Report

IOT SMART WASTE SEGREGATION PROJECT

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Course :
Data aquasition and signal conditioning

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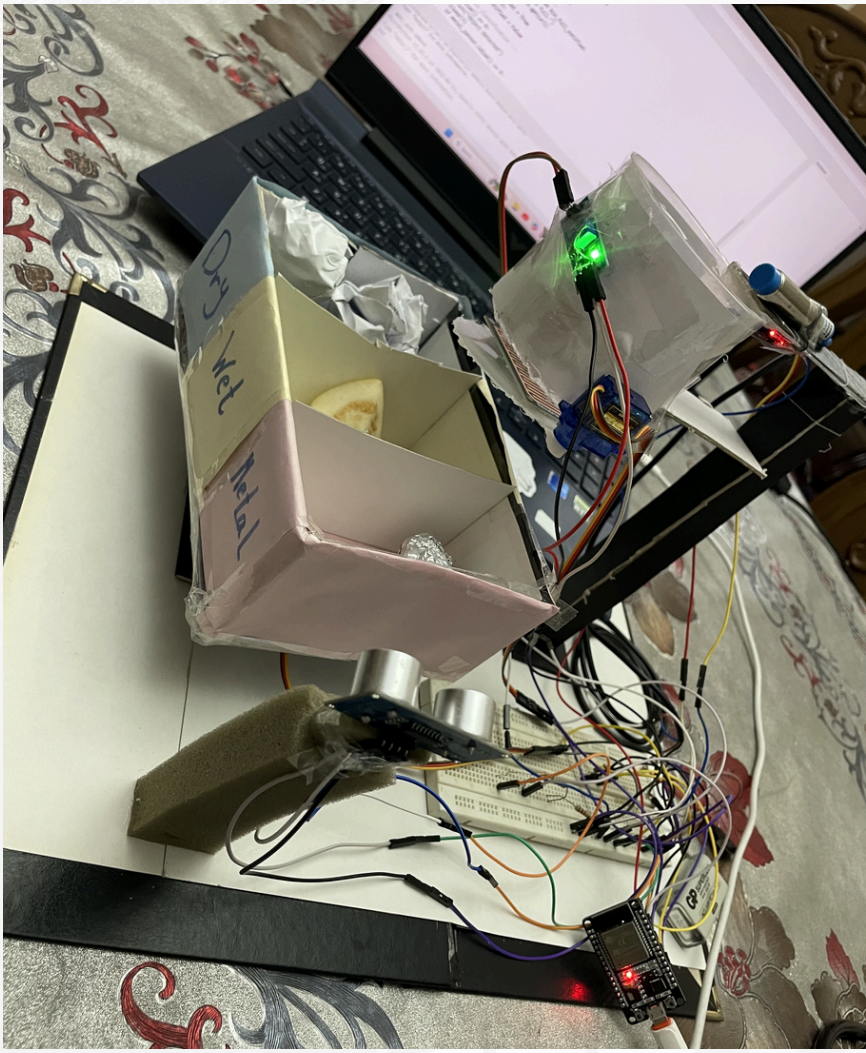
Introduction

This Project is designed to automate the process of sorting waste into wet, dry, and metallic categories using the ESP32 microcontroller. The system employs various sensors: an inductive proximity sensor to detect metallic waste, a raindrop sensor for wet waste, and an IR sensor for dry waste. An ultrasonic sensor measures the distance to detect when the waste bin is full. When the bin reaches its maximum level, the ESP32 automatically sends a notification message via Telegram to alert the user for timely disposal. This smart integration of IoT and automation reduces human effort, enhances waste management efficiency, and supports cleaner, more sustainable environmental practices.



Components

1)Esp32 Microcontroller:

The core of the system that processes all sensor signals, controls output devices, and sends Telegram notifications when the bin is full.

2)Ultrasonic Sensor – Piezoelectric Transducer:

Works on the piezoelectric principle. It converts electrical energy into ultrasonic sound waves and measures the time for the echo to return, determining distance. Used here to detect when the bin is full.

3)IR Sensor – Optoelectronic Transducer:

Uses infrared light emission and detection to identify object. It works by converting electrical energy into infrared light (via an LED) and then detecting the reflected light (via a photodiode).

4)Raindrop Sensor – Resistive Transducer:

Detects wet waste using a change in resistance when water or moisture contacts the sensor's conductive surface. The resistance variation is converted into an electrical signal.

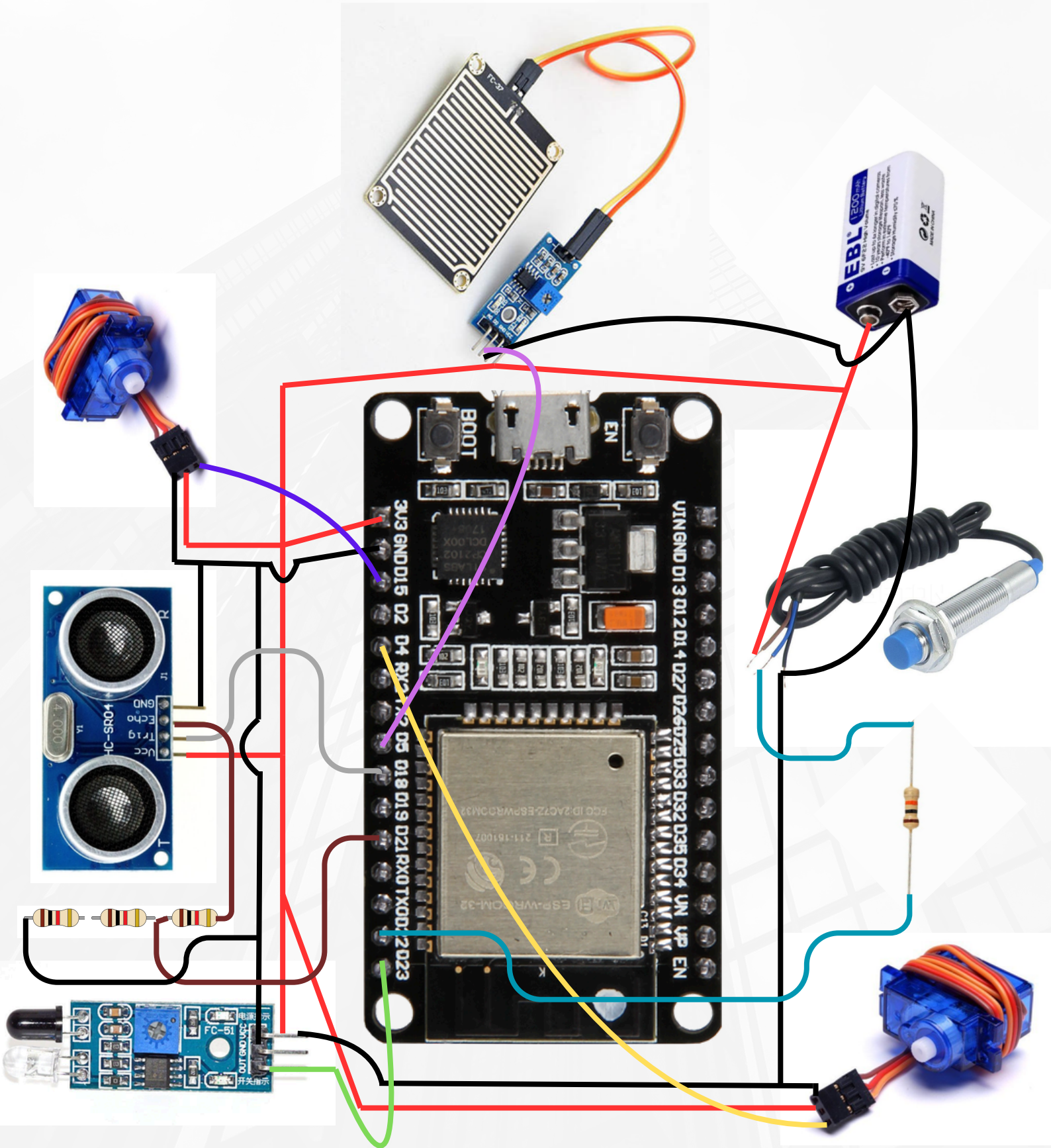
5)Inductive Proximity Sensor – Inductive Transducer

Generates an electromagnetic field and senses metallic objects when they disturb this field. It converts electromagnetic variations into an electrical output signal.

6)Servo Motor – Electromechanical Transducer

Converts electrical energy from the ESP32 into mechanical motion to control waste segregation process.

Circuit and Code



```
from machine import Pin, PWM, time_pulse_us
import time
import network
import urequests
from time import sleep

# Wi-Fi setup
ssid = "TP-Link_E954"
password = "31225076"
wlan = network.WLAN(network.STA_IF)
wlan.active(True)
wlan.connect(ssid, password)
while not wlan.isconnected():
    print("Connecting to WiFi...")
    sleep(1)
print("Connected to WiFi")

# Telegram setup
Bot_token = "8330630060:AAFJCYjep8dhb-bHn3zni20BVOmWKNjfsgc"
chat_id = "1963912850"
msg = "Trash bin is full"
url = f"https://api.telegram.org/bot{Bot_token}/sendMessage?chat_id={chat_id}&text={msg}"

# Pins
trigger = Pin(18, Pin.OUT)
echo = Pin(21, Pin.IN)
servo1 = PWM(Pin(15), freq=50)
servo2 = PWM(Pin(4), freq=50)
RainSensor = Pin(5, Pin.IN)
ir = Pin(23, Pin.IN)
```

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```
if 5 <= distance < 25 and not bin_full_notified:
    print("🟢 Trash bin is full.")
    response = urequests.get(url)
    response.close()
    bin_full_notified = True
elif distance > 25:
    bin_full_notified = False

# --- Object classification ---
if ir.value() == 0:
    print("Object detected")
    sleep(3)
    if metal_sensor.value() == 0:
        print("Metal detected")
        set_angle(servo2, 180)
        set_angle(servo1, 0)
        set_angle(servo1, 90)
        set_angle(servo2, 90)
    else:
        if RainSensor.value() == 0:
            print("Wet detected")
            set_angle(servo1, 0)
            set_angle(servo1, 90)
        else:
            print("Dry detected")
            set_angle(servo2, 0)
            set_angle(servo1, 0)
            set_angle(servo1, 90)
            set_angle(servo2, 90)
```

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```
metal_sensor = Pin(22, Pin.IN)

SOUND_SPEED = 0.0343

def set_angle(servo, angle):
    duty = int((angle / 180) * 102 + 26)
    servo.duty(duty)
    sleep(1)

# Initialize servos
et_angle(servo1, 90)
et_angle(servo2, 90)

in_full_notified = False

hile True:
    # --- Ultrasonic distance measurement ---
    trigger.value(0)
    time.sleep_us(2)
    trigger.value(1)
    time.sleep_us(10)
    trigger.value(0)

    try:
        duration = time_pulse_us(echo, 1, 30000)
        distance = (duration * SOUND_SPEED) / 2
    except OSError:
        distance = 999
```

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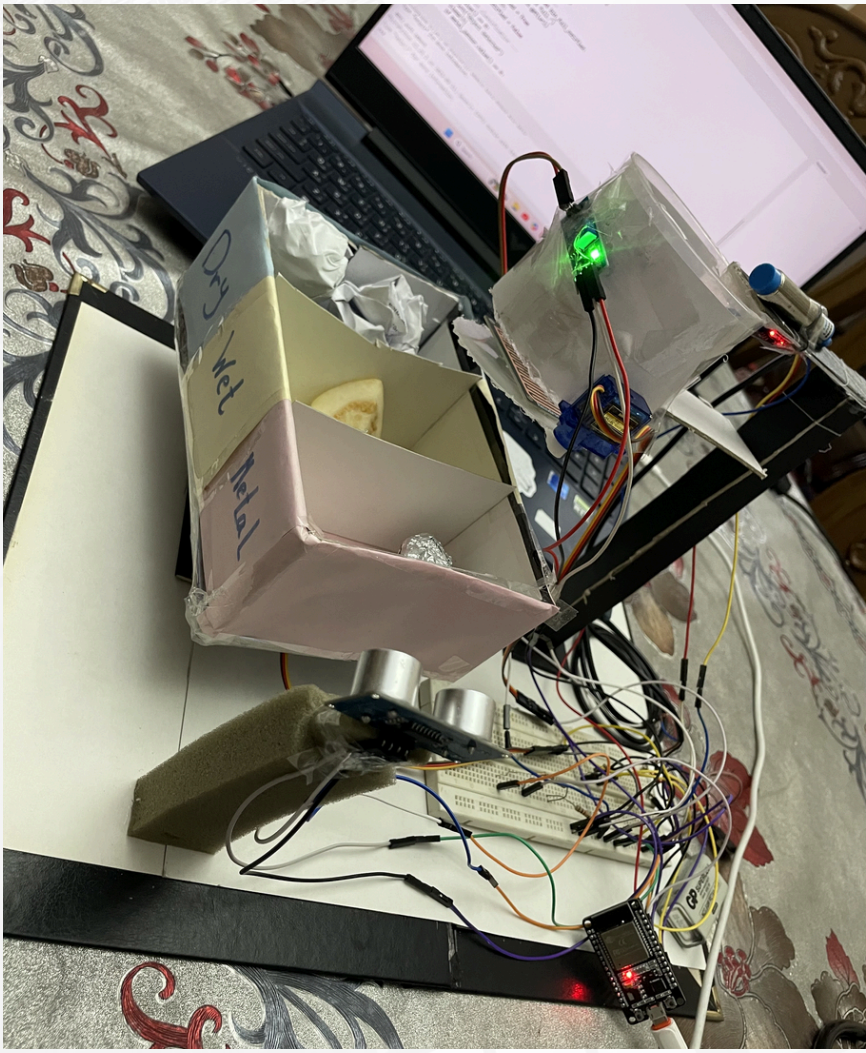
Project idea of working

When a person through waste in the bin IR sensor detects the waste object then Proximity and rain drop sensor detects if it is metal or wet object accordingly servo motor in the botom bin moves to value(0 or 90 or 180)degrees, after that servo in the upper bin opens to let object fall. ultrasonic detects bin is full or not based upon specific distance then sends a message via telegram that the bin is full.



Conclusion

The IoT Smart Waste Segregation System successfully demonstrates how automation and sensor technology can make waste management more efficient and hygienic. By using the ESP32 microcontroller along with various sensors — ultrasonic, IR, raindrop, and inductive proximity — the system accurately identifies and separates waste into wet, dry, and metallic categories. The inclusion of Telegram notifications ensures real-time monitoring when the bin becomes full, reducing manual supervision. This project highlights the potential of IoT-based solutions in promoting cleaner environments, minimizing human effort, and supporting sustainable smart city initiatives.