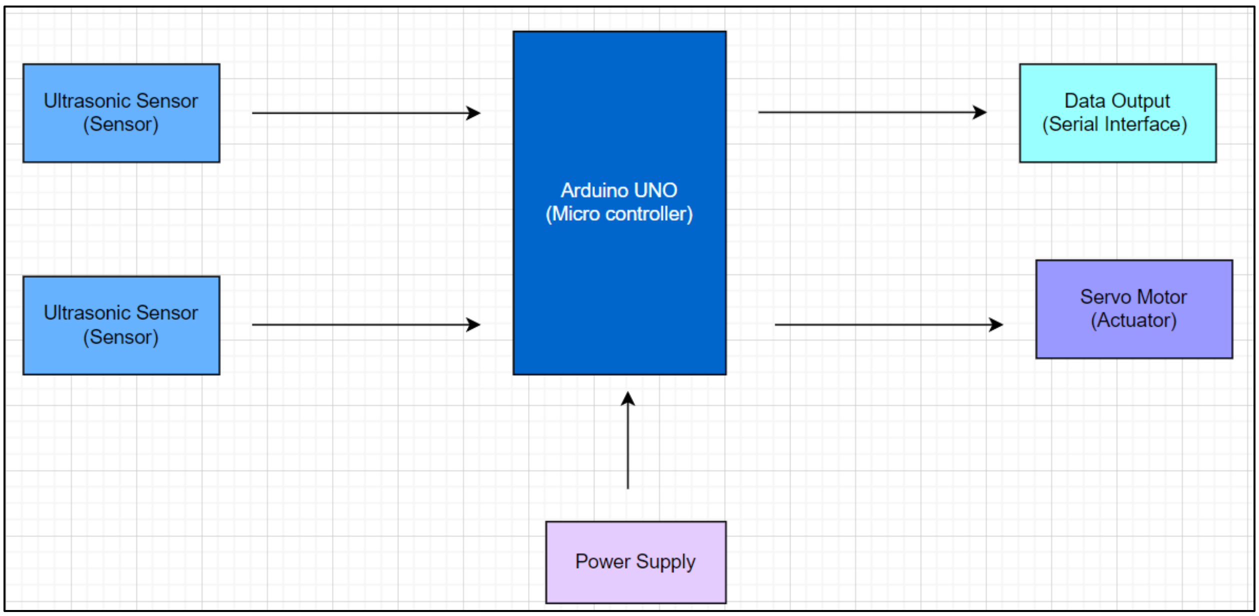

Figure 8: Block Diagram.

System Architecture:

It is a conceptual representation of the components which reflect the behaviour of a system (Naren, 2019) .It involves the description of system components, the externally visible properties of those components, the relationships and interactions between them.

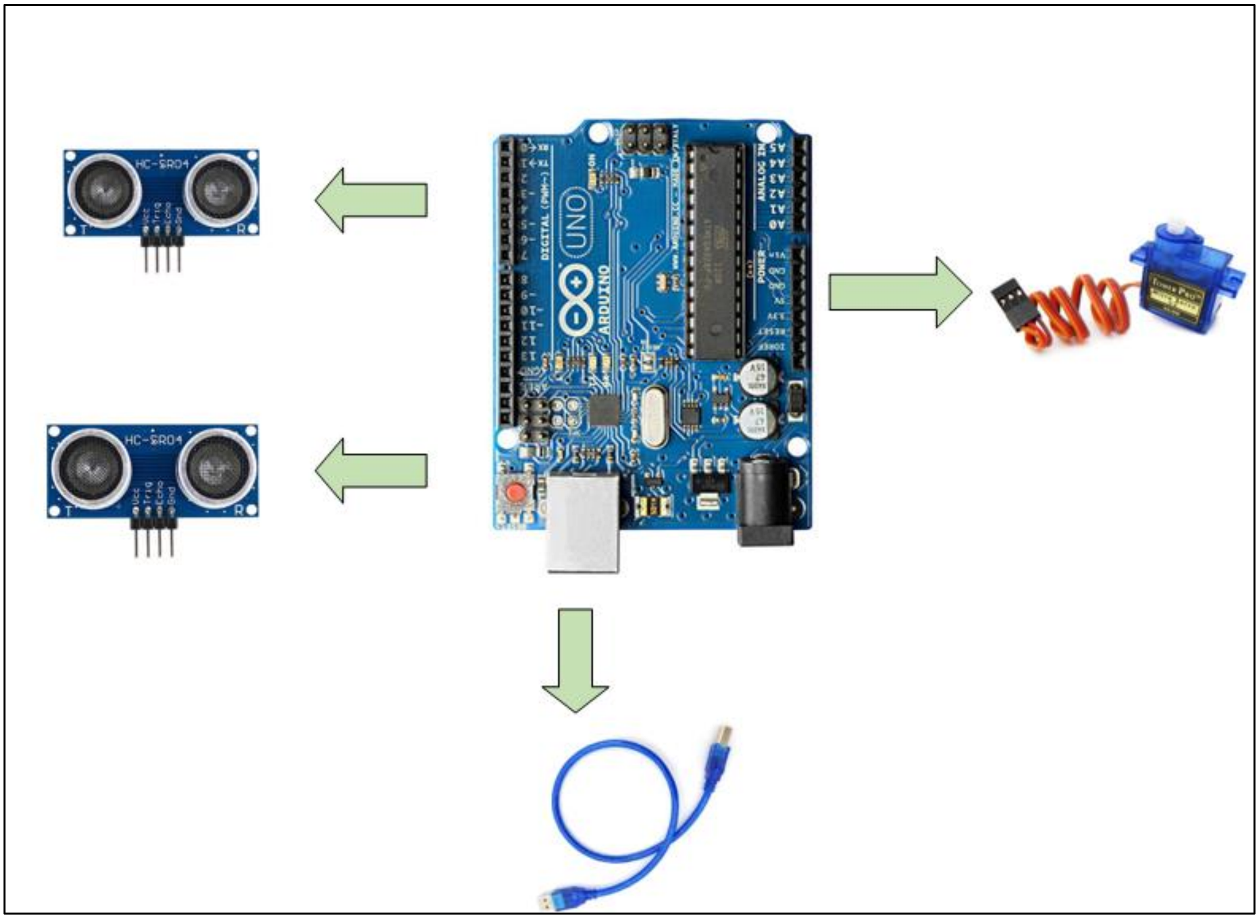

Figure 9: System Architecture.

Circuit Diagram:

Circuit diagrams simplify understanding of electrical circuits by visually illustrating how different components are connected. They show the relationships between components, making it easier to understand how everything functions together (BYJU'S, 2024). Circuit diagrams are essential tools for designing, analyzing, and troubleshooting electronic circuits.

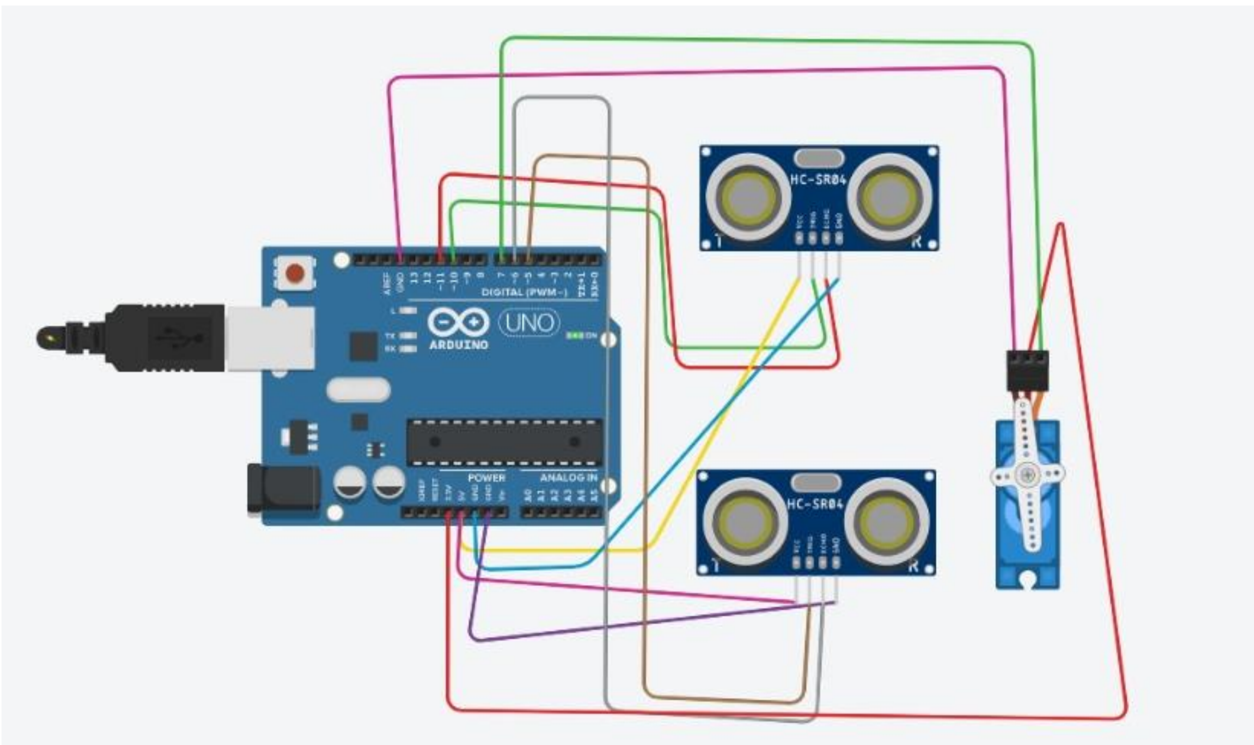

Figure 10:Circuit diagram.

Schematics Diagram:

A schematic diagram uses digital symbols to represent electronic components and their connections (Lim, 2019) .Circuit diagrams are essential tools for designing, analyzing, and troubleshooting electronic circuits.

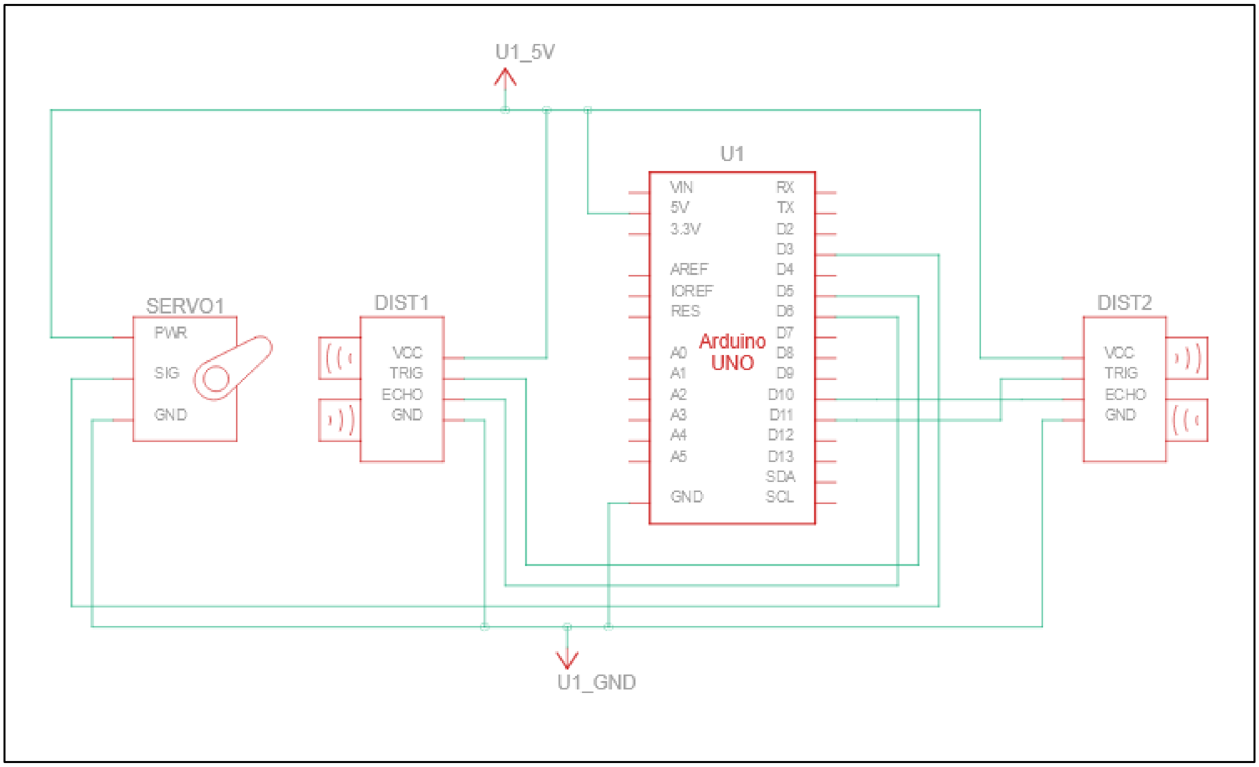

Figure 11: Schematic Diagram.

Flowchart:

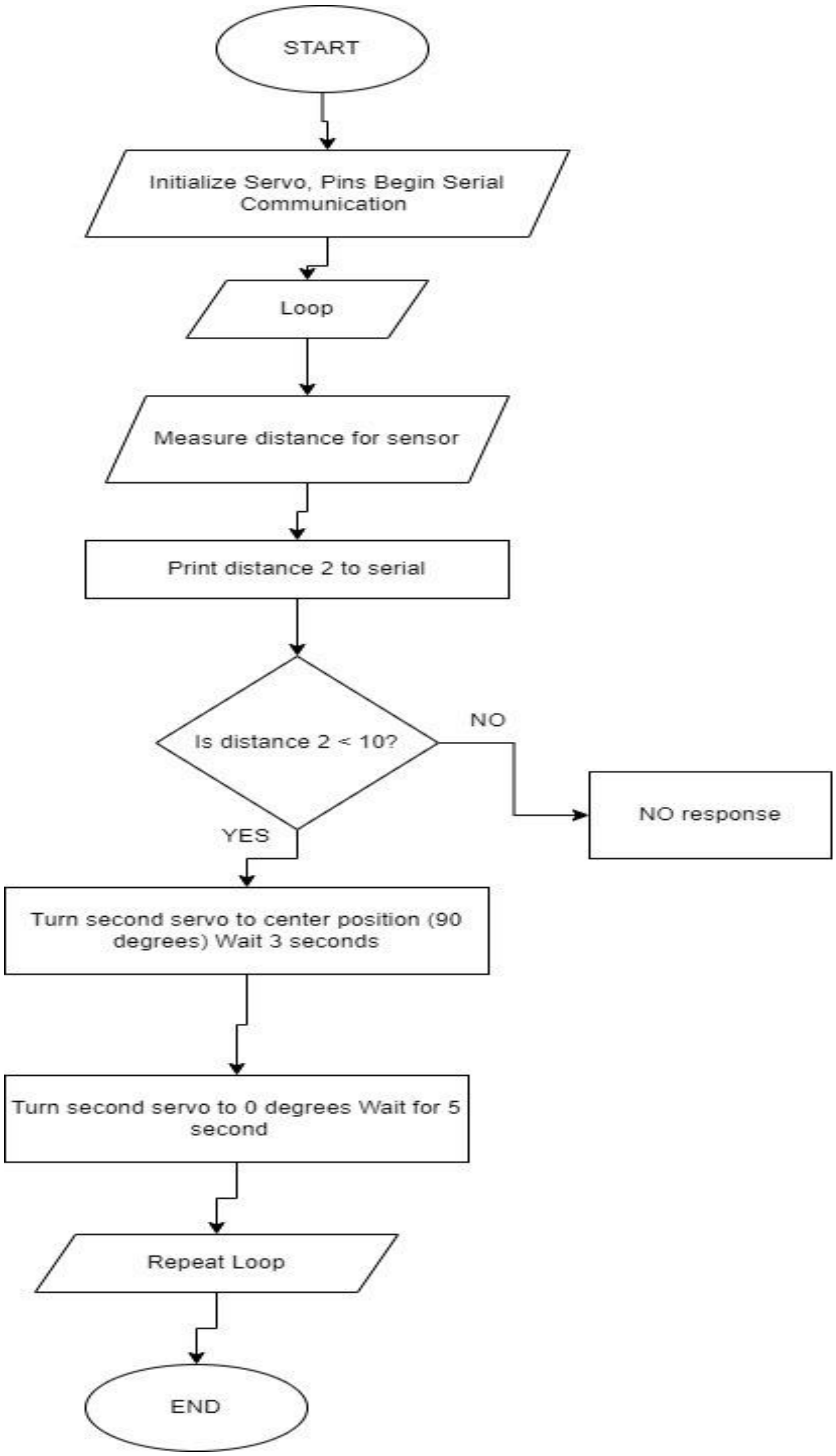

Figure 12:Flowchart of the code.

3. Development

This section describes the steps involved in developing the Smart Dustbin project, from beginning to the end.

3.1 Planning and design

The planning and design stage of the Smart Dustbin project began with a team meeting aimed to define the project scope and objectives. We chose waste management as an area that needs innovation because we wanted to develop a technology that would have a social impact.

Our first task was to clearly define the project scope and goal. The team gathered to exchange ideas and discussed how technology could help with important waste management problems. Our main objectives were to reduce environmental pollution through improved waste handling, raise public knowledge of correct waste management, and increase the efficiency of waste disposal.

To fully understand the present difficulties that urban waste management systems face, a thorough assessment was carried out. This included examining the public's attitude toward waste disposal, environmental impact reports, and the current waste collecting and disposal procedures. The evaluation's conclusions were very helpful in defining the specific features that the Smart Dustbin required to meet these challenges.

Based on the needs assessment, we defined the core features of the Smart Dustbin included: Real-time waste level monitoring using sensors to detect fill levels and prevent overflows. A user-friendly design to guide proper waste management.

3.2 Resource collection

A number of devices and tools were needed to completely showcase the progress of this project. Those devices were to be managed from different sources. Around half of the devices were managed from the resource department of Islington college itself. Each of the group members provided their assist in finding the resources for this project. The devices obtained from the resource department at Islington college are:

- Arduino
- Jumper Wires
- Ultrasonic Sensor
- Servo motor

Some of the resources obtained except from the Islington college resource department are some extra jumper wires, An extra ultrasonic sensor and a breadboard.

3.3 System Development

Phase 1: At First, we connected our Arduino to the laptop to see if it works.

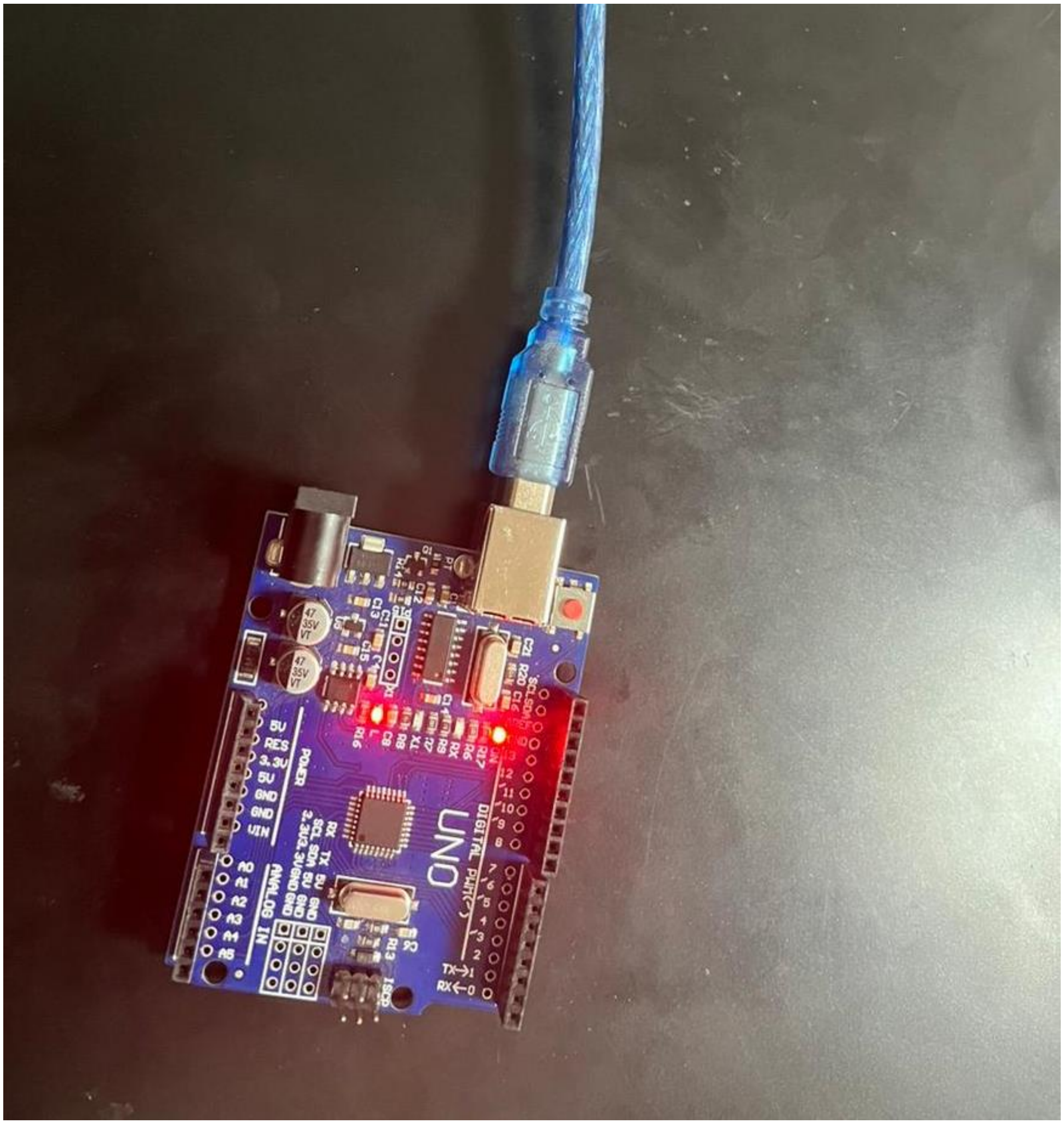

Figure 13:Connecting Arduino to the laptop.

Phase 2: Now we connect the ultrasonic sensor to the Arduino which is going to open the lid of the dustbin. The wires were joined in the following procedure:

D10 of Arduino to Echo pin of sensor

D11 of Arduino to Trigger pin of sensor

GND of Arduino to GND pin of sensor

5v of Arduino to 5v pin of sensor

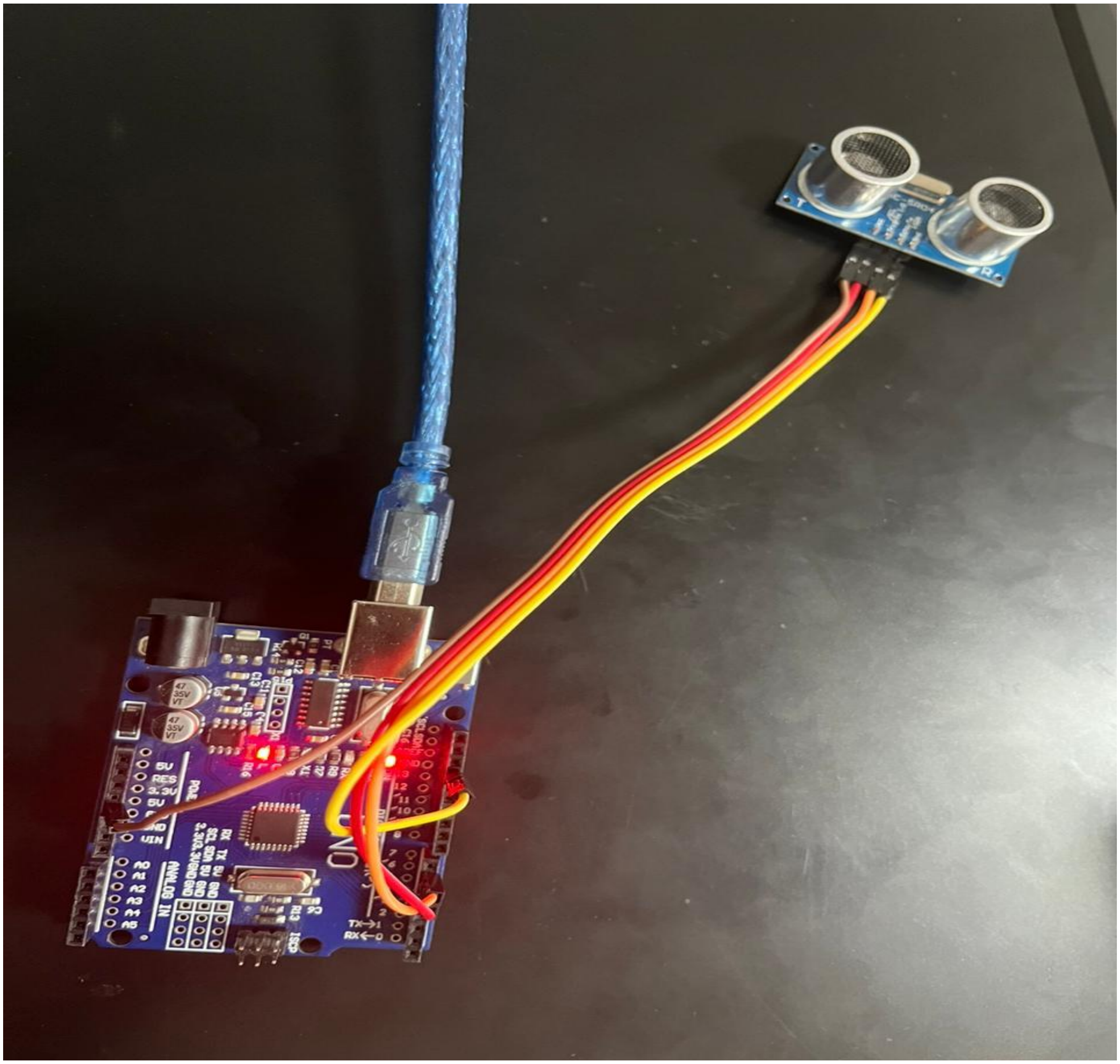

Figure 14:Joining ultrasonic sensor to Arduino.

Phase 3: Now we connect the servo motor to the Arduino with the help of jumper wires.

The wires were joined in the following procedure:

D3 of Arduino to input of sensor

GND of Arduino to GND of sensor

5V of Arduino to 5V of sensor

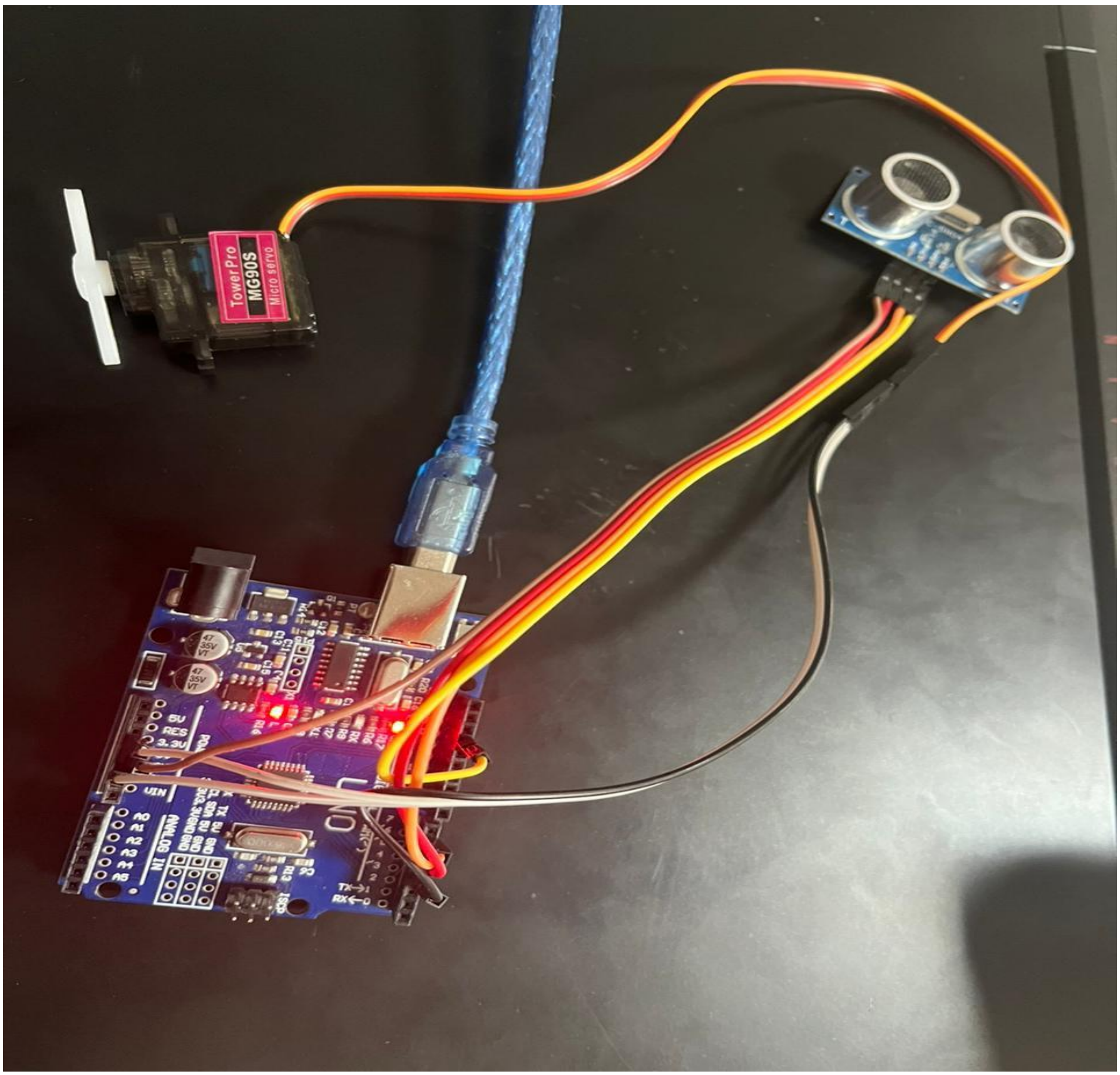

Figure 15:Joining servo motor to Arduino.

Phase 4: Now we join another ultrasonic sensor to measure the waste level of the dustbin. The connections are as follows:

D6 of the Arduino to echo pin of the sensor

D5 of the Arduino to trigger pin of the sensor

GND of the Arduino to GND pin of the sensor

5V of the Arduino to 5V pin of the sensor

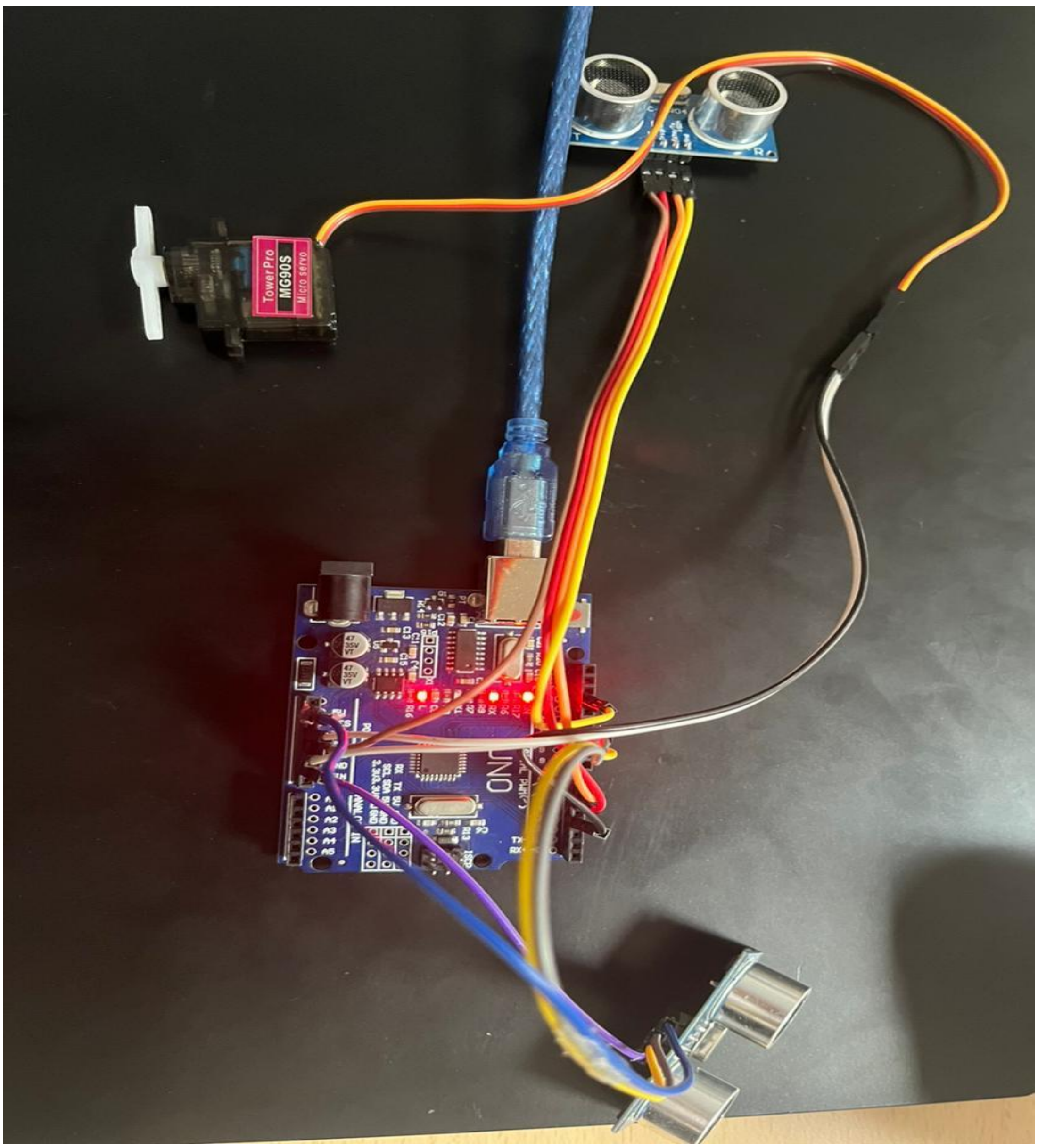

Figure 16:Joining all parts together.

4. Results and Findings

The Smart Dustbin is now operational and prepared for execution after the development stage. To handle waste more efficiently, the system makes use of sensors.

4.1 Test 1: To demonstrate the execution of code.

Test	1
Objective	To show the code compiling.
Activity	- Code is written in C++ and executed in Arduino IDE. - Connecting Arduino with laptop. Compiling the code.
Expected Result	The code compiles successfully.
Actual Result	The code was not compiled and shows error.
Conclusion	The test was successful.

Table 1: Test 1

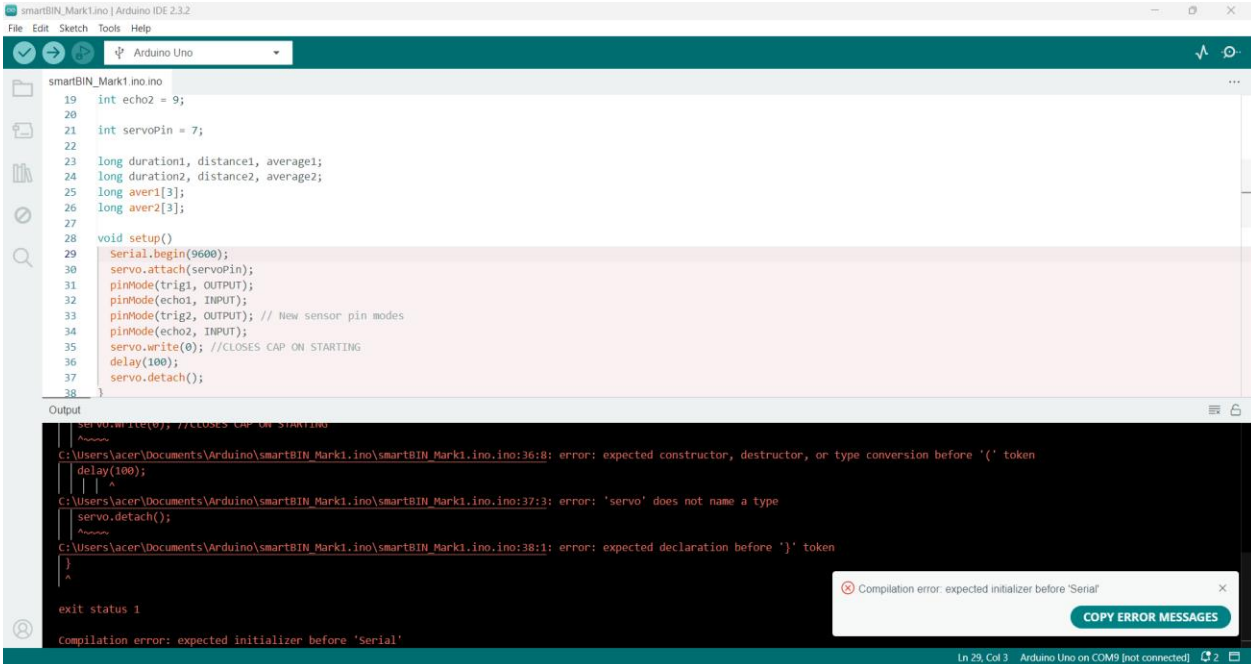

Figure 17:Checking the compilation of the code.

4.2 Test 2: To check if the code compiles and runs correctly.

Test	2
Objective	To check if the code compiles and runs correctly.
Activity	- The code is compiled. - The code is then uploaded to see if it works.
Expected Result	The code is compiled and when it is uploaded it works successfully.
Actual Result	The code is compiled and when it is uploaded it works successfully.
Conclusion	The test was successful.

Table 2: Test 2

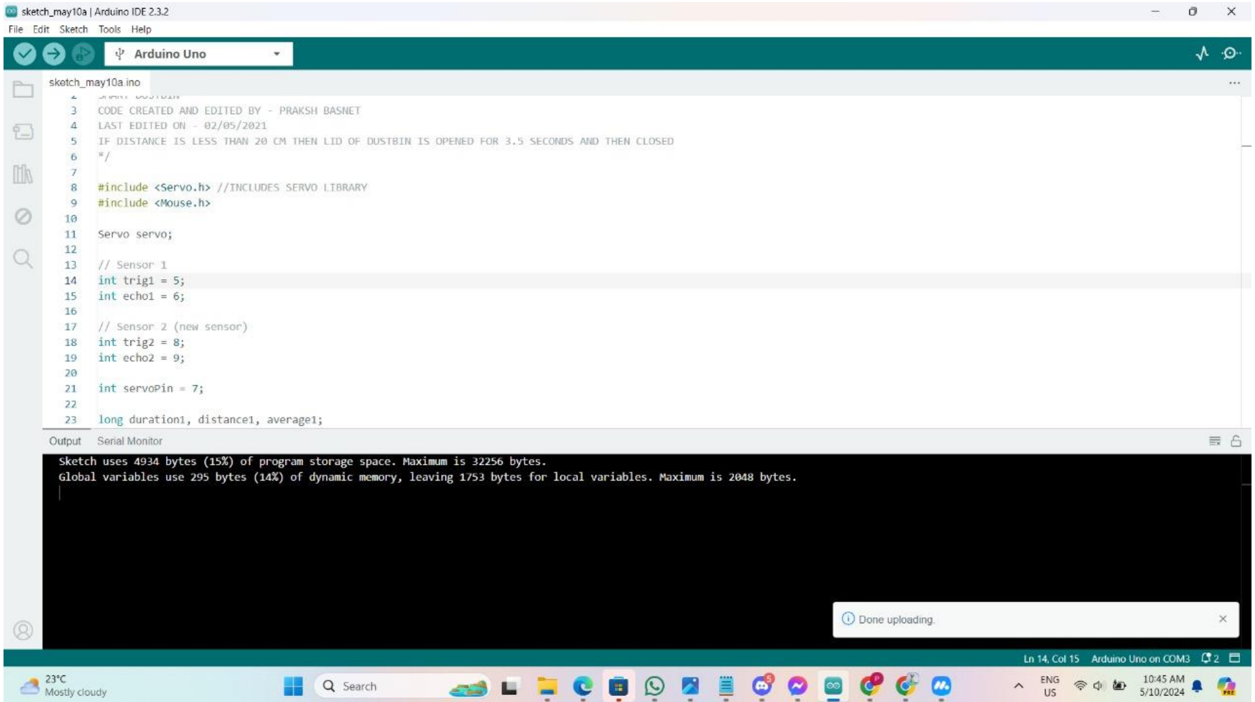

Figure 18:Checking if code works properly.

4.3 Test 3: Real-Time Quantity Monitoring

Test	3
Objective	To verify if the smart dustbin accurately displays the real-time quantity of waste inside and shows the remaining capacity.
Activity	- The code is executed. - Waste is slowly added to the dustbin to simulate usage.
Expected Result	The system should accurately display when the dustbin is half full, indicating how much more space is left for additional waste.
Actual Result	The system correctly identified when it was half full and displayed the remaining capacity accurately.
Conclusion	The test was successful.

Table 3: Test 3

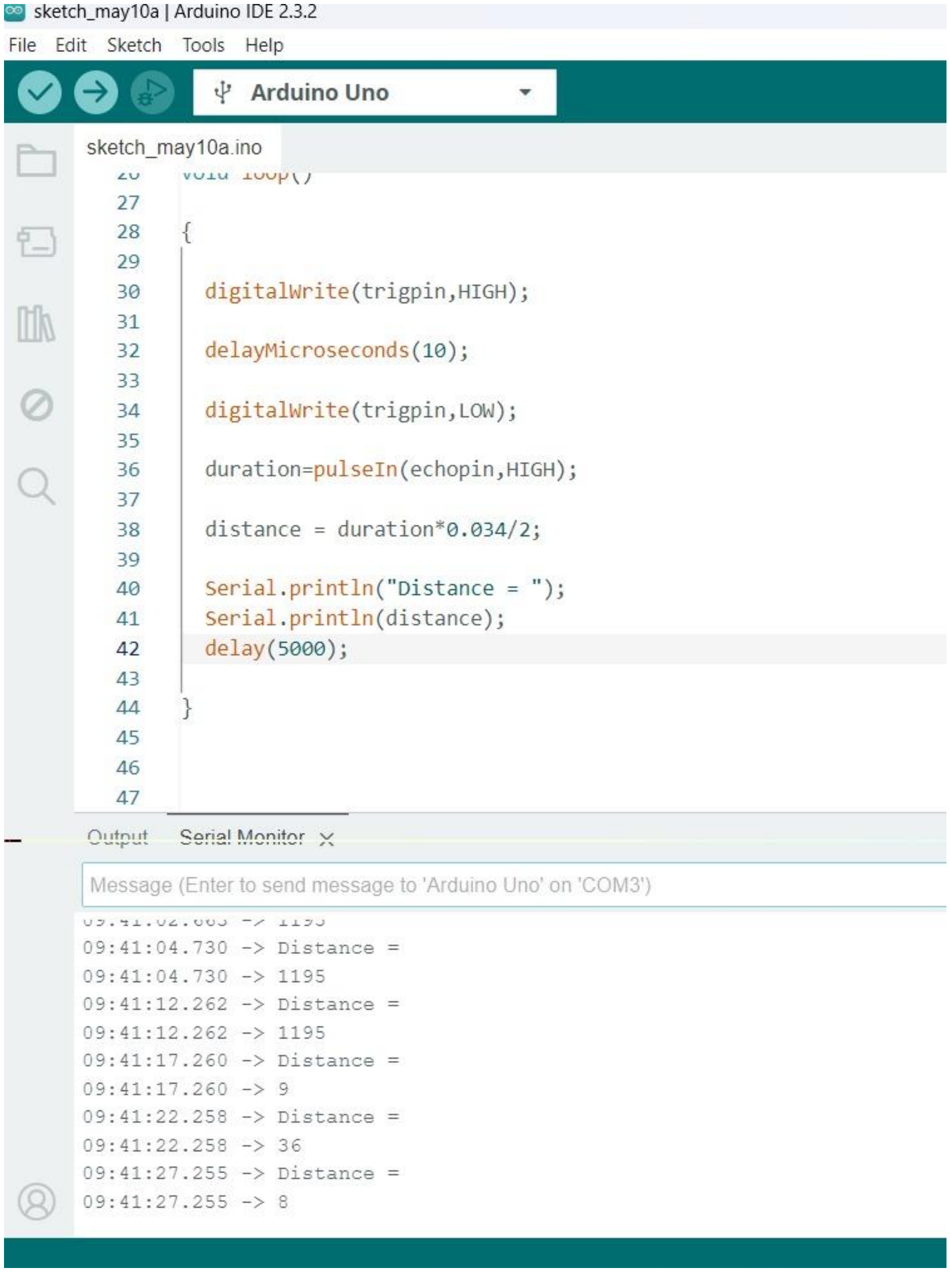

Figure 19:Checking if distance sensor works.

5 Future work

The Smart Dustbin project has potential for future enhancements and broader applications. Plans include for upgrading the design to handle larger garbage volumes suitable for business or residential buildings, which would require increasing the bin's durability and capacity. In order to increase the accuracy of waste separating, especially for various recyclables, there is also an effort for using more advanced sensors and machine learning algorithms.

Another objective is integration into smart city infrastructures, which will enable the Smart Dustbin to interact with other smart systems for urban management. To maximize impact and enable broad adoption, efforts will be made to work with government bodies to work these technologies into urban planning and public policy. It has advantages including lower carbon emissions, higher recycling rates, and fewer landfill use. Not only will these improvements and integrations improve the Smart Dustbin's performance, but they will also make a big difference in creating more sustainable and effective urban settings.

The group is committed to continuous improvement and continues to search for ways to work collaboratively to improve the Smart Dustbin's features and impact. Priorities involve communicating with people and raising awareness of environmental issues.

6 Conclusion

In conclusion, the Smart Dustbin project represents an important step in the use of IoT technology to improve waste management. It has successfully demonstrated its potential by enabling real-time monitoring of waste levels, keeping cities cleaner and causing less damage to the environment, automated operations of dustbins. Tests on the project showed positive outcomes, demonstrating that it can reduce the frequency of trash collection, saving money and lowering pollution helping to improve public health and create cleaner urban environments.

Even though there were difficulties, such design mistakes in previous dustbin, the project has advanced through ongoing testing and user feedback, resulting in improvements to functionality and usability. In addition to encouraging increased public acceptance and use, these improvements have cleared the path for next technologies that have the potential to completely transform urban trash management.

The Smart Dustbin system has a lot of potential for development and can be part of bigger smart city infrastructures in the future. More durable designs appropriate for high-volume waste locations, advanced sensors for improved waste segregation, and interaction with other IoT systems to create an effective and solid urban management network are possible future forms. This creative method for waste management can improve the sustainability and cleanliness of cities by working with government agencies and urban planners, which will benefit every citizen's quality of life. The Smart Dustbin project is a promising example of how IoT might be used to efficiently address problems in the real world as technology develops.

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8. Appendix

```
/*
  SMART DUSTBIN
*/
#include <Servo.h>  //INCLUDES SERVO LIBRARY

Servo servo;
int trig = 5;
int echo = 6;
int servoPin = 7;
long duration, distance, average;
long aver[3];

void setup() {
  Serial.begin(9600);
  servo.attach(servoPin);
  pinMode(trig, OUTPUT);
  pinMode(echo, INPUT);
  servo.write(0); //CLOSES CAP ON STARTING
  delay(100);
  servo.detach();
}

void measure() {
  digitalWrite(trig, LOW);
  delayMicroseconds(5);
```

```
  digitalWrite(trig, HIGH);
  delayMicroseconds(15);
  digitalWrite(trig, LOW);
  pinMode(echo, INPUT);
  duration = pulseIn(echo, HIGH);
  distance = (duration / 2) / 29.1; //CALCULATES DISTANCE
}

void loop() {
  Serial.println(distance);     //CAN BE DISABLED
  for (int i = 0; i <= 2; i++) { //CALCULATES AVERAGE DISTANCE
    measure();
    aver[i] = distance;
    delay(10);
  }
  distance = (aver[0] + aver[1] + aver[2]) / 3;

  if ( distance <= 20 ) { //CHANGE AS PER AS NEED
    servo.attach(servoPin);
    delay(1);
    servo.write(0);
    delay(3500); //CHANGE AS PER AS NEED
    servo.write(180);
    delay(1500); //CHANGE AS PER AS NEED
    servo.detach();
  }
}
```