Automated Trash Sorting Robot

Abstract: We present a robot capable of detecting the type of object (dry, wet, or metal) and autonomously disposing of it into the respective bin. The detection process is facilitated through feedback from infrared (IR), soil moisture, and proximity sensors.

Introduction:

This innovative solution aims to navigate through public spaces, using sensors to identify and sort different types of waste into recycling and non-recycling categories for proper disposal and streamline waste segregation processes, contributing to environmental sustainability and efficient resource management.

In response to the worsening degradation of Dhaka city, our team embarked on the development of a solution aimed at improving waste management practices. Looking ahead, we plan to integrate the robot into a point system to incentivize waste segregation and implement a belt system for enhanced efficiency and scalability, envisioning a future where our solution plays a pivotal role in revitalizing urban environments.

Components:

- Servo Motor (SG90) x2
- Raindrops Sensor -HW-028
- Metal Detector/Proximity Sensor
- Ultrasound Sensor
- Male to male wires
- Male to Female wires
- IC7805
- 16x2 LCD
- Breadboard
- Arduino Uno
- Power supply

For structure:

- Plastic bottle
- Pipe
- Pen
- 50mm PVC board (frame)

Planning and Design:

We've categorized objects into three sections: dry, wet, and metal. Initially, an IR sensor detects any object thrown into the basket. Subsequently, two additional sensors, proximity and raindrop sensors, are activated. The proximity sensor identifies metal objects, while the raindrop sensor detects wet ones. This multi-sensor approach enhances our waste segregation system's accuracy and efficiency.

We devised a paper-made basket divided into three sections—dry, wet, and metal—attached atop a servo motor. Upon an object being thrown in, the IR sensor triggers the detection process. If neither the proximity sensor nor the raindrop sensor signals positively, the object is identified as dry. In this case, the basket remains stationary and rotates 0 degrees. Upon detecting a wet object, the servo motor rotates 90 degrees, aligning the basket with the wet section, allowing the object to be deposited accordingly. Similarly, upon identifying a metal object, the servo rotates 180 degrees, positioning the basket for the metal object's deposit.
This automated mechanism streamlines waste segregation by precisely directing objects to their designated slots based on their characteristics. By utilizing the servo motor to adjust the basket's orientation, we ensure precise sorting without the need for manual intervention.

Structure:

We constructed the project structure using board, pipes, pens, and a bottle, reinforced by mounting it on a PVC board for stability. The breadboard and wires were securely attached with glue to ensure a stable system. A cover was installed over the structure, housing a servo motor at the basket's mouth. Upon object detection and categorization, the servo rotates 180 degrees, causing the object to drop into its designated slot.

Circuit Setup:

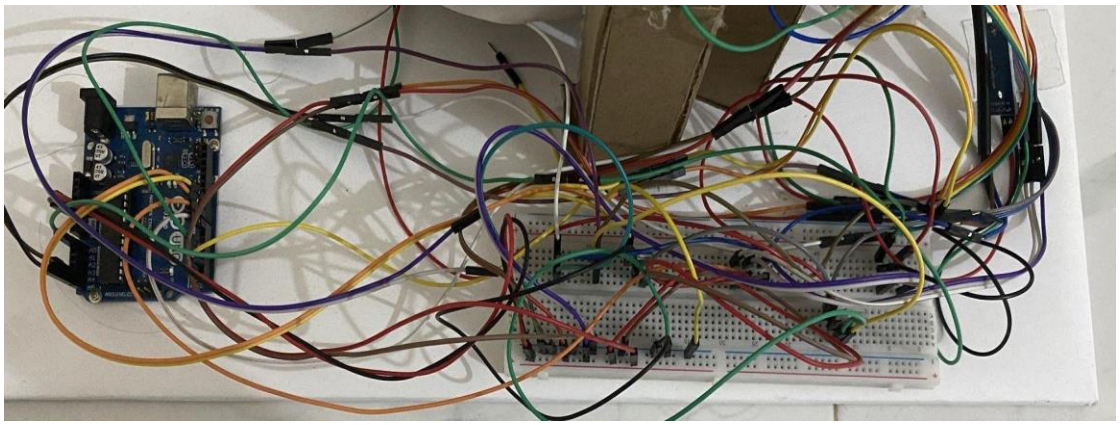
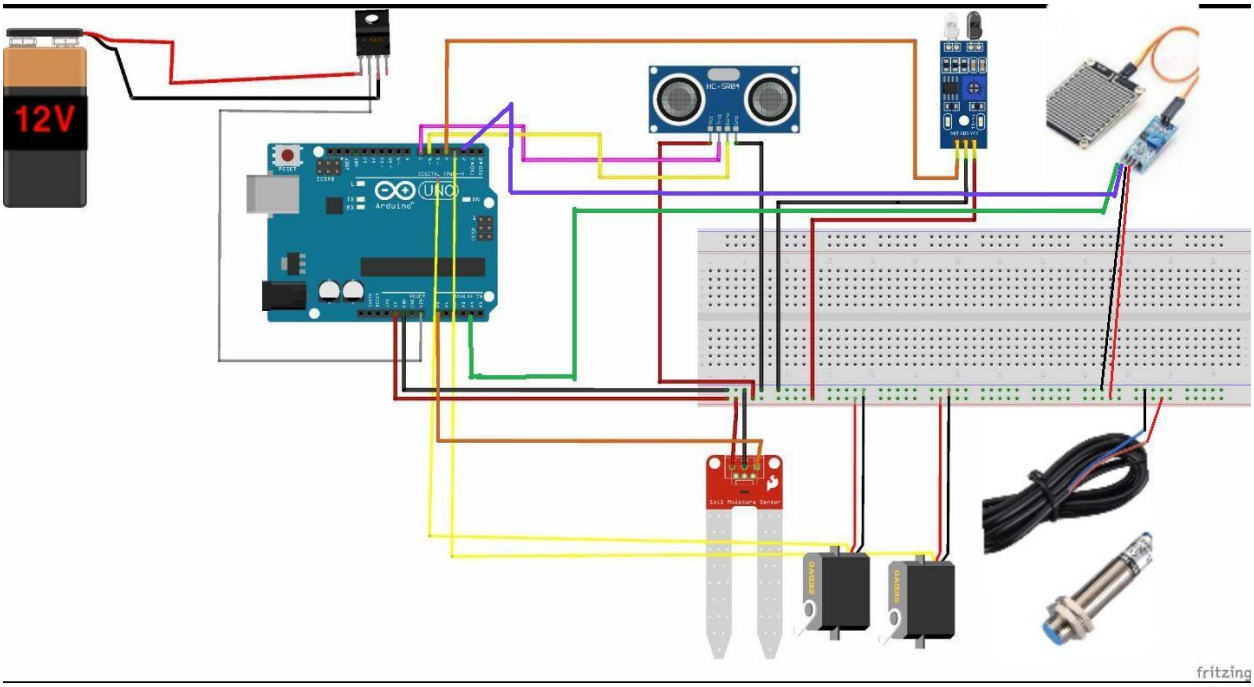
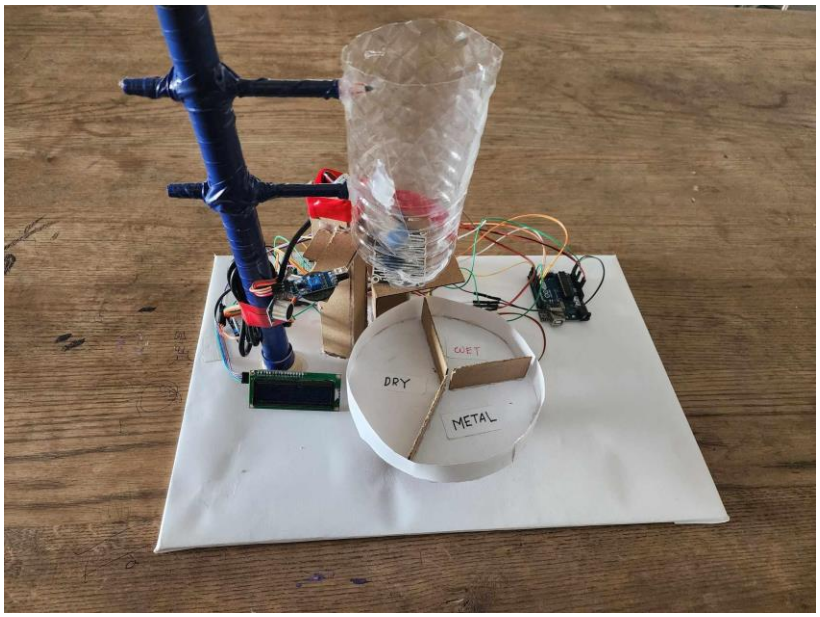


Fig: Circuit

Circuit Diagram:



Hardware Setup:



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IC7805:

It is a voltage regulator IC that is used to provide a constant output voltage of 5V.

16x2 LCD:

A liquid crystal display that can show 16 characters in each of its two rows, providing a total of 32 characters of information. It showed the welcome text, and the types of objects that had been identified.

Sensors:

Microcontroller:

Servo Motor:

Microcontroller Programming:

Code:

```
#include <Servo.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

// IR Sensor Pin
const int irPin = 7;

// Metal Detector Sensor Pin
const int sensorPin = 2;

// Moisture Sensor Pin
const int potPin = A0;

// Servo Motors
Servo lowerServo;  // Servo on pin 4
Servo upperServo;  // Servo on pin 8

// LCD Display
LiquidCrystal_I2C lcd(0x27, 16, 2); // Set the LCD address to 0x27 for a 16 chars and 2 line display

// Variables for Sensors
int objectDetected;
int sensorValue;
int fsoil;

void setup() {
  // Start Serial Communication
  Serial.begin(9600);

  // Initialize the LCD
  lcd.init();
  lcd.backlight();

  // Display a welcome message
  lcd.setCursor(0, 0);
```

```
  lcd.print("CSE461 Group 8");

  // Pin Modes
  pinMode(irPin, INPUT);
  pinMode(sensorPin, INPUT);

  // Attach Servos
  lowerServo.attach(4);
  upperServo.attach(8);

  // Initial position of servos
  lowerServo.write(0); // Lower servo starts at 0 degrees, closed position
  upperServo.write(0); // Upper servo starts at 0 degrees, closed position
}

void loop() {
  // IR Sensor Check
  objectDetected = digitalRead(irPin);

  // Check and print the object detection status continuously
  if (objectDetected == LOW) {
    Serial.println("Object Detected!");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Object Detected!");

    sensorValue = digitalRead(sensorPin);
    if (sensorValue == HIGH) { // Metal Detected
      Serial.println("Metal");
      lcd.setCursor(0, 1);
      lcd.print("Metal");
      lowerServo.write(180); // Rotate lowerServo to 180 degrees for metal detection
    } else {
      fsoil = 0; // Reset soil moisture average before calculation
      for (int i = 0; i < 3; i++) {
        int soil = analogRead(potPin);
        soil = constrain(soil, 485, 1023);
        fsoil += map(soil, 485, 1023, 100, 0);
```

```
      delay(75);
    }
    fsoil /= 3;

    if (fsoil > 3) {
      Serial.println("Wet");
      lcd.setCursor(0, 1);
      lcd.print("Wet");
      lowerServo.write(90); // Rotate lowerServo to 90 degrees for wet soil
    } else {
      Serial.println("Dry");
      lcd.setCursor(0, 1);
      lcd.print("Dry");
      lowerServo.write(0); // Rotate lowerServo to 0 degrees for dry soil
    }
  }

  // Delay to allow the lower servo to move into position
  delay(1000);

  // Open the upper compartment to drop the element
  upperServo.write(180);
  delay(1000);

  // Reset positions
  upperServo.write(0);
  lowerServo.write(0);
  delay(1000);
 }

 delay(1000); // Main loop delay to manage cycle time
}
```

Testing and debugging: After several tests, we have made some modifications, which are given below:

Modifications:

Initially, we planned to use ultrasound sensors to detect objects, but we found that they didn't always give us accurate readings. Thus, we made the decision to use infrared sensors in their place. These sensors strengthen our robot's dependability by being more effective at detecting objects inside the trash bin. This change allowed us to improve the accuracy and efficiency of our project. So, we repurposed the ultrasound sensor to determine whether the bin is full or not. By doing so, we've created a more comprehensive waste management system.

Also, we planned to use soil moisture sensors to detect wet objects, but they malfunctioned. Subsequently, we replaced them with raindrop sensors, which proved to be more effective. This modification enhanced our waste segregation robot's ability to accurately identify wet waste and provide a more robust solution .

User Manual: