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Smart Bin

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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.

Abstract

The rapid growth of urbanization and population has led to a significant increase in waste generation, posing a major challenge for waste management systems worldwide. A critical issue in waste management is the lack of proper segregation at the source, which hinders recycling efforts. Despite advancements in technology, traditional waste disposal methods remain largely manual, and even the implementation of multiple bins for different waste types has proven ineffective due to improper usage. To address this problem, we propose Smart Bin, an IoT-based smart waste segregation system. This project integrates Arduino, servo motors, stepper motors, and sensors (raindrop moisture sensor, IR sensor, and proximity sensor) to automatically classify and segregate waste into dry, wet, and metal categories within a single outer bin structure. The system eliminates the need for manual segregation by detecting waste type upon disposal and directing it to the appropriate inner compartment. The project aims to enhance waste management efficiency by automating segregation, reducing contamination, and improving recycling rates. Key objectives include developing a functional prototype, understanding IoT and sensor-based automation, and researching sustainable waste management solutions. The expected outcome is a cost-effective, scalable solution applicable in public spaces, educational institutions, and recycling facilities. By combining traditional waste collection methods with modern IoT technology, this project presents an innovative approach to waste segregation, promoting environmental sustainability and smart city development.

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1. Introduction

Internet of Things (IoT) has revolutionized today's world; it has become a major part of life. It solves the modern age problem with modern solutions. In today's context the world's population has been rapidly increasing and with increment of it, the volume of waste production increases at a pace which raises an alarming state for waste management and the need of segregation of waste.

To tackle this issue, we have come up with a proposal of developing an IOT based Smart Bin. this project will be segregating waste right at the time of disposal. In this project Smart Bin will leverage Arduino, motors and sensors which will detect the material of the waste and dump it into the container made for the certain material. This will segregate dry, wet and metal waste into 3 different containers that lie at the inner side, but in the outer infrastructure it will be having a single container. So basically, all the segregation process happens at the inner container after the waste is disposed on the top of the main container. So, this project will be the combination of traditional method of waste collection with the touch of modernization techniques. (Scotchbrook, 2024)

1.1. Current scenario

In today's world, rapid growth in urbanization gave rise to increased volume of waste that has made waste management a great hustle (Ojha, 2025). Even at such a peak point of urbanization, yet the process of waste management remains manual in almost all the corners worldwide. The major issue for waste management was found to be unsegregated waste at the time of disposal due to which the waste is taken to dumping site could not be recycled. (Nepal, 2023)

1.2. Problem statement and project as a solution

Problem Statement

The major problem for the waste management has been the unsegregated waste at the time of disposal from the source. (Scotchbrook, 2024) Despite of being in the 21st century, the world of modernization, yet the waste disposal system remains the same as the traditional ones. Even though nowadays we could see 3-4 different dustbins placed side by for disposal of the different wastes based on their type, yet the problem remains same. This also drags attention to another major problem for unmanaged waste management and segregation that despite of having solution as presence of multiple containers it didn't work. It shreds a light on the point that in

order to manage waste there is need of implementation of traditional way of waste collection with a modern touch. (Nepal, 2023)

Project as a solution

This Smart Bin project stands out as a solution for the unmanaged waste segregation likewise it also outweighs the concept of having 3-4 containers for waste segregation. Since this project is IoT based, it will be having a single container on the outer side, but the inner side will be having 3 separate containers; one for the dry waste, another for the wet waste and the other one for the metals. It will be based on Arduino, motors along with Raindrops and Proximity sensors. Even after implementing mitigation strategy as separate container for separate type of waste yet the problem remains same as people are still mixing all the waste in a single container. So, this point also makes this project standout as s perfect solution as this project will be having a single container that will segregate waste automatically based on their types, just we need to do is to dump waste into container and with the implementation of IoT it will segregate waste internally on 3 containers on the inner layer. (Ojha, 2025)

1.3. Aim and Objectives

1.3.1. Aim

The aim of this project is to produce a prototype of a smart dustbin that enhances waste management efficiency by segregating trash by dryness, wetness and whether it is a metal or not.

1.3.2. Objectives

- To make a prototype of a smart dustbin that could replace a normal dustbin.
- To learn about Arduino, sensors, actuators and how it works.
- To solve the problem of waste management through the smart dustbin.
- To research about IoT devices and IoT technologies and include it in the report.
- To make a prototype of a smart dustbin that uses appropriate sensors to classify and separate waste into dry, wet and metal categories.

2. Background

2.1. System overview

The prototype system proposed for this project is a smart dustbin that detects the waste based on different categories; dry, moist or metal and segregates them in different containers inside the same dustbin. The prototype system is selected because of the different problems seen in the waste management sector and hopes to contribute to solving this problem. This prototype will help solve this problem by segregating the waste right at the source which would make waste management and collection much easier. This system will utilize a combination of sensors, actuators, and processing units to ensure efficient and accurate segregation.

The main component of the prototype system is the Arduino Uno which is a microcontroller that will act as the brains of the system. The Arduino is connected to different sensors and actuators that all together make the whole system. The three sensor components that are utilized in this system are the Infrared sensor, Proximity switch, Raindrop sensor. The prototype system firstly has a detection area and then a disposal area. The detection area is located above, and the disposal area is located below it. In the detection area the waste is thrown by a user then the IR sensor detects it and triggers the function that will then use the proximity switch and raindrop sensor to determine whether the waste is dry, wet or metal. After the waste is identified as either dry, wet or metal the disposal area function is triggered. The sensors and actuators used in this section are the IR sensor, Servo motor and Stepper motor. The IR sensor is the main component that decides whether the disposal function is triggered or not, when the IR sensor is triggered and when the waste determination is completed the detection area sends the corresponding data to the detection area which will then trigger the stepper motor, and the stepper motor will then rotate the different container part according to the waste. When the detection part is right below the proper container the servo motor will be triggered and then the waste is dumped in the proper container.

2.2. Designing Diagrams

2.2.1. Block Diagram

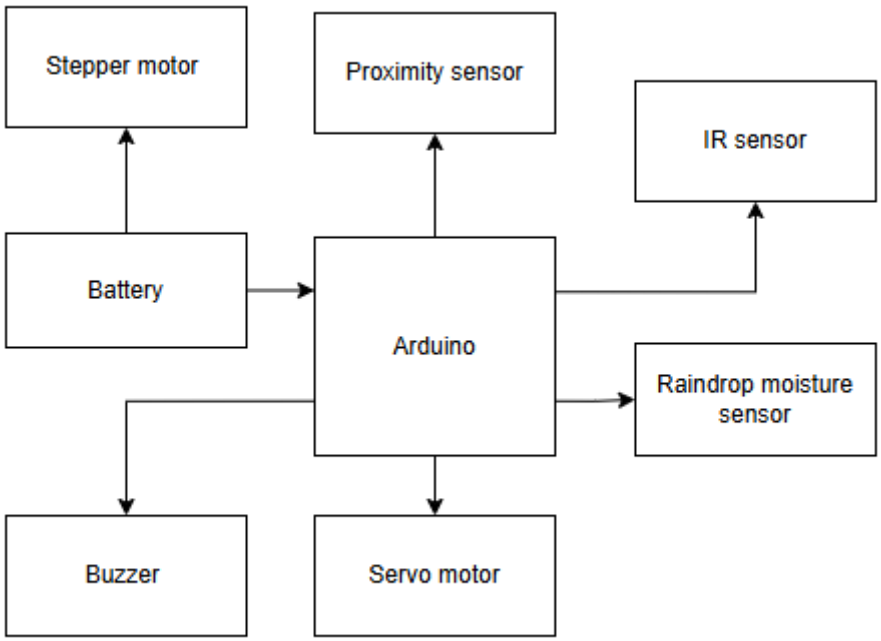

Figure 1:Block Diagram.

2.2.2. System Architecture

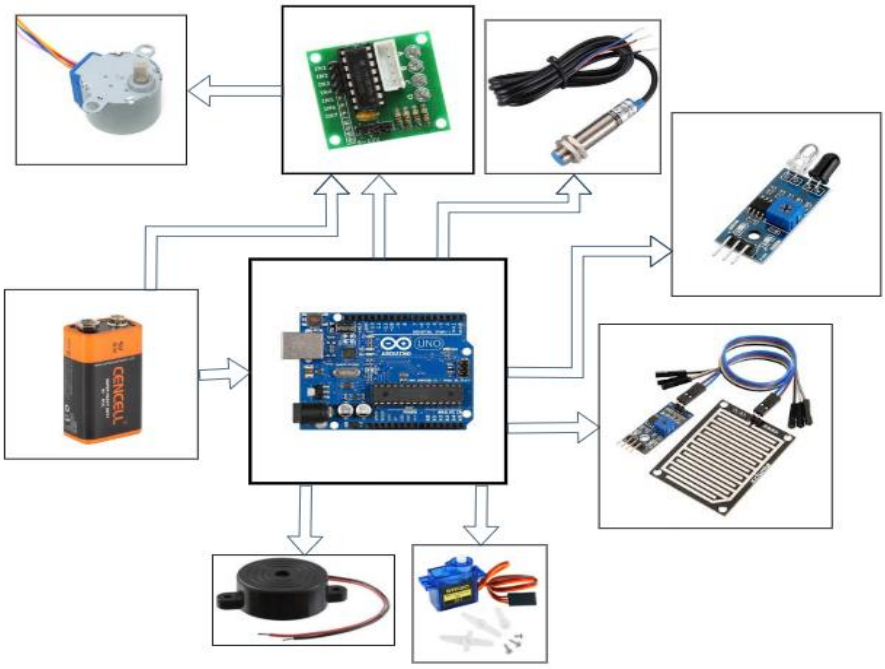

Figure 2: Hardware architecture of the system.

2.2.3. Circuit Diagram

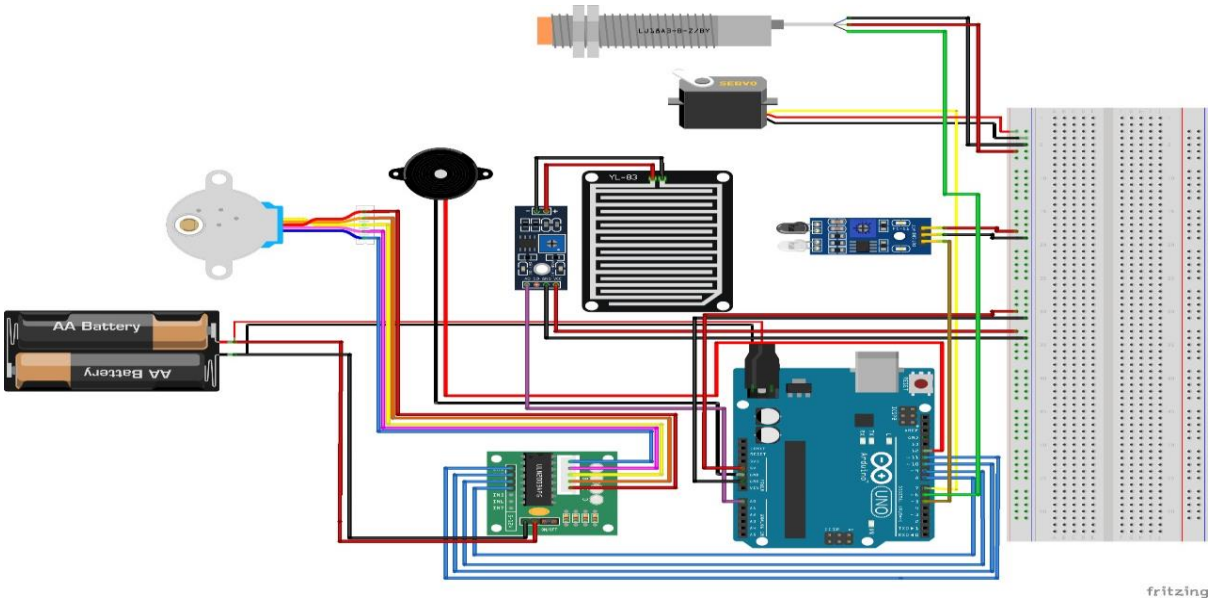

Figure 3:Circuit Diagram.

2.2.4. Schematic diagram

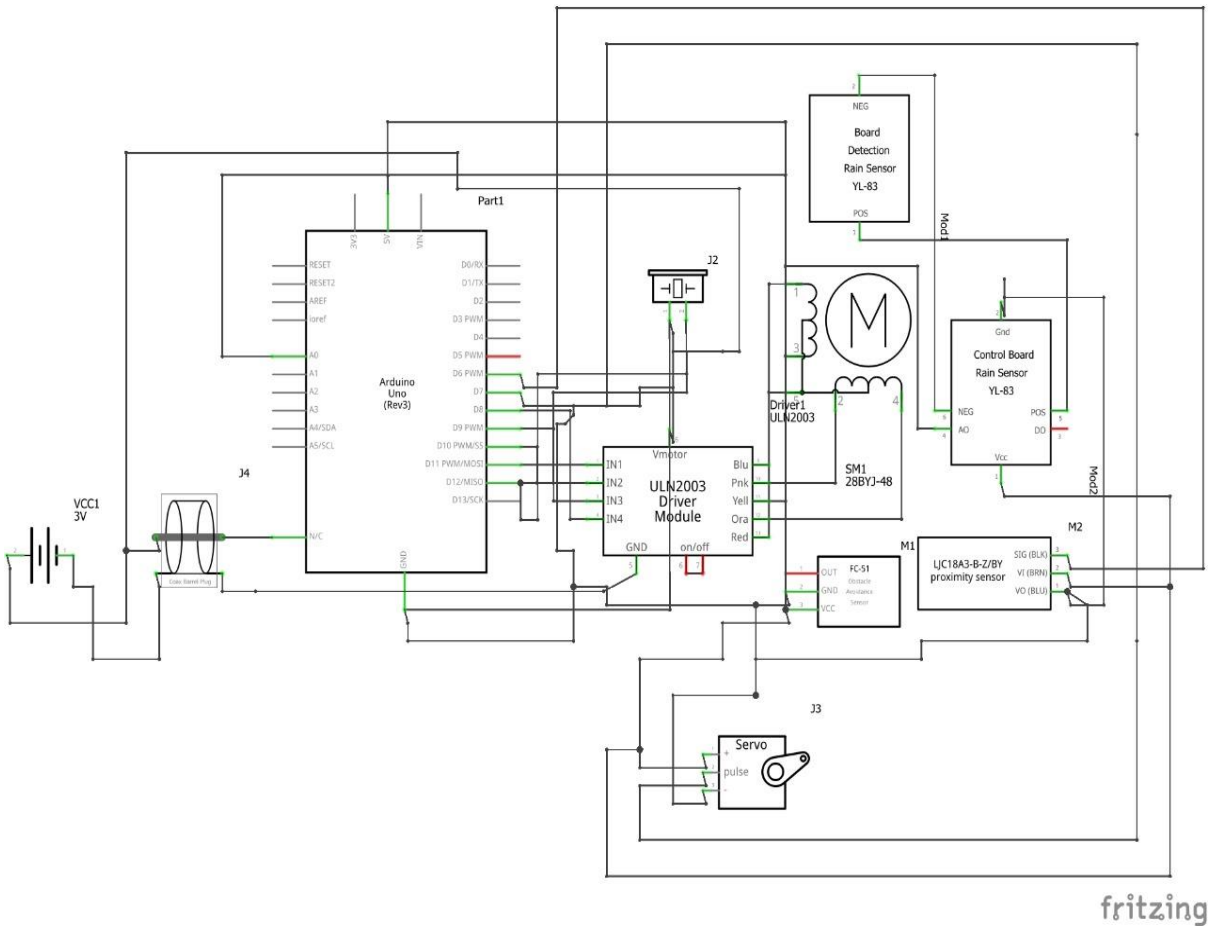

Figure 4: Schematic Diagram.

2.2.4. Flow Chart

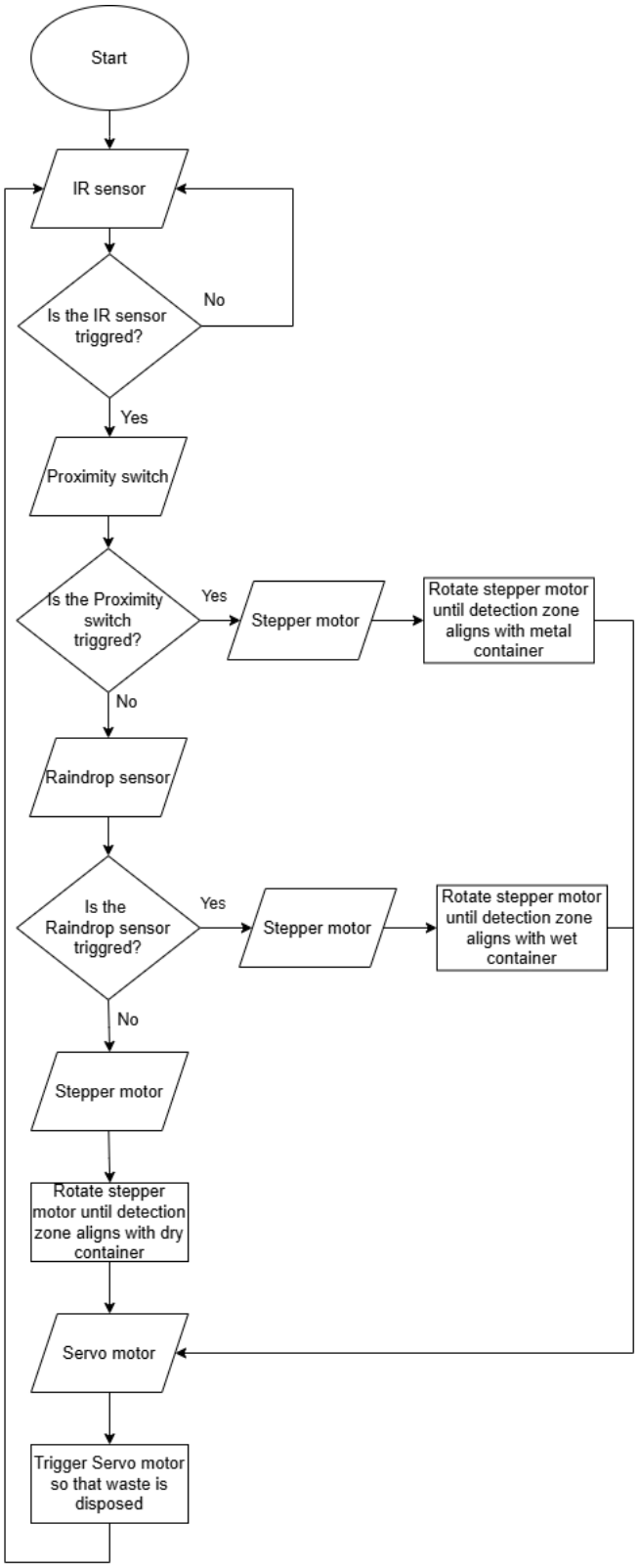

Figure 5: Flow Chart.

2.3. Requirement Analysis

2.3.1. Hardware components

Arduino

The Arduino is a programmable microcontroller which serves as the brain of the system by processing sensor inputs and managing the motors. It reads signals from the IR sensor, moisture sensor, and proximity sensor to determine how to handle the waste. Based on this data, it controls the servo motor to open and close the dustbin lid and operates the stepper motor to move the waste segregation partition accordingly. (Badamasi, 2014)

Figure 6:Arduino

Servo 9g motor

The servo 9g motor is a small motor that moves back and forth within a set range. It is responsible for opening and closing the dustbin lid. The Arduino signals the servo motor to open the lid automatically, which allows hands-free and hygienic waste disposal experience. (Sarah L. Harris, 2022)

Figure 7: Servo motor

Stepper motor

The stepper motor is a special motor that moves in small, specific steps. In this project, this motor is used to move the partition inside the dustbin to separate wet and dry waste. When the moisture sensor or proximity sensor detects the type of waste, the Arduino signals the stepper motor to shift the partition to the correct position. This makes sure that each type of waste goes into its selected section by making the waste sorting process more accurate and efficient. (Tanu Arefin, 2014)

Figure 8: Stepper motor

Stepper motor driver

The stepper motor is a special motor that moves in small, specific steps. In this project, this motor is used to move the partition inside the dustbin to separate wet and dry waste. When the moisture sensor or proximity sensor detects the type of waste, the Arduino signals the stepper motor to shift the partition to the correct position. This makes sure that each type of waste goes into its selected section by making the waste sorting process more accurate and efficient. (al, 2015)

Figure 9: Stepper driver

Rain drops moisture sensor

The rain drops moisture sensor is used to detect the moisture content. when the waste is dropped into the bin, the sensor checks whether if it is wet or dry and sends the information to the Arduino. If the waste is wet, the Arduino signals the stepper motor to move the partition and direct the waste into wet section. (Yogesh.S, 2021)

Figure 10: Raindrop sensor

IR sensor

An IR(Infrared)sensor is a device that helps detect objects or measures distance using infrared light. (Ajmera, 2017)

Figure 11: IR sensor

Proximity sensor

The proximity sensor detects the presence of objects without physical contact. In this project, it identifies the type of waste as metal. The Arduino then directs the stepper motor to sort the waste into the correct portion of the bin, ensuring accurate waste segregation. (Dorina Pucaru, 2017)

Figure 12: Proximity sensor

2.3.2 Software components

Arduino IDE

The Arduino IDE (Integrated Development Environment) is a software used to write, compile, and upload code to Arduino microcontrollers. In this project, it serves as a tool that allows us to program the Arduino board to control various components like sensors and motors. The IDE provides a simple text editor where we write code, and it is then translated into a format which Arduino can understand. Once we write the code and compile, it is uploaded to the Arduino board through a USB connection. (Jo‘rayev, 2022) After this the board executes the instructions by controlling the hardware components accordingly. The IDE also has a serial monitor that shows us what the board is doing which can be helpful to us to fix any problems. This makes sure that everything in the system works together properly for sorting the waste. The Arduino IDE is a simple and useful tool for both beginners and experts to program Arduino Projects. (Badamasi, 2014)

2.3.3. Category of sensors and actuators

Sensors

IR Sensor

- Model Number: HW201
- Model Name: Flying Fish
- Type: Active Sensor (Based on energy conversion)

  : Digital Sensor (Based on nature of output signal)

Proximity Sensor

- Model Number: LJ1283-4-J/BX
- Model Name: Cylinder Proximity Sensor
- Type: Active Sensor (Based on energy conversion)

  : Digital Sensor (Based on nature of output signal)

Rain Drop Moisture Sensor

- Model Number: MH-RD
- Model Name: Raindrops Module
- Type: Passive Sensor (Based on energy conversion)

  : Digital Sensor (Based on nature of output signal)

Actuators

Servo motor

- Model Number: SG90
- Model Name: Micro Servo 9g
- Type: Rotatory Actuator (Based on output movement)

  : Electrical Actuator (Based on source of energy)

Stepper Motor

- Model Number: 28BYJ-48
- Model Name: Step Motor
- Type: Rotatory Actuator (Based on output movement)

  : Electrical Actuator (Based on source of energy)

3. Development

This section of the report contains a comprehensive step-by-step development process of the Smart Bin project. This includes steps beginning from the initial phase of the planning followed till the executing of the project. This part of the report contains an overview of the planning and the designing phases of the project with the resources used along with the breakdown of step-by-step process of the final project development.

3.1. Planning and Design

To initiate this project with a vision the team had the planning and the designing phase. For this particular project, an IoT based smart bin was to be developed which would be helpful in segregating the waste and waste issue faced in each and every household, city and country. To start any project, planning and vision of what the final would look like is must.

Then the project was initiated by designing the circuit diagram using the Tinker Cad and Fritzing software. While designing, most of the hardware requirements for the project was available in the tinker cad but few were unavailable that made the team to switch to the Fritzing Software then the hardware component was selected, and the connection was made using the jumper wire. So, at the initial phase the virtual diagram of circuit diagram was completed. After this the collection of all the resources was held and then in team we connected all hardware components in real life. Then each team member made the connection individually which gave a clear concept of working mechanism which further helped each of the team members to make a project with right connection in final without any hassle.

The original idea behind this project was because of the problem faced worldwide. As it is known that more than once in our lives, we have faced the problem of waste management. Hence, this IoT system is not only a project but a step towards the solution of the problem mentioned above. Different devices were used during the completion of this project. Each of those devices are mentioned properly in section two i.e., Background part. Smart Bin project is not just a project but a step towards the better tomorrow where the world will be free from the problem of waste management and lead towards the recycling process.

3.2 Resource Collection

In order to execute it from just a concept to a final project a lot of devices were used. The resource used in this project were managed from various sources, which are Resource Department of Islington College, Himalayan Solution and rest from the households of the team members. The list of devices obtained from the Resource Department of Islington college are provided below:

- Arduino
- Buzzer
- Jumper Wires
- IR sensor
- Breadboard
- Servo motor

Some of the resources are obtained except from the Islington college resources obtained from the Himalayan Solution are listed below:

- Extra Jumper Wires
- Proximity Sensor
- Raindrop Moisture Sensor
- Stepper Motor
- A couple of Batteries

Rest of the resources like pipes, screws, board for the model of project were collected from the houses of team members which were not in use.

3.3 System Development

The system is an IoT based Smart bin which segregate the waste, different devices were used to complete this project.

Step 1:

At first an Arduino was to connect to pc via a USB cable. Once the code has been completed and debugged, Within the Arduino IDE, the correct board (i.e., Arduino Uno) and COM port are selected from the Tools menu, the code is uploaded.

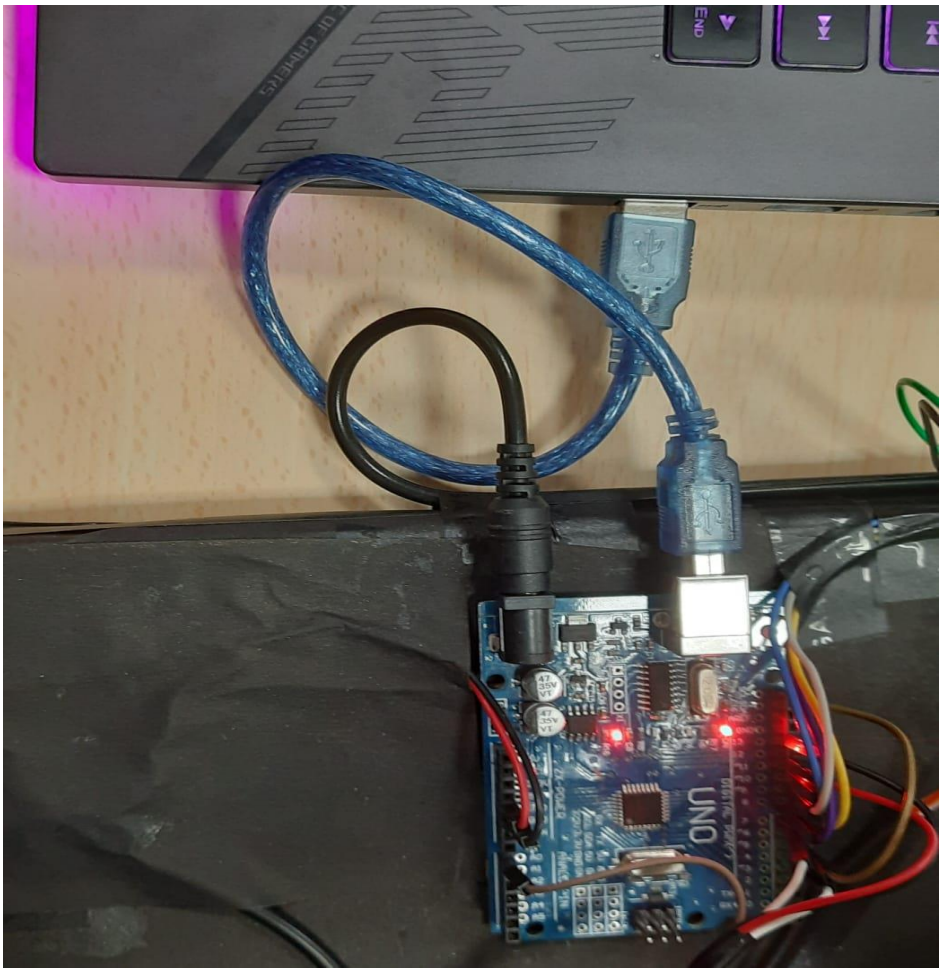

Figure 13: Uploading code in Arduino.

Step 2: Input devices are placed in their places.

Breadboard was used to distribute the power supply to different sensor and motor basic connection of wires were done to the breadboard. Different input devices like IR sensor, a proximity sensor and a raindrop sensor are connected to an Arduino using and a breadboard for power distribution. The breadboard is conected with 5V and GND from the Arduino. The IR sensor's Vcc port is connected to the 5V rail on the breadboard, and its Ground is connected to the GND port of breadboard, allowing it to increase the number of ports for use. The Out pin of the IR sensor is connected to a digital input pin 5 on the Arduino. Proximity sensor's wires the brown wire (Vcc) connects to the 5V port of breadboard, the blue wire (GND) connects to the ground port of breadboard, and the black wire (signal output) is connected to pin 6 on the Arduino. The raindrop sensor is connected with its Vcc to the 5V breadboard rail, GND to the ground rail, and the AO (analog output) pin is connected to the A0 analog input pin on the Arduino, enabling the Arduino to receive analog data indicating moisture levels.

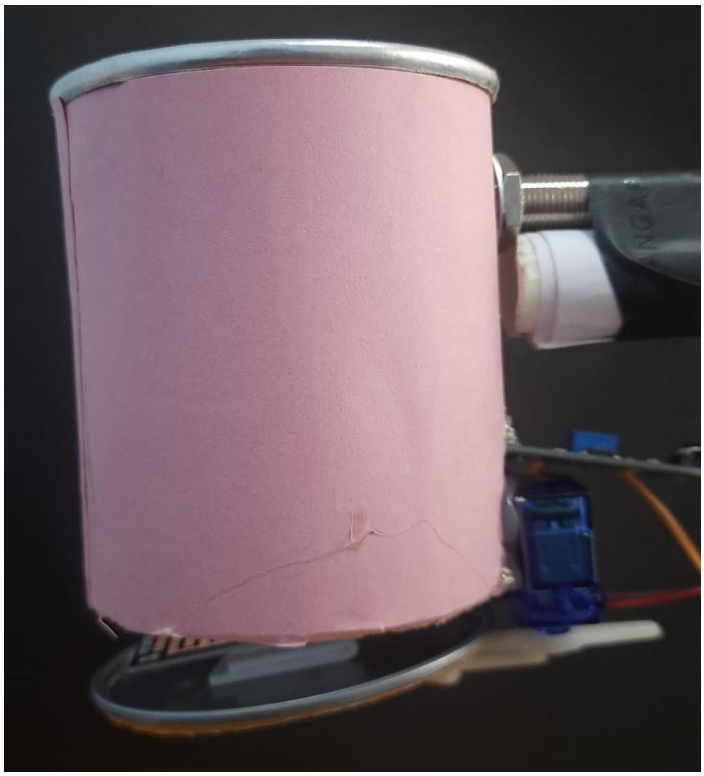

Figure 14: Connection of Input Devices.

Step 3: Output devices are connected into their places.

Output devices like motors and a buzzer are connected to the Arduino uno and breadboard. The stepper motor is controlled through a stepper driver/module, 5v is not enough for the stepper motor so it is directly connected to a battery for sufficient current supply. The control pins of the stepper module are connected IN1 to pin 8, IN2 to pin 9, IN3 to pin 10, and IN4 to pin 11, to the Arduino ports allowing the Arduino to control the motor's rotation. The servo motor wires the yellow (signal) wire is connected to pin 7 of the Arduino, the red power wire is connected to the 5V port on the breadboard, and the brown (ground) wire is connected to the ground rail on the breadboard. Additionally, a buzzer is connected with its positive terminal (+) going to pin 12 on the Arduino and its negative terminal (-) connected directly to GND on the Arduino, allowing the microcontroller to control sound output. This setup enables full integration of motor control and sound feedback using the Arduino and external components.

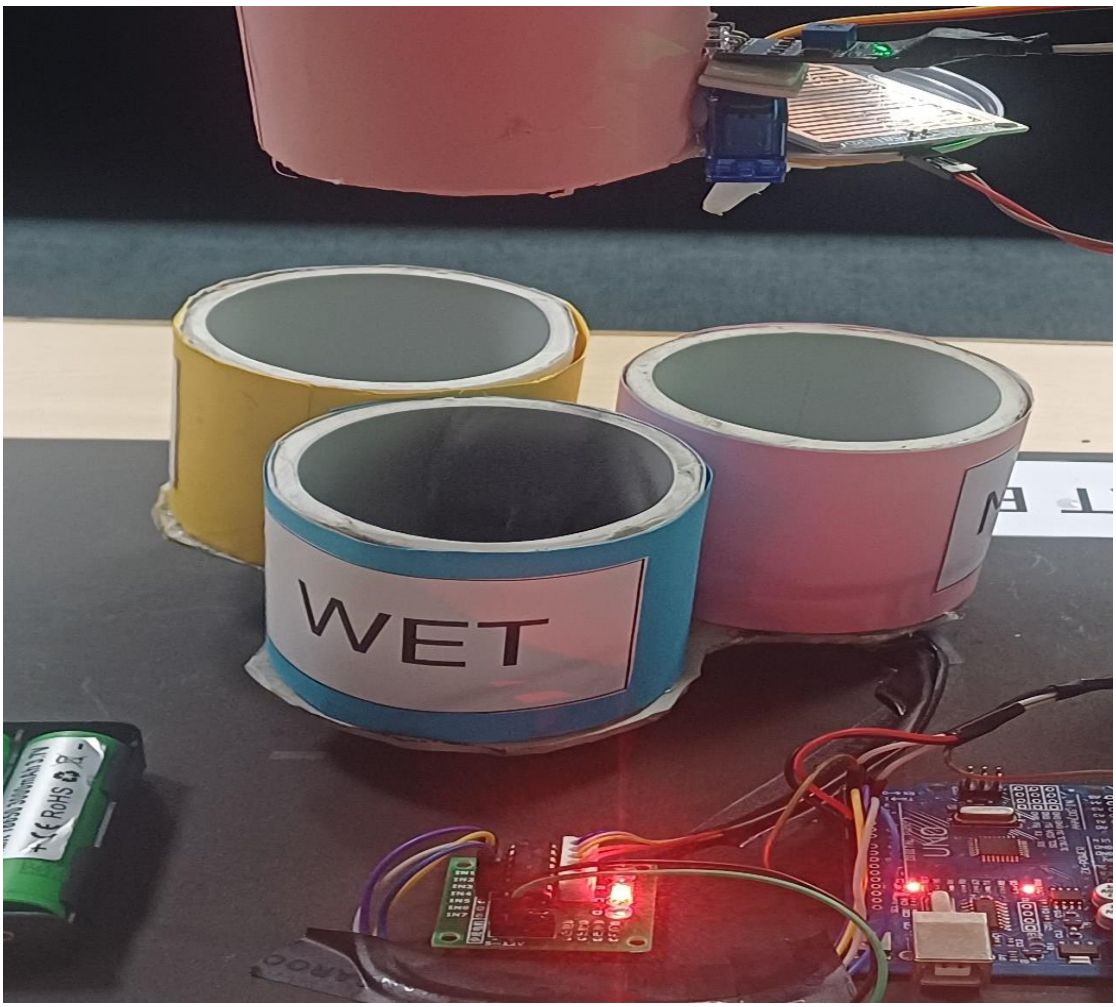

Figure 15: Connection of Input Devices

Step 4:

The final project, a Smart Waste Segregation Bin has been developed using Arduino, various sensors, motors, and a buzzer to automatically identify and sort waste into dry, metal, and wet categories. The system uses an IR sensor, proximity sensor, and raindrop sensor as input devices to detect the type of waste. All sensors are powered via a breadboard connected to the Arduino's 5V and ground pins. The proximity sensor' black wire use for signal is connected to pin 6 on the Arduino, while the raindrop sensor's analog output is connected to A0 for the signal of moisture, which identify wet waste. A buzzer is connected to pin 12 on the Arduino and ground, to provide sound alerts during operation, after the detection of the waste.

A stepper motor and a servo motor are used to separate the waste. The stepper motor, powered by an external battery, is controlled through a driver module connected to Arduino pins 8, 9, 10, and 11, helps to rotate the foundation for bin alignment. The servo motor is responsible for dropping the waste into the correct compartment, the yellow wire for signal is connected with its signal pin on pin 7 of arduino, powered via the 5V breadboard, and grounded properly. This integrated system smart bin detect the presence and type of waste and automatically segregate it into appropriate categories dry, metal, or wet thereby promoting efficient and eco-friendly waste management.

Figure 16: Final model of the project.

4. Results and Findings

4.1 Results

The Smart Bin project successfully developed an innovative waste segregation system that uses IOT technology to address the long-standing challenge of improper waste sorting. By integrating sensors such as IR, moisture, and proximity sensors along with servo and stepper motors, the system can accurately identify whether the waste is dry, wet, or metal, and automatically direct it to the appropriate compartment all within a single outer bin. This smart bin removes the need for manual segregation, reducing errors and inefficiencies. The result is a cost-effective, intelligent solution that enhances waste management by improving sorting accuracy, reducing contamination, and increasing recycling efficiency. Its compact and design makes it highly adaptable and suitable for use in public areas, schools, and recycling centers, supporting both environmental sustainability and the broader goals of smart city development.

4.2 Findings

In this section, different test scenarios are identified to show whether the project is completely running or not.

Test 1

Objective	To verify that the IR (Infrared) sensors can detect the presence of waste when it is placed inside the bin, initiating the waste identification process.
Action	A sample of dry waste (e.g., paper) was placed into the bin's input section, triggering the IR sensor.
Expected Outcome	The IR sensor should successfully detect the presence of an object (dry waste), sending a signal to the microcontroller to begin the classification process. The system should proceed to assess the moisture level and other properties to determine that the waste is dry.
Actual Outcome	The IR sensor successfully detected the waste input and initiated the classification process. The system continued to assess and classify the waste as dry.
Result	The test was successful. The IR sensor reliably detected waste entry, confirming its effectiveness in triggering the segregation mechanism.

Figure 17: Testig dry waste (paper).

Figure 18: Segregation of dry waste.

Test 2

Objective	To confirm that the moisture sensor can detect wet waste accurately and trigger the system to classify and segregate it appropriately.
Action	A sample of wet waste (e.g., damp tissue) was placed into the smart bin's input section.
Expected Outcome	The IR sensor first detects the presence of waste. The moisture sensor identifies moisture content in the waste. Based on the moisture reading, the system determines the waste is wet and activates the stepper motor to direct it to the wet waste compartment.
Actual Outcome	The IR sensor detected the waste. The moisture sensor successfully sensed the presence of moisture. The waste was accurately classified as wet and sorted into the wet compartment.
Result	Test was successful

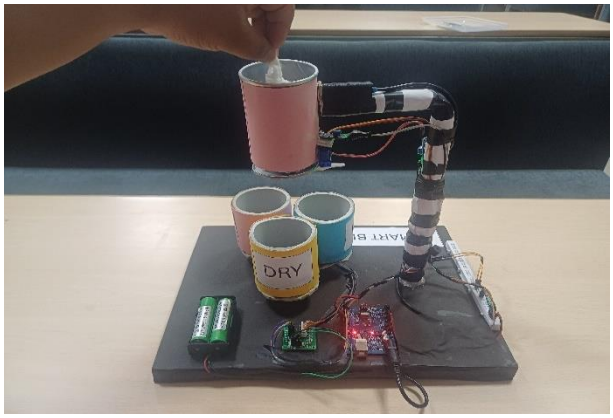

Figure 19: Testing of wet tissue.

Figure 20: Segregation of wet waste.

Test 3

Objective	To verify that the proximity sensor can accurately detect metallic waste and ensure the system classifies and segregates it correctly.
Action	A piece of metallic waste (e.g., small metal) was placed into the smart bin's input section.
Expected Outcome	The IR sensor detects the presence of waste. The moisture sensor detects no moisture (indicating it is not wet). The metal sensor identifies the metallic content in the waste. The system classifies the waste as metal and directs it to the metal compartment using the motor mechanism.
Actual Outcome	The IR sensor successfully detected the waste. The moisture sensor confirmed there was no moisture. The metal sensor identified the waste as metal. The system correctly sorted the waste into the metal compartment.
Result	Test was successful

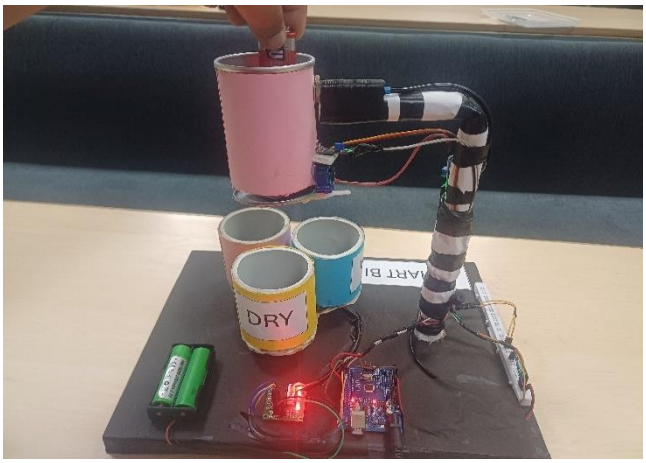

Figure 21: Testing of metal waste.

Figure 22: Segregation of metal waste.

Test 4

Objective	To evaluate the accuracy and reliability of the rain drop moisture sensor in distinguishing between wet and dry waste, especially after previous wet waste detection.
Action	First, place a piece of wet waste (e.g., damp tissue) into the bin. After the system processes the wet waste, immediately place dry waste (e.g., paper) into the bin without wiping or resetting the sensor.
Expected Outcome	The moisture sensor detects wet waste correctly and routes it to the wet waste compartment. The sensor should detect no moisture in the dry waste and classify it as dry, routing it accordingly.
Actual Outcome	The sensor successfully detected wet waste and directed it to the wet compartment. Due to residual moisture on the sensor surface, the system misclassified the dry waste as wet and incorrectly routed it to the wet compartment.
Result	Test was unsuccessful

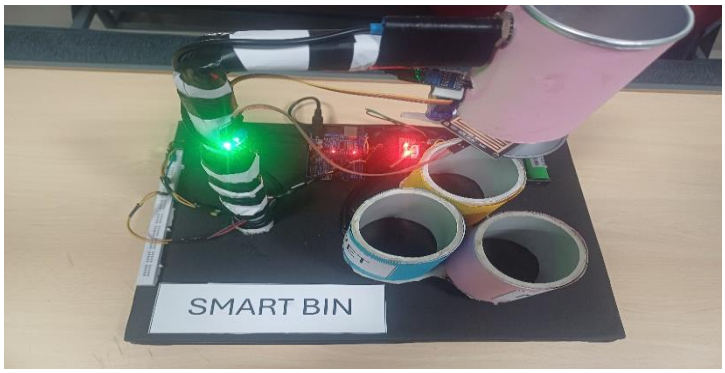

Figure 23: Detection of wet waste after segregation.

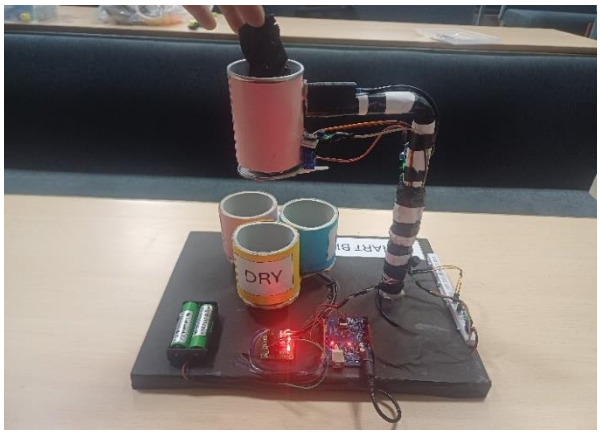

Figure 25: Trying waste.

Figure 24: Unable to segregate waste.

Test 5

Objective	To check whether the proximity sensor can detect metal when it is mixed with plastic material.
Action	A piece of waste containing both plastic and metal was placed into the Smart Bin to test the metal detection capability of the sensor.
Expected Outcome	The proximity sensor should detect the presence of metal in the waste and direct it to the metal compartment.
Actual Outcome	The sensor failed to detect the metal because it was partially covered or mixed with plastic. As a result, the waste was not classified as metal and was misdirected to the wrong compartment.
Result	Test was unsuccessful

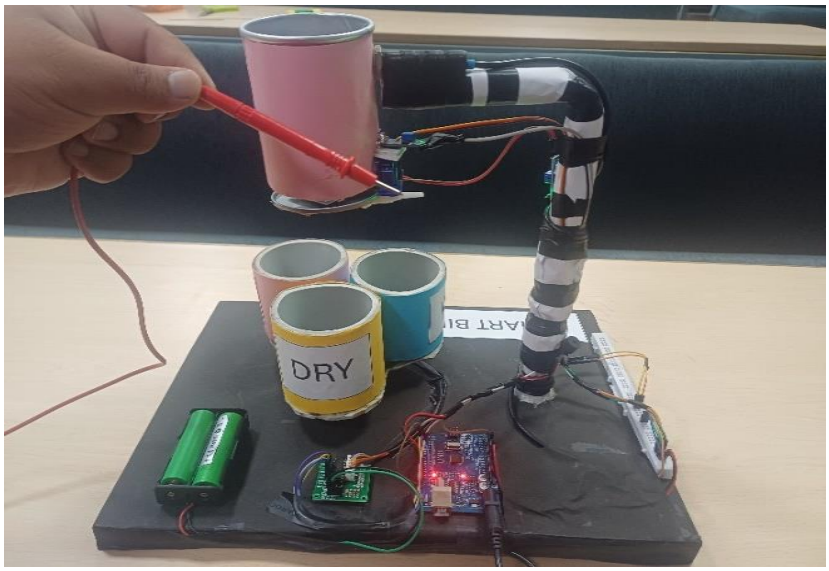

Figure 26: Trying mixed waste of plastic and metal.

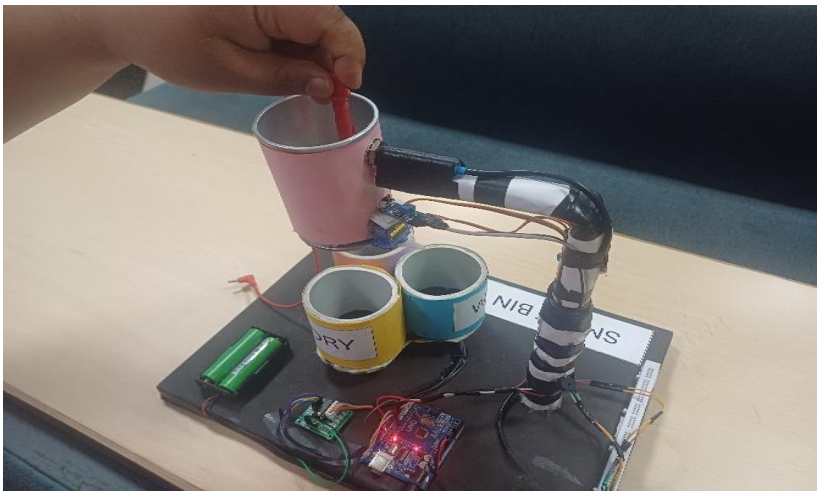

Figure 27: Unable to segregate the mixed wase.

Test 6

Objective	To show that code runs without error.
Action	With the help of Arduino IDE application code was written, verified and uploaded on Arduino
Expected Outcome	The code would be complied successfully without any error.
Actual Outcome	The code was not executed and show error
Result	Test was unsuccessful

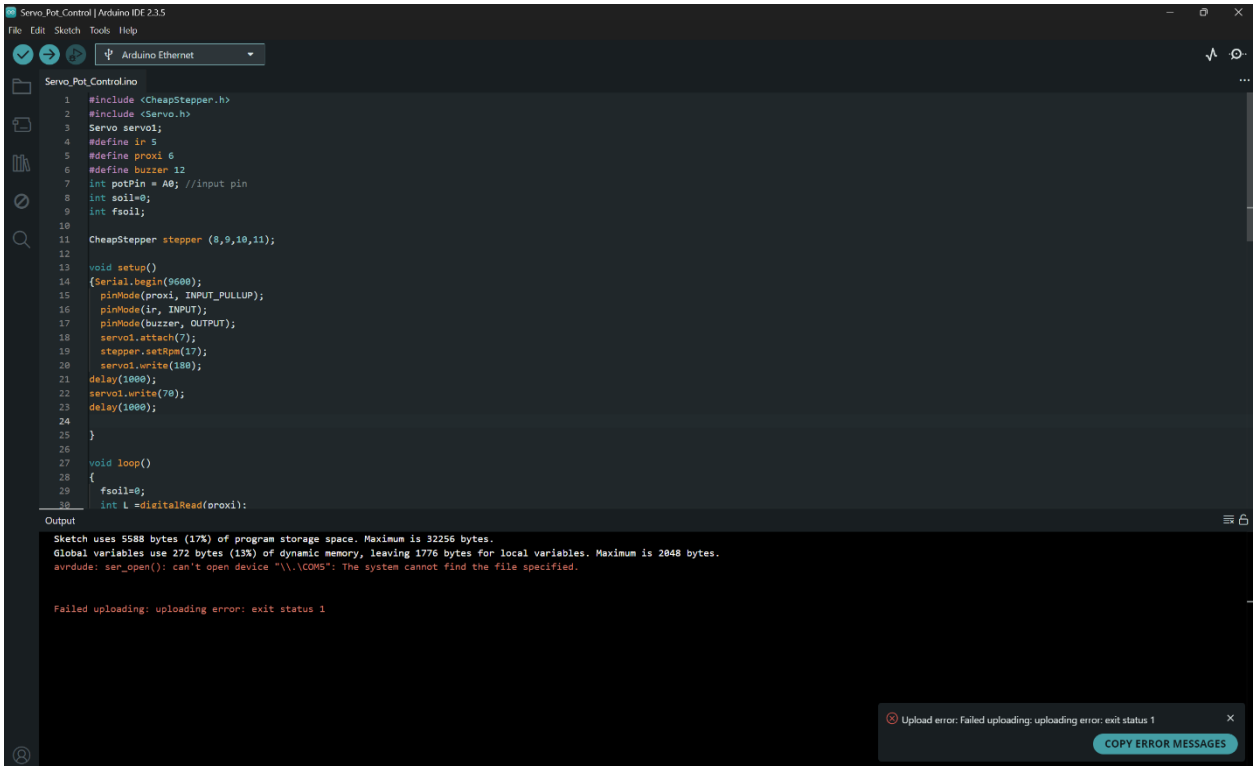

Figure 28: Uploading the Code.

5. Future Works

This system can be regarded as fully functional though there are many things which can be improved to make things easier, comfortable, and more accurate. Some of the future works that's need to be improved or added to the project are given below:

1. Smart notifications to users

A notification system should be integrated into the project because it would alert users through mobile applications or computers when their dustbins get full. The system notifies users and staff about the emptying time of the bin to prevent unnecessary mess or overflowing. A notification system integrated into the waste system will enable better and faster waste collection.

2. AI-based waste recognition

The addition of a small camera combined with artificial intelligence technology allows waste recognition so automatic sorting can occur. The dustbin employs sensors at present but will gain enhanced intelligence from AI to sort multiple waste materials accurately.

3. Solar-powered system

The utilization of solar power requires the addition of a small solar panel to the dustbin structure. project is becoming eco-friendly with lower costs due to the replacement of normal electricity with solar-powered energy.

4. Cloud computing integration

The dustbin can access cloud computing to store data such as the number of waste collections as well as the waste types and user usage records in internet servers. The collected data helps analyse waste patterns for developing better waste management throughout cities or specific areas.

5. Adding more sensors enhance abilities to sorting mixed waste

The device can benefit from additional sensor components to identify diverse waste categories including metal and glass types. The current waste separation system deals with wet/dry materials while additional sensors will enhance dustbin waste sorting abilities which was facing by the mixed waste leading to better waste recycling results.

6. Conclusion

In this Project, an automatic sorting smart dustbin was designed and developed for wet, dry and metal waste with the help of sensors and an Arduino microcontroller. The main goal was to enhance waste management, decrease human effort and promote recycling in a better way. The system was successfully built and tested and it worked as expected by sorting the waste into the correct sections. This project demonstrated that even so minor pieces of technology can in fact solve genuine issues of daily life.

The project provided essential knowledge about the use of sensors, microcontrollers and IoT technology which works together to create smart solutions. It also helped us to recognize various challenges involved such as sensor accuracy, managing power requirements and the need for smooth communication between hardware and software components.

The waste management system can bring many benefits in public places, homes, schools, offices and cities helping to keep the environment clean by reducing manual effort and motivating people to recycle more.

In the future, the smart bin can be developed with phone notification, cloud storage of waste data, solar panels, AI recognition of waste type and rewards system to motivate people. These features can make the dustbin smarter, more useful and even more eco-friendly.

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8. Appendix

```
#include <CheapStepper.h>

#include <Servo.h>

#define IR_SENSOR_PIN 5

#define PROXIMITY_SENSOR_PIN 6

#define BUZZER_PIN 12

#define SOIL_SENSOR_PIN A0

const int SOIL_MIN = 485;

const int SOIL_MAX = 1023;

const int MOISTURE_THRESHOLD = 20;

Servo servo1;

CheapStepper stepper(8, 9, 10, 11);

void setup() {

  Serial.begin(9600);

  pinMode(PROXIMITY_SENSOR_PIN, INPUT_PULLUP);

  pinMode(IR_SENSOR_PIN, INPUT);

  pinMode(BUZZER_PIN, OUTPUT);

  servo1.attach(7);

  stepper.setRpm(17);

  // Initialize servo position

  servo1.write(180);

  delay(1000);

  servo1.write(70);

  delay(1000);

}
```

```
void loop() {
  // Check proximity sensor
  if (digitalRead(PROXIMITY_SENSOR_PIN) == LOW) {
    Serial.println("Proximity Detected");
    tone(BUZZER_PIN, 1000, 1000);
    stepper.moveDegreesCW(240);
    delay(1000);
    openAndCloseLid();
    stepper.moveDegreesCCW(240);
    delay(1000);
  }
  // Check IR sensor
  if (digitalRead(IR_SENSOR_PIN) == LOW) {
    Serial.println("IR Triggered");
    tone(BUZZER_PIN, 1000, 500);
    delay(1000);
    int averageMoisture = readAverageSoilMoisture();
    Serial.print("Soil Moisture: ");
    Serial.print(averageMoisture);
    Serial.println("%");
    if (averageMoisture > MOISTURE_THRESHOLD) {
      // Wet soil
      stepper.moveDegreesCW(120);
      delay(1000);
```

```
      openAndCloseLid();
      stepper.moveDegreesCCW(120);
      delay(1000);
    } else {
      // Dry soil
      tone(BUZZER_PIN, 1000, 500);
      delay(1000);
      openAndCloseLid();
    }
  }
}
void openAndCloseLid() {
  servo1.write(180);
  delay(1000);
  servo1.write(70);
  delay(1000);
}
int readAverageSoilMoisture() {
  int total = 0;
  for (int i = 0; i < 3; i++) {
    int raw = analogRead(SOIL_SENSOR_PIN);
    raw = constrain(raw, SOIL_MIN, SOIL_MAX);
    total += map(raw, SOIL_MIN, SOIL_MAX, 100, 0);
    delay(75);
```

```
  }
  return total / 3;
}
```