Smart Dustbin

INTRODUCTION

The Smart Dustbin is a user-friendly and hygienic waste disposal system designed to address the growing need for automation in daily tasks. By employing ultrasonic sensors, a servo motor, and LED indicators, the dustbin can detect the presence of a person, assess its fill level, and open or close its lid automatically. This touchless design ensures cleanliness and convenience, making it ideal for homes, offices, and public spaces. Additionally, the project demonstrates the seamless integration of electronics and automation to improve waste management practices.

COMPONENTS

Aurdino UNO, Dustbin, Servo Motor (SG-90), Ultrasonic Sensors (HC-SR04) (2), Red, Blue and Green LED(s), Jumper Wires, Breadboard, 9V Power Supply, Resistors(1k) (4), Tape

PRINCIPLE AND WORKING

1. *Ultrasonic Sensors*

HC-SR04

Ultrasonic sensors, such as the **HC-SR04**, work by emitting ultrasonic sound waves that reflect off nearby objects.
How it works:

- The sensor's trigger pin emits sound waves at 40 kHz. These waves bounce off an object and are received by the echo pin.

- The Arduino calculates the time taken for the echo to return and determines the distance using the formula:

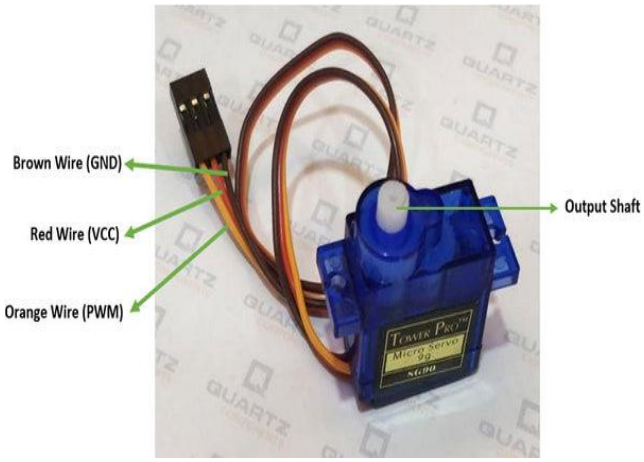
$$\text{Distance} = \frac{Time * 0.34}{2}$$

- **Usage in the Smart Dustbin:**
  - One ultrasonic sensor detects the proximity of a person (to open the lid).
  - Another sensor monitors the fill level of the dustbin, ensuring it does not overflow.

2. Servo Motor

Servo motors, like the SG90, are precise actuators capable of rotating to specific angles.

- **How it works:**
  - The motor rotates between 0° and 180°, as directed by the Arduino.
- **Usage in the Smart Dustbin:**
  - The servo motor is used to open and close the dustbin lid.



SERVO MOTOR SG-90

  - When a person is detected, the Arduino sends a signal to the servo to rotate to 180° (open position). After a delay, the servo rotates back to 0° (closed position).

3. *Arduino Uno*

The Arduino Uno is the microcontroller that serves as the “brain” of the Smart Dustbin, interpreting sensor data and controlling outputs like the servo motor and LEDs.

- **Key Features:**
    - **Digital Input/Output Pins:** Used to interface with sensors, LEDs, and actuators.
    - **Analog Pins:** For reading variable signals (not used in this project).
- **Usage in the Smart Dustbin:**
    - Processes distance data from the ultrasonic sensors.
    - Controls the servo motor's movement based on sensor inputs.
    - Manages LED indicators to signal the bin's status (full or not full).

ARDUINO UNO

Assembly

Lid Mechanism:

- The bin's top face is modified with a cardboard plate cut into a circular shape.
- The plate is divided into two semicircular parts:

❖ ***Stable Plate:***

- Fixed firmly to the rim of the bin.
- Holds the servo motor on its upper side.
- A thread is attached to the servo motor's arm, connected to the movable plate**.**

❖ ***Movable Plate:***

- Functions as the dustbin's lid, moving between open and closed positions based on the servo motor's rotation.

Internal Electronics Setup:

- A mini breadboard is installed beneath the stable plate (inside the bin) to facilitate wiring and connections.

- Components like the Arduino Uno and the ultrasonic sensor for level detection are mounted on or near the breadboard for stability and ease of access.

- The Arduino Uno acts as the control hub, processing signals from the sensors and controlling the servo motor and LEDs.

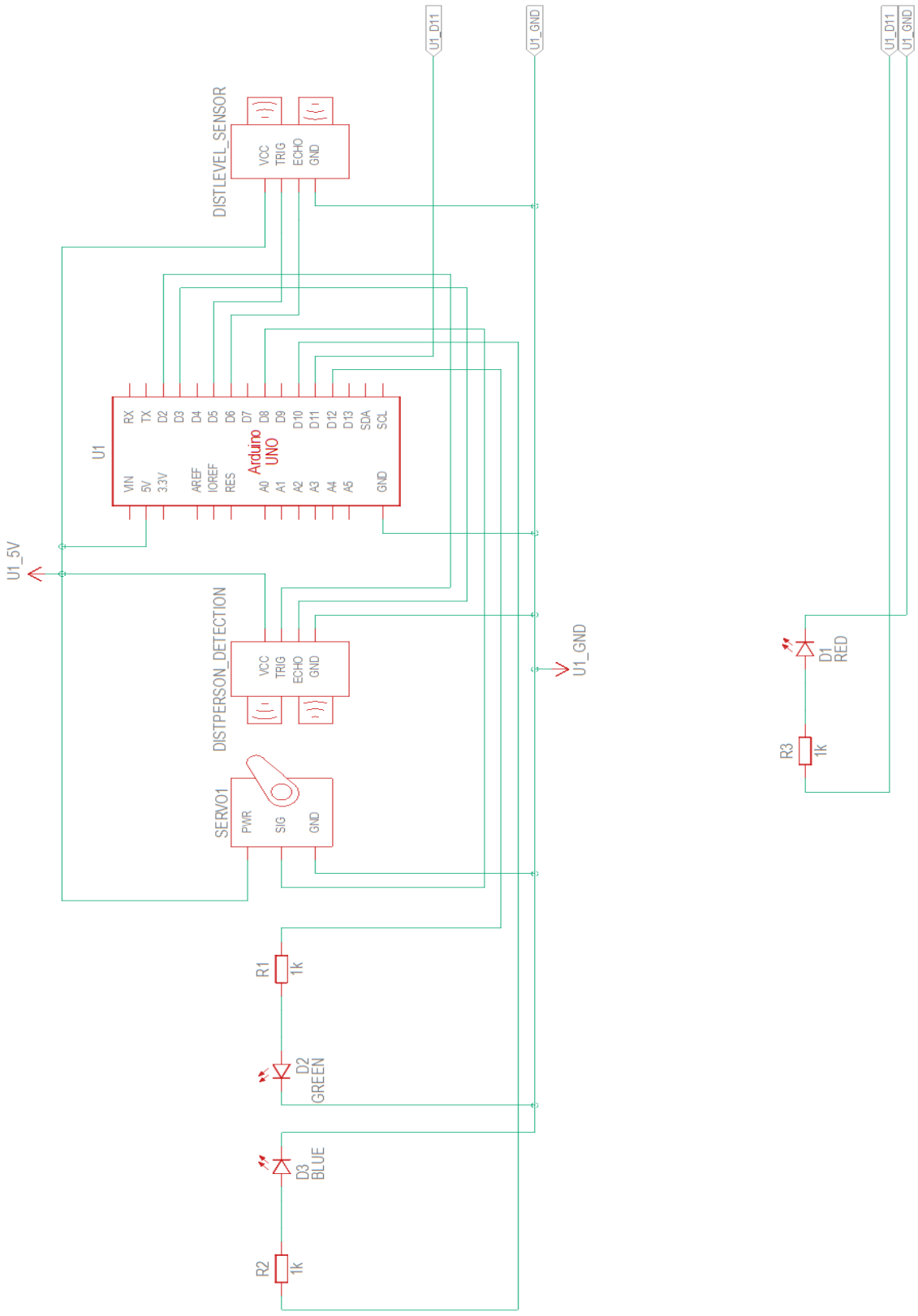
External Components:

- *Person Detection Ultrasonic Sensor* is fixed on the front face of the dustbin, outside the bin structure, to detect approaching person.
- *Red LED* indicates that the bin is full, *Green LED* indicates the bin is not full and can be used and *Blue LED* indicates that person is detected and motor will start functioning These LEDs are placed on the outer body of the bin for easy visibility.

Connections and Wiring:

- The connections for all components are routed through the bin's periphery to maintain a neat appearance.
- **Specific connections include:**
    - **Servo Motor:** Connected to the Arduino's digital pin 8.
    - **Ultrasonic Sensors:**
        - The person detection sensor is connected to pins 2 (Trig) and 3 (Echo).
        - The bin level detection sensor is connected to pins 5 (Trig) and 6 (Echo).
    - **LEDs:**
        - Red LED connected to pin 11 through a 1kΩ resistor for current limiting.
        - Green LED connected to pin 12 through 1kΩ resistors**.**
        - Blue LED connected to pin 10 through 1kΩ resistors
- **Power Supply:** The Arduino and all components are powered through the 5V pin from a stable power source.

=CIRCUIT DIAGRAM



Aurdino Code

```
#include <Servo.h>

const int trigPin1 = 2;  // Trigger pin for person detection (U1)
const int echoPin1 = 3;  // Echo pin for person detection (U1)
const int trigPin2 = 5;  // Trigger pin for bin level detection (U2)
const int echoPin2 = 6;  // Echo pin for bin level detection (U2)
const int redLED = 11;    // Red LED pin (indicating bin is full)
const int BLUELED = 10;    // Blue LED pin (indicating bin is functioning)
const int greenLED = 12;  // Green LED pin (indicating bin is not full)
const int servoPin = 8;  // Servo motor pin (controls the lid)

Servo lidServo; // Create Servo object
const int lidOpenAngle = 180;  // Lid open angle for servo motor
const int lidCloseAngle = 0;  // Lid close angle for servo motor

// Function to measure distance using Ultrasonic sensor
long measureDistance(int trigPin, int echoPin) {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  long duration = pulseIn(echoPin, HIGH);
  long distance = duration * 0.034 / 2;  // Calculate distance in cm
  return distance;
}

void setup() {
  // Pin modes
  pinMode(trigPin1, OUTPUT);
  pinMode(echoPin1, INPUT);
  pinMode(trigPin2, OUTPUT);
  pinMode(echoPin2, INPUT);
  pinMode(redLED, OUTPUT);
  pinMode(BLUELED, OUTPUT);
  pinMode(greenLED, OUTPUT);

  // Initialize Servo
  lidServo.attach(servoPin);
  lidServo.write(lidCloseAngle);  // Keep lid closed at the start

  // Start Serial communication for debugging
  Serial.begin(9600);
}
```

```
void loop() {
  long personDistance = measureDistance(trigPin1, echoPin1);  // Person
  long binLevelDistance = measureDistance(trigPin2, echoPin2);  // Bin l

  // Check if the bin is not full
  if (binLevelDistance >= 5) {
    digitalWrite(greenLED, HIGH);
    digitalWrite(redLED, LOW);
    digitalWrite(BLUELED, LOW);

    // Check if a person is detected within range
    if (personDistance >= 2 && personDistance <= 60)
    {
      Serial.println("Person detected!");
      Serial.print("Person Distance: ");
      Serial.println(personDistance);
      digitalWrite(BLUELED, HIGH);     // Blue LED on
      delay(1000); // Wait 1 seconds to allow person to reach the bin
      lidServo.write(lidOpenAngle);  // Open the lid
      Serial.println("Bin is not full. Lid opened!");
      delay(6000);  // Keep the lid open for 8 seconds
      lidServo.write(lidCloseAngle);  // Close the lid
      digitalWrite(BLUELED, LOW);     // Blue LED off
      Serial.println("Lid closed.");
    }

    else  {
      lidServo.write(lidCloseAngle);  // Ensure the lid stays closed

    }
  } else {

    digitalWrite(redLED, HIGH);
    digitalWrite(BLUELED, LOW);
    digitalWrite(greenLED, LOW);
    lidServo.write(lidCloseAngle);
  }
}
```

Working

The Smart Dustbin functions seamlessly based on sensor data and motor control. Here's how it operates:

1. ***Idle State:***
    - The lid remains closed initially, and the bin's status is indicated by the LEDs:
        - **Green LED** ON: Bin is not full.
        - **Red LED** OFF: Bin is ready for use.
        - **Blue LED** OFF: No person detected
2. ***Person Detection:***
    - The **person detection ultrasonic sensor** checks for a user approaching the bin within a specified range (e.g., 70 cm).
    - If detected, the following sequence is triggered:
        - Blue LED glows and the lid opens as the servo motor rotates the movable plate to an open position (180°).
        - The lid remains open for 6 seconds to allow waste disposal.
        - The servo motor then rotates the movable plate back to a closed position (0°).
3. ***Bin Level Monitoring:***
    - The **level detection ultrasonic sensor** measures the distance to the waste inside the bin.
    - If the bin's fill level exceeds the threshold (e.g., less than 5 cm remaining):
        - **Red LED** ON: Bin is full.
        - **Green LED** OFF: No more waste can be added.
        - **Blue LED** OFF: Person detection doesn't matter

4. ***Automated Lid Control:***
    - The servo motor ensures the lid moves only when the bin is not full and a person is detected.
    - This touch-free mechanism minimizes the spread of germs and maintains cleanliness.

Precautions

1. Ultrasonic Sensors:
- Align sensors properly to avoid detection errors or blind spots.
- Keep sensors clean and free of obstructions for accurate readings.
- Position sensors in open areas to minimize false or missed detections.
2. Arduino Power Supply:
- Use a stable 5V DC power source to avoid resets or damage.
- Connect high-power components, like LEDs and motors, via resistors (e.g., 22kΩ for LEDs) or external sources.
- Ensure all connections are secure to prevent loose wiring issues.
3. Servo Motor and Thread Mechanism:
- Attach the thread securely with enough tension for smooth lid movement without straining the motor.
- Ensure the movable plate rotates freely, avoiding obstructions that could damage the motor.
4. Wiring and Connections:
- Route wires neatly along the bin's periphery to prevent tangling or disconnections.
- Use a breadboard to organize connections between sensors, LEDs, and the Arduino, ensuring firm pin connections.
5. Blind Spot Considerations:
- If a sensor is fully covered, it will fail to detect objects or give false readings.
- Place sensors where they are unlikely to be blocked during regular use for consistent performance.

Applications & Extensions

Power Options

- The Smart Dustbin can be powered using a rechargeable battery, making it portable and suitable for outdoor environments.
- Alternatively, a plug-in power supply is ideal for indoor use, eliminating the need for frequent recharging.

Applications

1. **Hygienic Waste Disposal:**
    - Ensures touchless waste management, reducing contamination risks in homes, offices, hospitals, and restaurants.
2. **Public Spaces:**
    - Improves waste management efficiency in malls, airports, parks, and other high-traffic areas.
3. **Educational Use:**
    - Acts as a hands-on project to teach sensor integration, Arduino programming, and automation concepts to students and hobbyists.
4. **Eco-friendly Practices:**
    - Encourages responsible waste disposal and integrates automation for environmental sustainability.

Extensions

1. **IoT Integration:**
    - Add Wi-Fi or Bluetooth modules for real-time monitoring via mobile apps, sending alerts when the bin is full.
2. **Solar Panel Setup:**
    - Incorporate solar panels for sustainable and energy-efficient operation in outdoor environments.
3. **Voice Command Integration:**
    - Add voice recognition modules to allow users to control the bin with simple voice commands for greater accessibility.
4. **Multi-bin Setup for Recycling:**
    - Extend the system to include multiple compartments with material-detecting sensors for automated waste sorting, promoting recycling.
5. **Odor Control Mechanism:**
    - Equip the dustbin with an odour sensor and a deodorizer or filter to reduce unpleasant smells, making it more suitable for indoor use**.**

Conclusion

The Smart Dustbin project demonstrates the practical application of automation and sensor technology to solve everyday problems. By integrating ultrasonic sensors, a servo motor, and an Arduino microcontroller, we have created a touchless, user-friendly waste disposal system. This project not only improves hygiene but also showcases the potential of combining electronics and programming to develop innovative solutions.

Through this project, we learned about:

- The working principles of ultrasonic sensors and servo motors.
- Effective power management using rechargeable batteries or plug-in options.
- The importance of clean wiring and reliable connections in a functional system.
- The potential for extensions such as IoT, solar power, and waste sorting to enhance usability and environmental impact.

The Smart Dustbin is a scalable solution, offering a foundation for further innovation in automated waste management**.**

References

- YouTube for Aurdino basics
- HC-SR04 Ultrasonic Sensor Datasheet
- SG90 Servo Motor Datasheet
- OpenAI's ChatGPT – Guidance and assistance in documentation, coding, and project troubleshooting.