- **SMART DUSTBIN PROJECT**

Acknowledgement:

We would like to extend our gratitude, firstly to the module leader, Mr. Saugat Man Shakya, and our tutor, Mr. Ayush Bhakta Pradhanang, for providing us with the opportunity to showcase our creativity and ideas through this coursework. We are thankful for the chance to explore the practical implications of IoT, which will be a valuable learning experience for us. We would not be able to carry out this project if it were not for their effective and resourceful teachings. Secondly, we are thankful to the sites like Oracle.com, computerhope.com, electronichub.org, and robocraze.com through which we were able to collect the resources and expertise required for this project.

Abstract

The main objective of this coursework is to create a smart dustbin system. This system applies the principles of IoT technology to promote sustainable and efficient waste management practices. By harnessing the power of automation, this smart dustbin system incorporates a motion-detecting lid, utilizing crucial hardware elements like an ultrasonic sensor, Arduino UNO, and a servo motor.

The development process involves linking the smart dustbin to the Arduino Uno, which operates as the microprocessor at the system's core. This connection is essential, as it allows seamless communication and control, which are fundamental in executing the smart features set in within the dustbin.

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Section 1: Introduction

Internet of Things (IoT) is a system where physical objects or “things” are incorporated with sensors, software, and additional technologies so they can communicate and share data with other devices and networks over the internet. These objects extend from simple household devices to high-tech industrial tools. The evolution in the field of IoT in this generation has led to the creation of many devices making our lives convenient (Oracle, 2023).

The IoT device that we are creating in this coursework is a “Smart Dustbin”. It operates on motion triggers, automatically opening its lid in response to motion. This system promotes hygiene by enabling hands free operation through motion activation. People are bound to use smart dustbins out of curiosity which indirectly promotes waste management. So, it will be an effective tool to educate people about sustainable waste management tactics.

The invention of smart dustbin has helped revolutionized the IoT industry and has played an important role in the evolution of it. With the help of smart dustbin, we will be able to create a sustainable future.

1.1: Current Scenario

The environmentally acceptable management of waste has become a global challenge due to limited resources, population growth, urbanization, and industrialization. Traditional dustbins have become inefficient for managing waste, and we cannot turn a blind eye to the number of landfill sites that are being formed day after day, hampering the lives of the locals. It is also expected that waste generation will likely increase in the future, so addressing it as soon as possible is crucial (Statistics, 2021).

On the other side, rubbish management is now feasible thanks to modern, high-tech gadgets like smart dustbins. Governments can use smart dustbins to control rubbish collection routes, which will increase overall efficiency of the process, also contributing to the reduction of landfill sites.

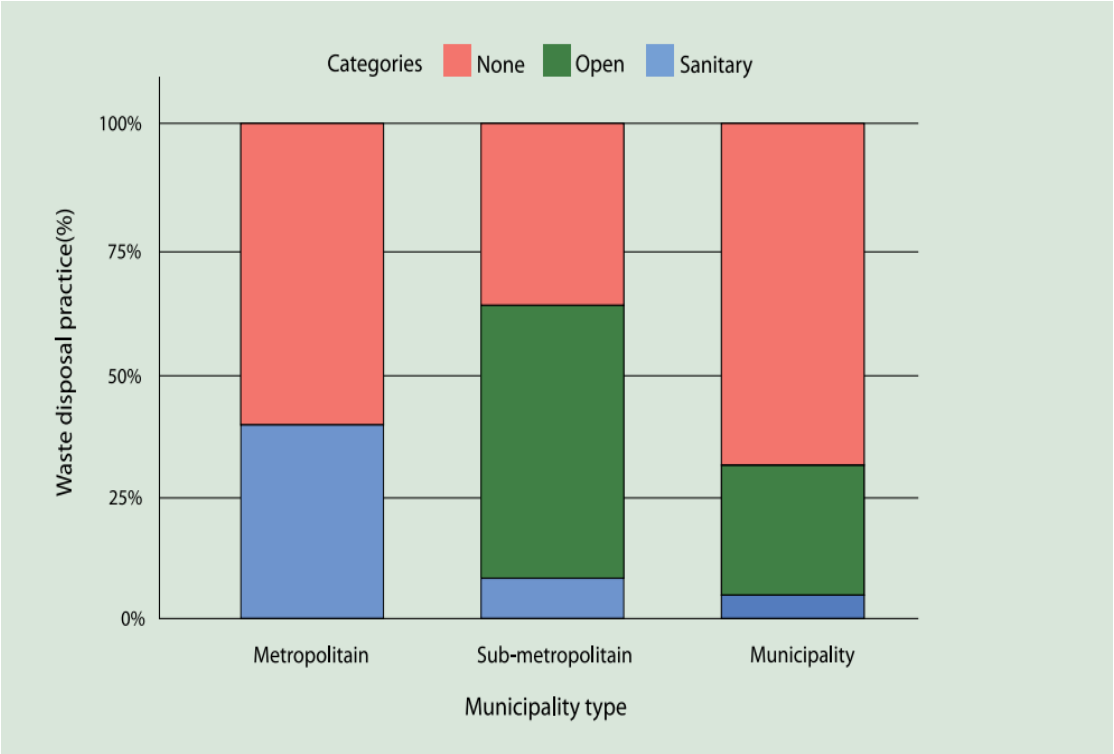

Figure 1: Waste disposal practise in Nepal as of 2021 *(Statistics, 2021)*.

1.2: Problem Statement and Project as a solution

In Nepal, efficient waste management is crucial for preventing the spread of illnesses, making its resolution essential for public health. Our goal is to tackle these issues and raise public awareness of the significance of appropriate waste disposal procedures by implementing a smart dustbin system. Our project aims to contribute to the development of better and more sustainable garbage disposal technique. The ultimate goal of this project is to make Nepal pollution-free for future generations and for our current well-being. Efficient waste management is a shared concern that directly impacts the quality of life for the people. Hence, solving it is crucial.

1.3: Aim and Objectives.

The primary goal of this project is to develop a smart dustbin system that is eco-friendly, flexible, and sustainable. In this project, sensor-based electronics are operated through code. The lid of the dustbin will automatically open and close with the help of the sensor and actuator.

Objectives

The objectives of developing this project are given below:

- For promoting recycling and other eco-friendly waste management techniques.
- For preventing dustbins from overflowing to keep public areas hygienic and clean.
- For facilitating sustainable waste management procedures by means of public awareness activities.
- For enhancing the standard of living and improving the routed and schedules for garbage collection, resulting in time and cost savings.

Section 2: Background

The purposed IoT device is the smart dustbin, which aids in keeping cities clean by going beyond merely holding waste. It utilizes sensors, actuators, and smart software to revolutionize waste disposal. In this project, several tools, and devices like Arduino uno, jumper wires, breadboard, servo motor were employed to complete it. Smart dustbin can be essential for modern households and institutions as it enables contactless waste management. Additionally, touchless operation minimizes the spread of germs, keeps users clean, and the lid stays closed most of the time, reducing unpleasant smells.

2.1: System Overview

In this project, Arduino was used to connect with an ultrasonic sensor and servo motor for touchless lid opening of the dustbin. The ultrasonic sensor detects an approaching object like hand or item within the setup range and transmits the data to the main processor or control unit, which is Arduino in this project. The Arduino then triggers the servo motor to rotate its arm, opening and closing the lid of the dustbin, as the actuator is connected to the lid with the help of thread.

This project, with fewer sensors and functionalities, often translates to lower power consumption and longer battery life. Similarly, the range of the ultrasonic sensor can be adjusted according to individual needs, allowing monitoring of the distance of the object for lid opening. Additionally, the lid can be set to remain open for a specified time by adjusting the delay time in the actuator. All these connection are made using different types of jumper wires, such as male-to-male and female-female jumper wires.

This project involved create relations and tables for the "Gadget Emporium” database with the SQL Command and list the snapshot of its resulting output. Ensure that referential integrity is established between related tables. The project demonstrated my ability to design efficient databases, execute complex queries, and critically evaluate database systems.

2.2: Designing Diagrams

2.2.1: Hardware Architecture

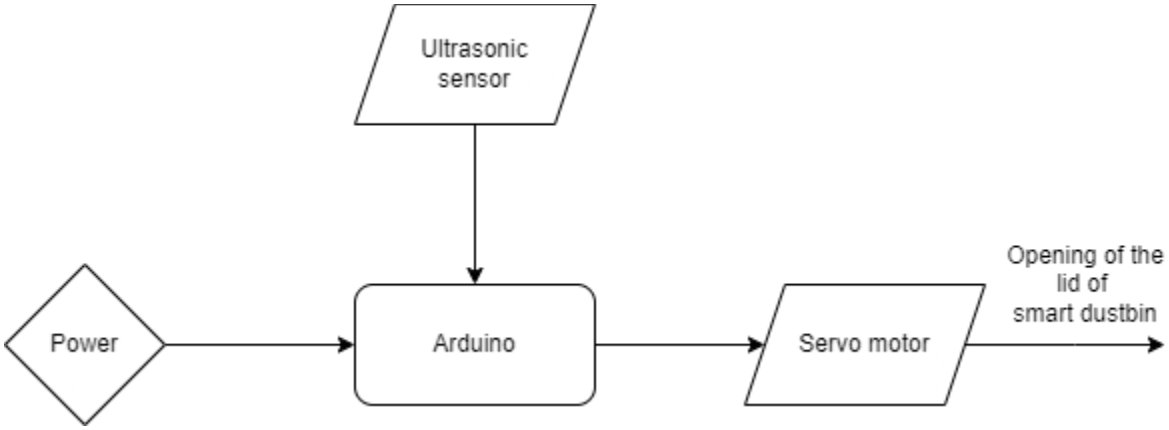

Figure 2: Hardware architecture of the system

2.2.2: Circuit Diagram

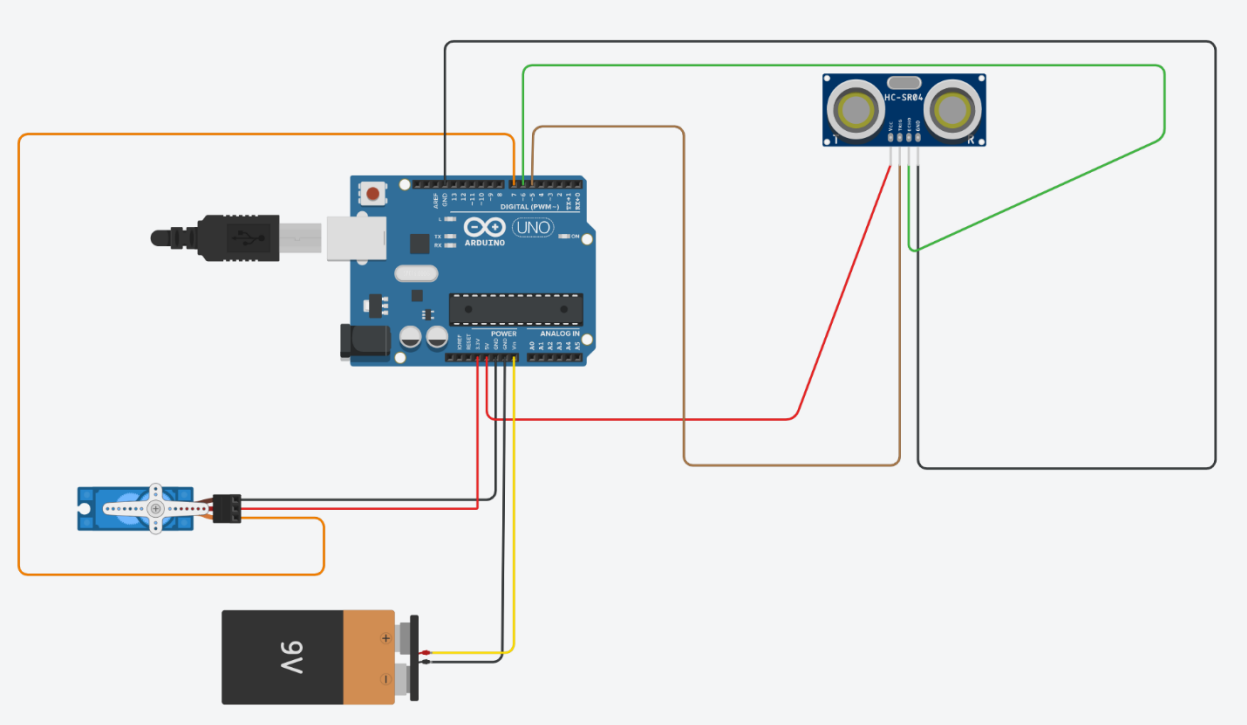

Figure 3: Circuit diagram of smart dustbin.

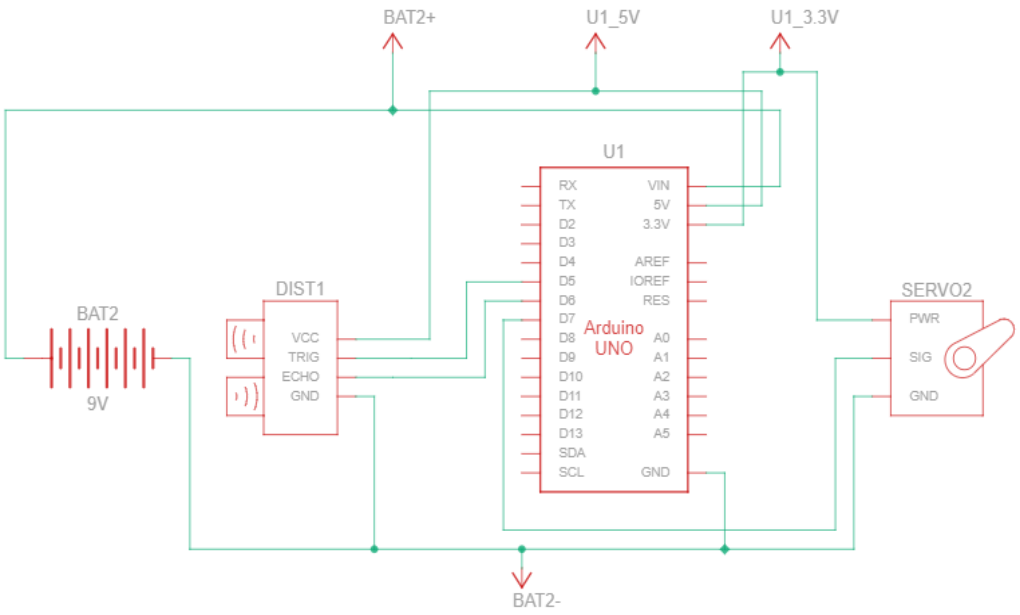

Figure 4: Schematic view of smart dustbin connection

Arduino pins	Connected To	Actuator and Sensor pins
3.3V	Servo motor	Power (Red)
GND	Servo motor	Ground (Black or Brown)
Digital 7(D7)	Servo motor	Signal (Yellow or White)
5V	Ultrasonic sensor	VCC
D5	Ultrasonic sensor	Trig
D6	Ultrasonic sensor	Echo
GND	Ultrasonic sensor	GND

Table 1: Cable connection in the circuit.

2.2.3: Flowchart

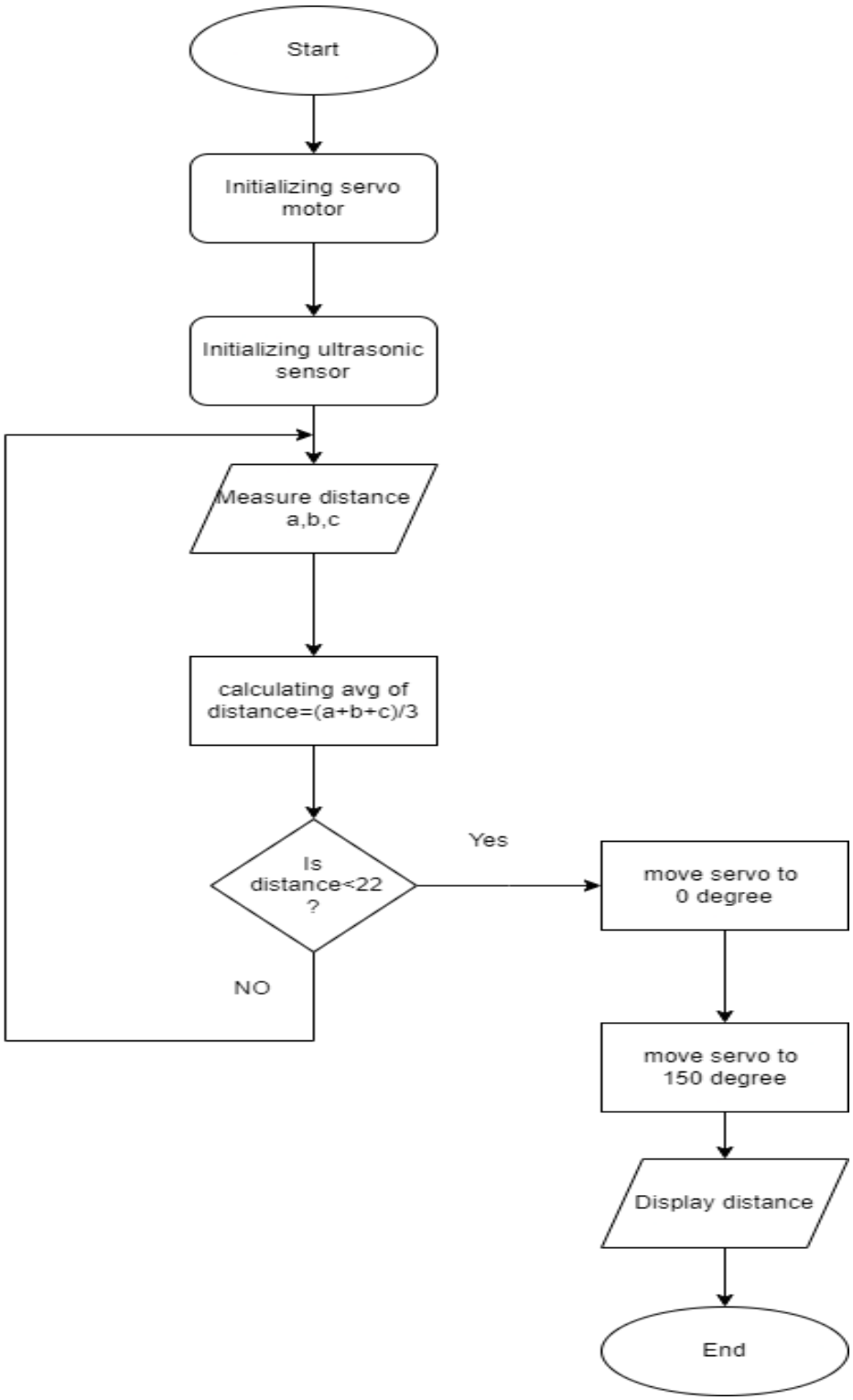

Figure 5: Flowchart.

2.3: Requirement Analysis

2.3.1: Hardware

- **Arduino uno**

  Arduino uno is a microcontroller board based on the ATmega328P. It can be connected to a computer with the help of a USB cable and can also be powered with battery. It has 14 digital input/output pins; 6 can be used as PWM outputs, and 6 analog inputs. It has a flash memory of 32 KB (Arduino, 2024).

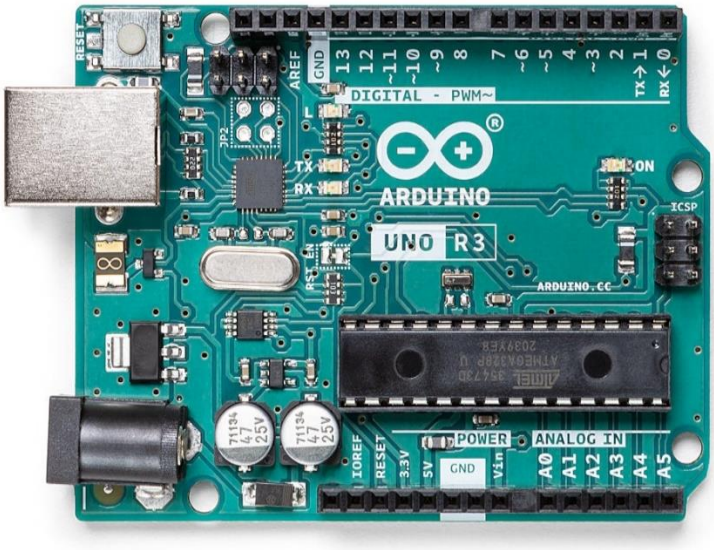

Figure 6: Arduino Uno.

- **Ultrasonic Sensor**

  The Ultrasonic sensor is an electronic device which is used to measure an objects distance by emitting high-frequency sound waves out and collecting the returning echoes. It contains two main components a transmitter and a receiver. It calculates the objects distance by timing how long it takes for the waves to bounce back to the sensor. It is an excellent way to measure the distance, speed, and position of the objects up to 400 cm. They are frequently used in a wide range of industries and applications because of their precision, non-contact nature, and capacity to operate in challenging environmental conditions (Robocraze, 2023).

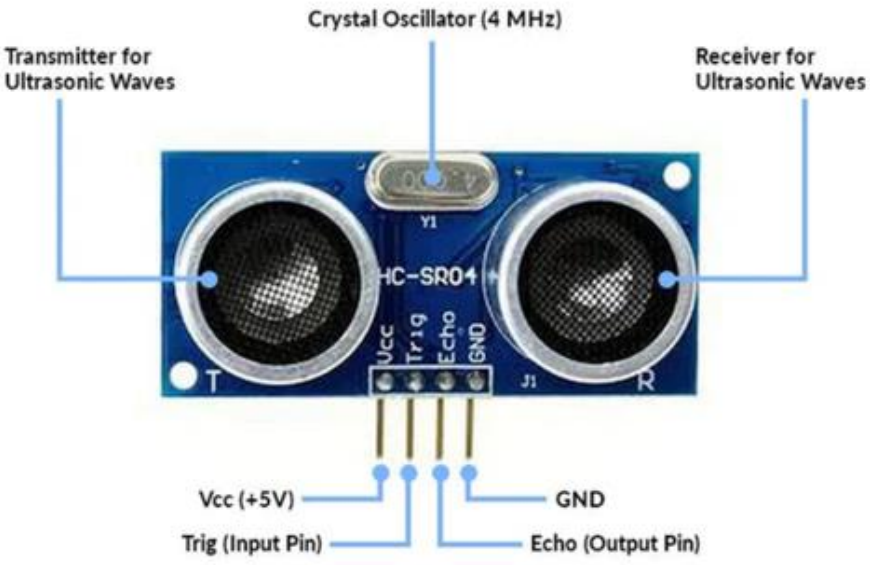

Figure 7: Ultrasonic sensor.

- **Servo motor**

  The servo motor is a linear or rotary actuator that has the capacity to rotate with remarkable accuracy and precision control. It contains a motor, feedback circuit, controller which uses position feedback to control the speed and final position of the motor. Servo motors excel at precision by translating electrical signals into exact movements making them ideal for the precision's tasks in robotics, automated manufacturing systems (testbook, 2023).

Figure 8: Servo motor.

- **Breadboard**

  A breadboard is a useful component for building temporary circuits as different components can be removed and replaced using jumper wire while different elements can be directly inserted into it. Normally the columns on the sides are used to connect power supply and rows in the middle of it are used to connect different components. It is very useful to prototype an idea or parts of a circuit quickly (Dahl, 2023).

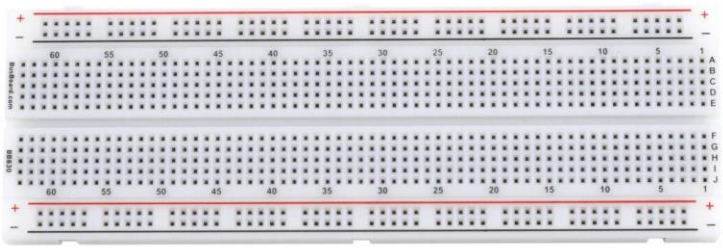

Figure 9: Breadboard.

- **Arduino Jumper wire**

  Jumper wires are crucial in electronics for interconnecting different components during prototyping or testing circuit without soldering. There are different types of jumper wire such as male-male, female-female jumper wires etc which are suitable for various electrical applications as they connect two different electrical circuits together. They are generally used in breadboard and prototyping tools like Arduino uno to connect different components together (mblassd, 2022).

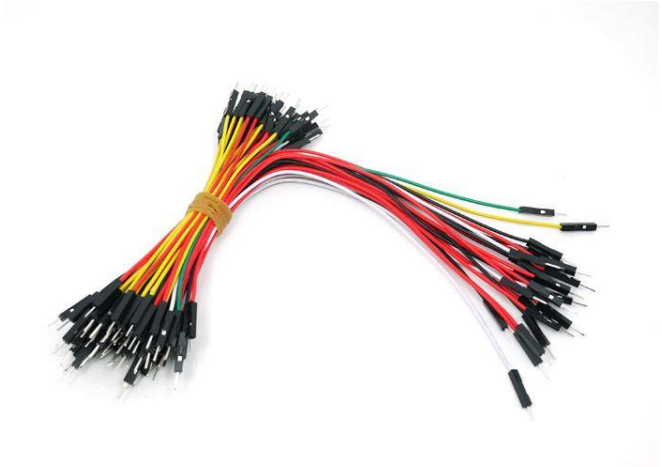

Figure 10: Jumper wire.

2.3.2: Software

- **Arduino IDE**

  Arduino IDE (Integrated Development Environment) is an open-source software that is mainly used for writing and compiling the code into the Arduino Module. It runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing, and compiling the code in the environment. It connects to the Arduino hardware to upload programs and communicate with them (Arduino, 2018).

Figure 11: Arduino IDE.

- **Tinkercad**

  Tinkercad is a free web app for 3D modelling which has electronics and code learning features. It provides user the option of turning their products into blocks or bricks. The objects can be duplicated, mirrored, and shifted (Zanyuk, 2022).

Figure 12: Tinkercad.

- **Draw.io**

  Draw.io is a software which is used in making diagrams and charts which has a large selection of shapes and hundreds of elements to develop them. It provides automatic or custom layout which is simple to use and mostly used browser-based end user diagramming software (Computer Hope, 2020).

Figure 13: Draw.io.

Section 3: Development

3.1: Planning and Design

Firstly, we discussed among the members regarding the IoT project that we were interested in creating. After much thought and consideration, we concluded that a smart dustbin IoT project would be in our best interest. Consequently, we started researching about the details of creating a smart dustbin and were able to find out the hardware and software requirements of the project. The design was initially simulated using Tinkercad.com before moving on to its physical.

3.2: Resource Collection

The necessary resources for this project were mainly collected from the college's Resources department. To obtain these resources, we were required to write an application addressed to the specific individuals involved. Once our application was approved, we acquired most of the required materials including jumper wires, a servo motor, and ultrasonic sensor. The Arduino UNO and breadboard were collected from a local store.

3.3: System Development

Phase 1: Firstly, the code required for the system was written in the Arduino IDE application and verified.

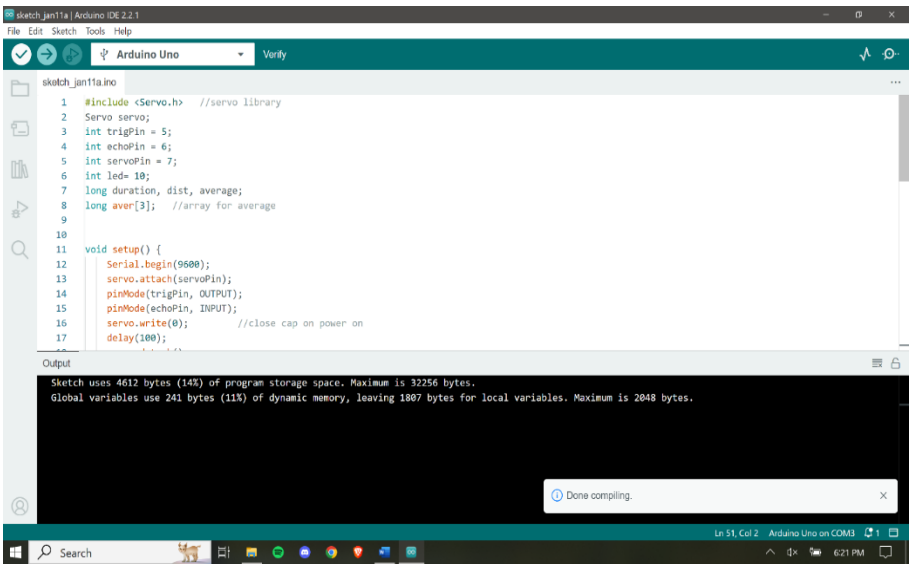

Figure 14: Writing codes in the Arduino IDE.

Phase 2: The physical architecture of the project was designed with reference to the Tinkercad simulation. The Arduino UNO was connected to the PC to supply power, and the codes was uploaded to it as presented in the image below:

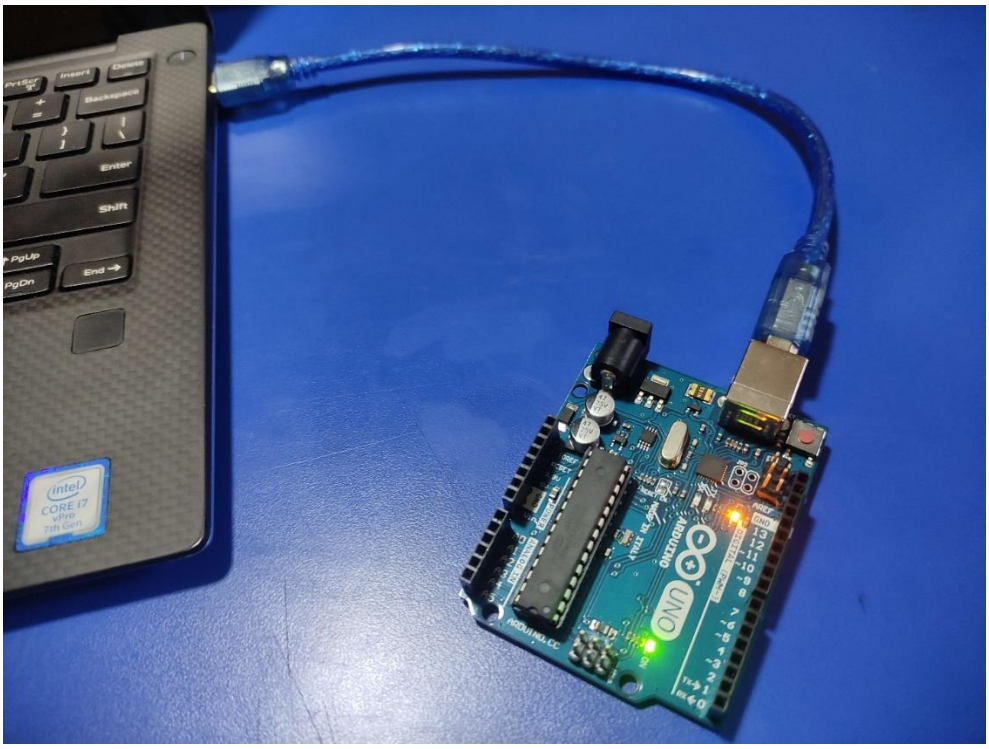

Figure 15: Connecting Arduino to the PC.

Phase 3: The ultrasonic sensor was connected to the breadboard, followed by the Arduino. The input pin(trig pin) was connected to the digital pin 5(D5) of the Arduino UNO, and the output pin(Echo pin) was connected to the digital pin 6(D6) of the Arduino. Similarly, the VCC pin was connected to the 5V of the Arduino to supply power, and the GND was connected to the GND of the Arduino.

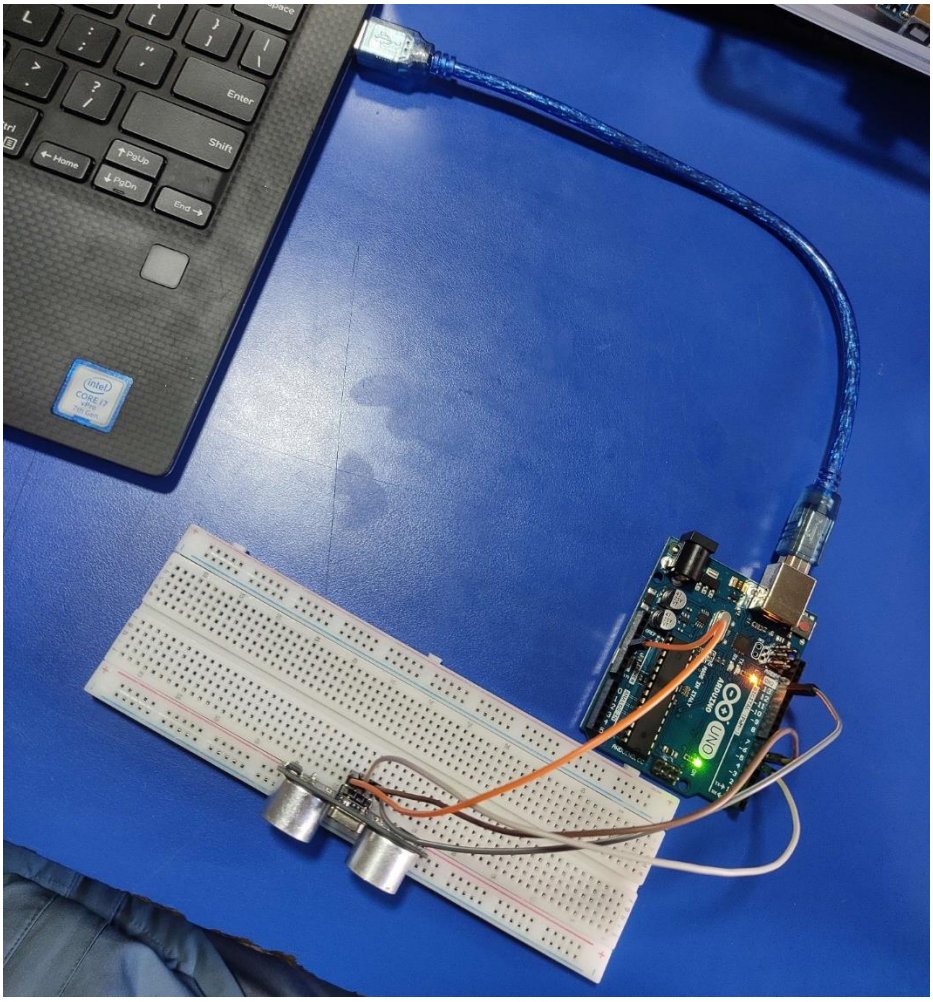

Figure 16: Connecting Arduino and Ultrasonic sensor to the breadboard.

Phase 4: Following the completion of the previous connections, the servo motor was then connected to the Arduino. The power pin of the servo motor was connected to the 3.3V of the Arduino for power supply, the GND was connected to the GND, and the Signal was attached to the digital pin 7 (D7) of the Arduino.

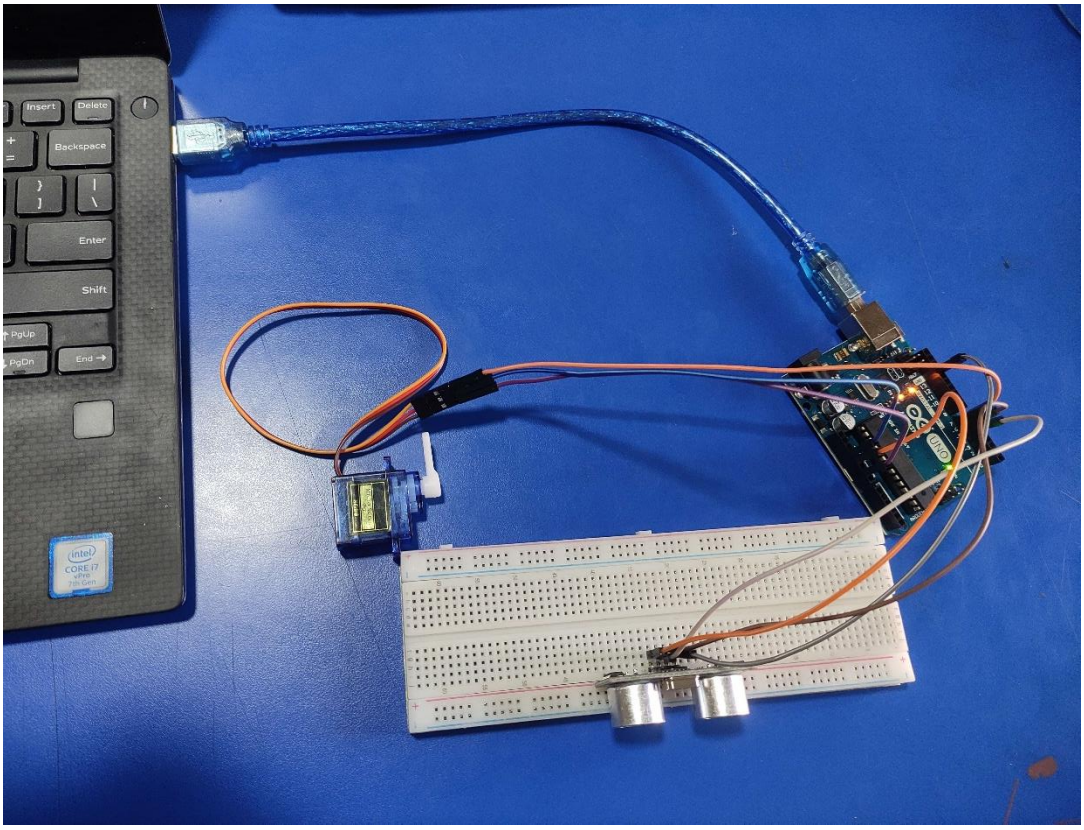

Figure 17: Incorporating the servo motor to the former connection.

Phase 5: After the completion of the circuit diagram, we proceeded to integrate the components into the dustbin, finishing the project.

Section 4: Results and Findings

4.1: Results:

At the end, the smart dustbin system was developed. When a hand is placed in front of the dustbin, the sensor sends out ultrasonic waves. If the hand is within the sensor's range, the waves bounce back as an input, triggering the connected servo motor to operate via Arduino. The servo motor, linked to the dustbin through a string, raises the lid when the ultrasonic sensor sends signals to it and lowers the lid once the signals stop.

4.2: Tests

Tests are done to verify that the system functions correctly.

4.2.1: Test-1

Objective	To verify the execution of the code.
Action	The codes were written in the Arduino IDE application and uploaded to the Arduino UNO
Expected outcomes	The code gets complied without any error.
Actual outcomes	The code got complied and was executed without any errors.
Result	The test is successful.

Table 2: Test to verify the code.

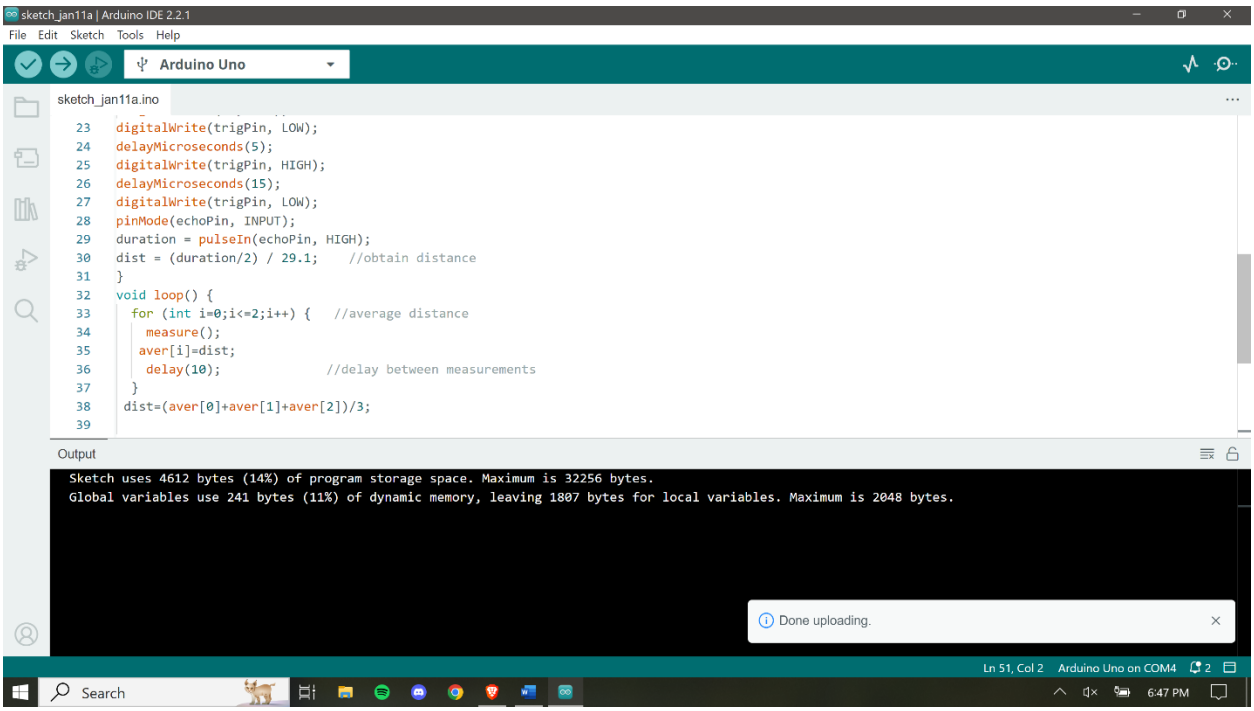

Figure 18: Compiled codes.

4.2.2: Test-2

Objective	To verify the functionality of the entire system.
Action	An object was placed in front of the dustbin.
Expected outcomes	The lid of the dustbin should open when the hand is placed in front of it, and it should close itself with a delay.
Actual outcomes	The lid of the dustbin opened when a hand was placed in front of it and closed after a delay.
Result	The test is successful.

Table 3: Test to verify functionality of the entire system.

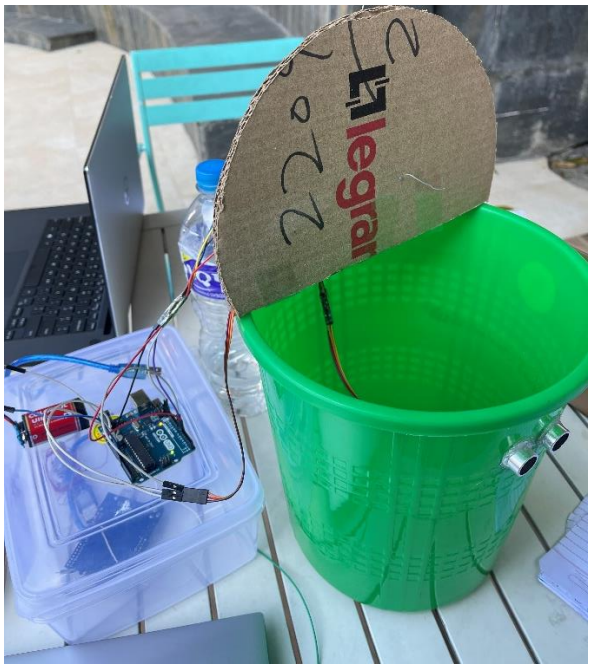

Figure 19: Lid opening on motion detection.

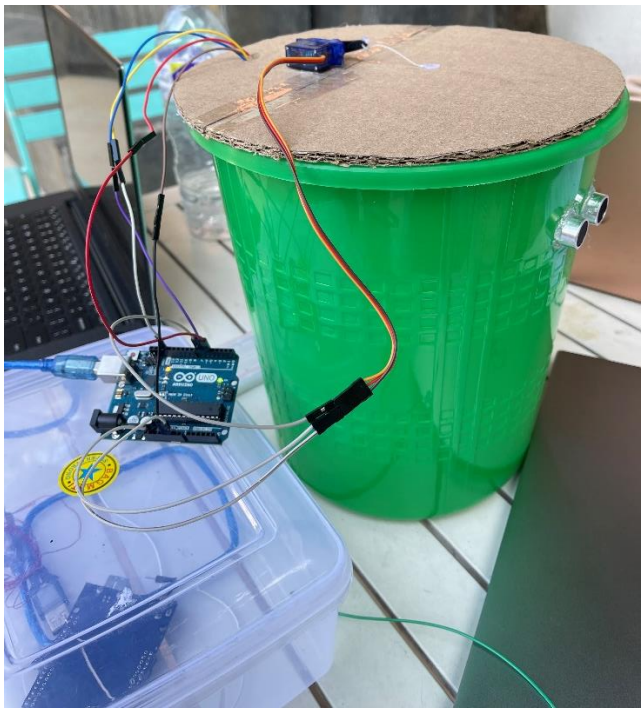

Figure 20: Lid closing.

Section 5: Future Works

The future prospects of this project are numerous. We were tasked with creating a prototype of an actual IoT device aimed at simplifying our day-to-day lives. The prototype of the smart dustbin that we have created still has room for improvement. Currently, the dustbin can open its lid upon detecting motion. However, there is potential to integrate additional features into this prototype in the future, such as monitoring waste levels inside the dustbin and sending notifications once it is full. It is also not as durable as we desire it to be, so we plan to enhance its durability by implementing necessary measures. Once all the necessary upgrades are made, this project will be ready for deployment on a large scale.

With the deployment of this project, we aim to fulfil our goal of promoting sustainable waste management practices and contributing to a sustainable Nepal. Our project will serve as an educational tool, raising awareness about the significance of waste management and highlighting the consequences of landfills and pollution.

Section 6: Conclusion:

In conclusion, we have successfully achieved the primary objective of this coursework by creating a functioning smart dustbin system. In this era of technology and development, IoT devices stand out as important inventions that have made our lives more convenient. They play a significant role in enhancing our quality of life and have become irreplaceable in various fields, contributing greatly to industrialization, medicine, and even routine household activities.

This coursework helped us learn about the process through which an IoT device is created and challenged us to come up with solutions to the problems that arose along the way. We had the opportunity to learn about various types of sensors and actuators and how they function collaboratively in an IoT device. The project helped us learn about the practical implications of IoT devices, turning it into a valuable learning experience. Moreover, we were able to develop our critical thinking, researching and problem-solving skills through this coursework.

Finally, this IoT project illustrates that a simple connection between a microcontroller, a sensor, and an actuator can simplify our work, showcasing significant advancements in automation in the field of invention. This progress makes our day-to-day tasks easier to accomplish.

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Section 8: Appendix

8.1: Source Code

```
#include <Servo.h>   //servo library

Servo servo;

int trigPin = 5;

int echoPin = 6;

int servoPin = 7;

long duration, dist, average;

long aver[3];   //array for average



void setup() {

    Serial.begin(9600);

    servo.attach(servoPin);

    pinMode(trigPin, OUTPUT);

    pinMode(echoPin, INPUT);

    servo.write(0);

    delay(100);

    servo.detach();

}


void measure() {
```

```
digitalWrite(trigPin, LOW);
delayMicroseconds(5);
digitalWrite(trigPin, HIGH);
delayMicroseconds(15);
digitalWrite(trigPin, LOW);
pinMode(echoPin, INPUT);
duration = pulseIn(echoPin, HIGH);
dist = (duration/2) / 29.1;
}
void loop() {
  for (int i=0;i<=2;i++) {
    measure();
   aver[i]=dist;
    delay(10);              //delay between measurements
  }
 dist=(aver[0]+aver[1]+aver[2])/3;

if ( dist<22 ) {
//distance for the ultrasonic sensors to sense objects
 servo.attach(servoPin);
  delay(1);
 servo.write(0);
```

```
 delay(3000);
 servo.write(150);
 delay(1000);
 servo.detach();
}
Serial.print(dist); //print the object distance in the range
}
```