PROJECT THESIS

Automatic AI IOT Based Dustbin System

Automatic Waste Segregation System

HEAD OF PROJECT

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I. Introduction and Background

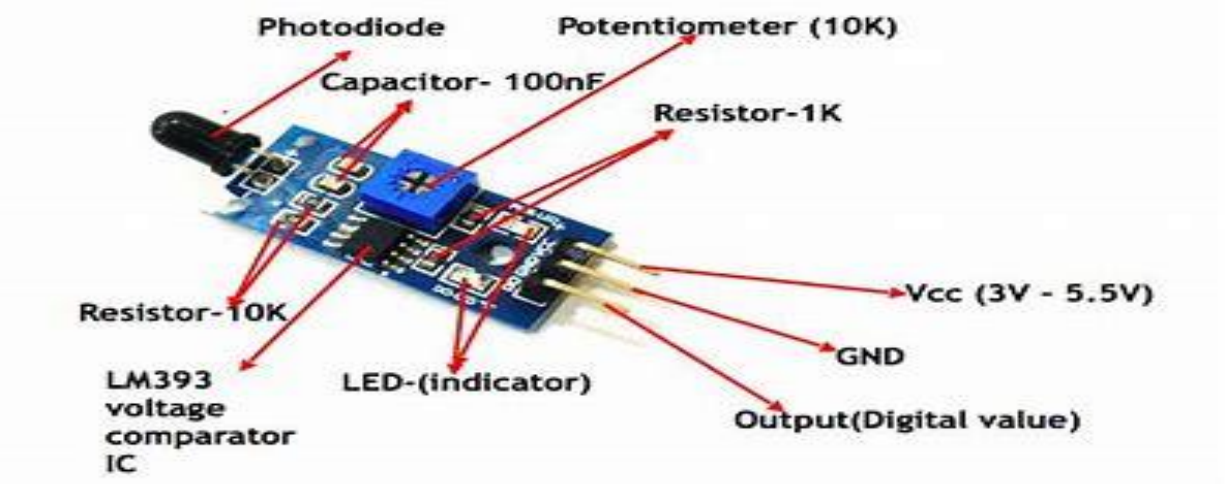
The effective segregation of waste (dry, wet, and metallic) is a crucial step in modern waste management and recycling. Manual segregation is often inefficient, unhygienic, and prone to error. This project proposes an **Automatic Waste Segregation System** using multiple sensors and electromechanical components to accurately classify and separate waste into three categories: **Metal**, **Wet**, and **Dry**. The system aims to improve recycling efficiency and promote better resource management.

II. System Components and Circuitry

The system uses an Arduino Uno microcontroller as its central processing unit to interpret sensor data and control the electromechanical components.

 IR Flame Sensor Module: This is a small electronic device that detects flames or bright light sources by sensing infrared light. It's often used in fire alarms.

- *Example*: When a candle flame is detected, the sensor sends a signal to a microcontroller to trigger an alarm.



 Active Buzzer: A buzzer that produces sound when powered with a direct current (DC) voltage. It has a built-in oscillator, so it doesn't need an external signal to make noise.

- ***Example*:** A doorbell that rings continuously when pressed.

Proximity Sensor (PNP-type): This sensor detects the presence of **metal** objects. When metal is detected, the sensor's state is **HIGH** (according to the code's logic, which reads proxiState == HIGH).

Rain Drop/Moisture Sensor: This sensor, connected to an analog pin ($A0$) [7], is used to measure the moisture content of the waste[8]. This reading is then used to differentiate between **Wet Waste** and **Dry Waste**.

2.2 Actuator Modules

The movement and alarm functions are handled by:

- **Stepper Motor (28BYJ-48):** Controlled by a Stepper Motor Driver (ULN2003)[9], it is responsible for rotating the segregation mechanism to direct the waste into the correct bin. It moves in specified degrees (e.g., 240° or 120°)[10101010101010101010].

- **Servo Motor (SG90):** This motor is used to operate a mechanism (likely a lid or gate) to allow waste entry[111111]. It moves between positions like 180° (open lid) and

Weight	9±1g	Size	22.4*12.5*22.8mm
Operating Voltage range	4.8V-6.0V	Running Degree	180±1°
Servo load speed	0.09±0.01sec/60° (4.8V) 0.08±0.01sec/60° (6V)	Stall torque	2.0±0.20kg.cm(4.8V) 2.2±0.20kg.cm(6V)
Pulse signal	PWM 50Hz/0.5-2.5ms	Operating Temperature Range	-25℃~ 70℃

2.3 Power Supply

The system is powered by two **3.7V Li-ion 18650 Batteries**[15].

BOARD TYPE

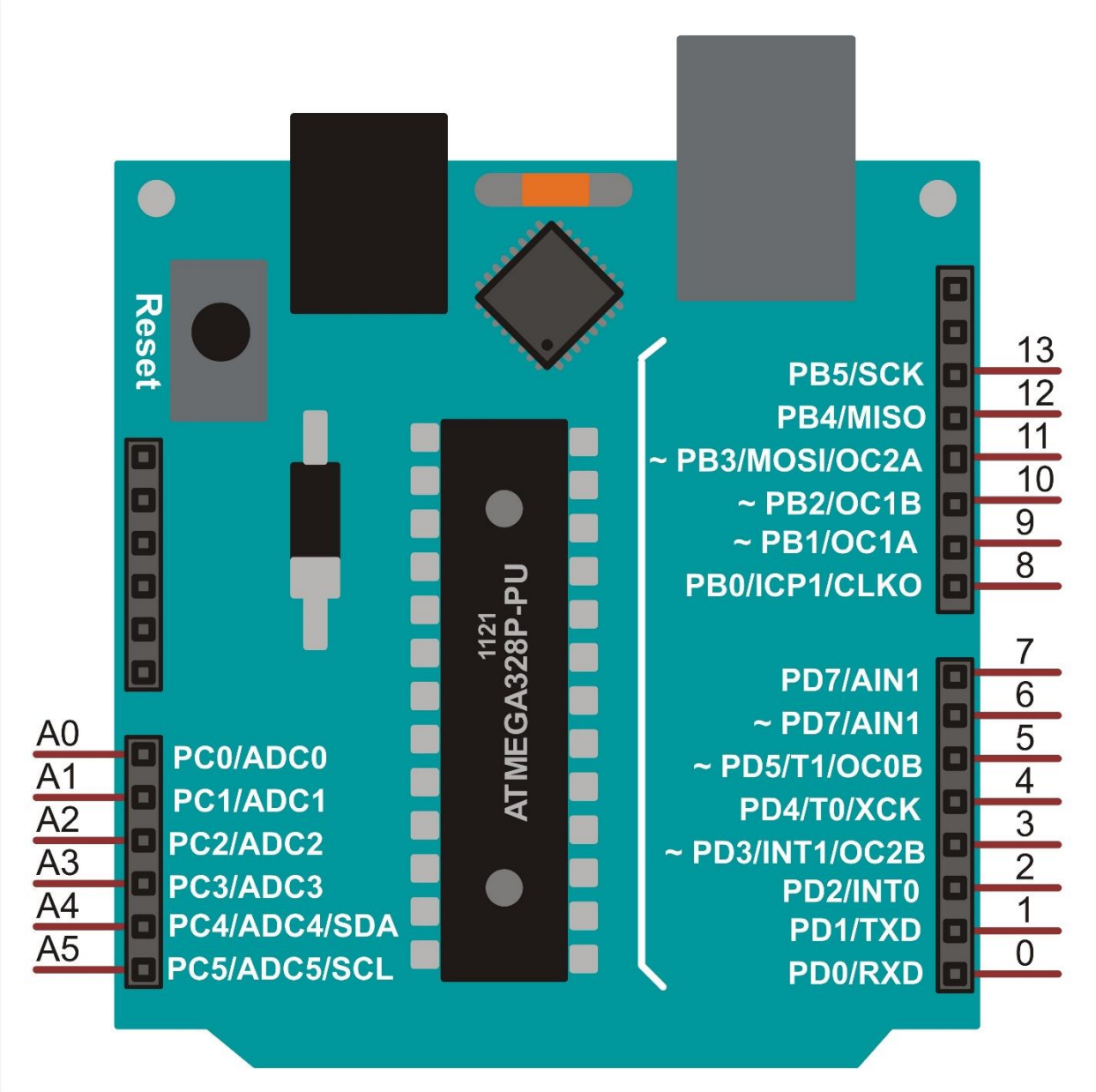
SMD

DIP

🧠 Arduino Uno: The Central Processor

The **Arduino Uno** board is the blue circuit board in the center of both circuit diagrams[2]. It is responsible for reading the input from the sensors and controlling the actuators.

- **Inputs (Sensors):**
    - **IR Sensor** is connected to Digital Pin 5 (IR_PIN)[3333].
    - **Proximity Sensor** is connected to Digital Pin 6 (PROXI_PIN)[4444].
    - **Rain Drop/Moisture Sensor** is connected to Analog Pin $A0$ (potPin)[5].
- **Outputs (Actuators):**
    - **Buzzer** is connected to Digital Pin 12 (BUZZER)[6666].
    - **Stepper Motor Driver** (ULN2003) is connected to Digital Pins 8, 9, 10, and 11, which control the Stepper Motor[7].
    - **Servo Motor** is connected to Digital Pin 7 (servo1.attach(7))[8888].



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The Arduino runs the program, reading the sensor states (e.g., if metal is detected [9]or if an object is present [10]) and then sending signals to the stepper and servo motors to segregate the waste[11111111].

III. Methodology and Working Principle

The system operates based on a hierarchical decision process implemented in the $\texttt{void loop()}$ function[16].

3.1 Setup (Initialization)

In the $\texttt{void setup()}$[17], the system initializes:

- The **Proximity (PIN 6)** and **IR Sensor (PIN 5)** as inputs[18].
- The **Buzzer (PIN 12)** as output[19].
- The **Servo Motor (PIN 7)** is attached [20], and its speed is set (e.g., 17 RPM for the Stepper)[21].
- The servo motor is initialized, moving from 180° (open) to 70° (close)[22222222].

3.2 Detection and Segregation Logic

The main segregation logic proceeds in three steps:

1. **Metal Detection:** The system first checks for the presence of **metal** using the **Proximity Sensor**[23].
    - **Condition:** If $\texttt{proxiState == HIGH}$[24].
    - **Action:** A buzzer tone is played, the Stepper Motor rotates **Clockwise** (240°) to the metal bin [25], the Servo opens and closes the lid [26262626], and the Stepper returns **Counter-Clockwise** (240°) to the home position[27].
2. **Object Detection (Non-Metal):** If no metal is detected, the system checks for any object using the **IR Sensor**[28].
    - **Condition:** If $\texttt{irState == LOW}$ (Object detected)[29].
    - **Moisture Measurement:** The system reads the moisture level from the Analog Sensor (Rain Drop/Moisture Sensor) three times for better accuracy[30303030]. The raw analog reading is constrained and mapped to a 0% to 100% moisture value[31313131].
3. **Wet/Dry Classification:** Based on the calculated moisture level ($\texttt{fsoil}$):
    - **Wet Waste:**
        - **Condition:** If $\texttt{fsoil > 20}$[32].

        - **Action:** The system announces "Wet Waste Detected" [33], plays a different buzzer tone, the Stepper Motor rotates **Clockwise** (120°) to the wet bin [34], the Servo opens/closes the lid [35353535], and the Stepper returns **Counter-Clockwise** (120°)[36].
    - **Dry Waste:**
        - **Condition:** If $\texttt{fsoil}$ is ≤ 20[37].
        - **Action:** The system announces "Dry Waste Detected" [38], plays a third buzzer tone, and the Servo opens and closes the lid for disposal into the dry bin (assuming the dry bin is the default or home position, as the Stepper does not rotate)[39393939].

IV. Conclusion

The implemented code and circuitry demonstrate a functional prototype for an automatic waste segregation system capable of identifying and separating **metal, wet, and dry waste**. By integrating a proximity sensor, an IR object sensor, and a moisture sensor, the system achieves intelligent, automated sorting[40]. This design can be scaled up for use in smart cities, offices, or residential buildings to significantly improve waste management practices.

💡 **The Proposal: Automatic AI, IoT-Based Waste Segregation System**

1. The Problem Statement

The management of trash, or **dustbin waste**, is a major problem in our society. The mixing of different waste materials leads to various environmental and health issues, such as foul odors (smelling) from food waste left in city places, which requires a better system of segregation.

2. The Innovation and Design

My innovation is the invention of an **Automatic AI and IoT-Based Dustbin System** for **Automatic Waste Segregation**.

This system will ensure that:

- **Plastic** goes into a different box (bin).
- **Silver/Metal** goes into a different box.
- **Organic/Eating** materials go into a different box.

3. Proposed Benefits and Applications

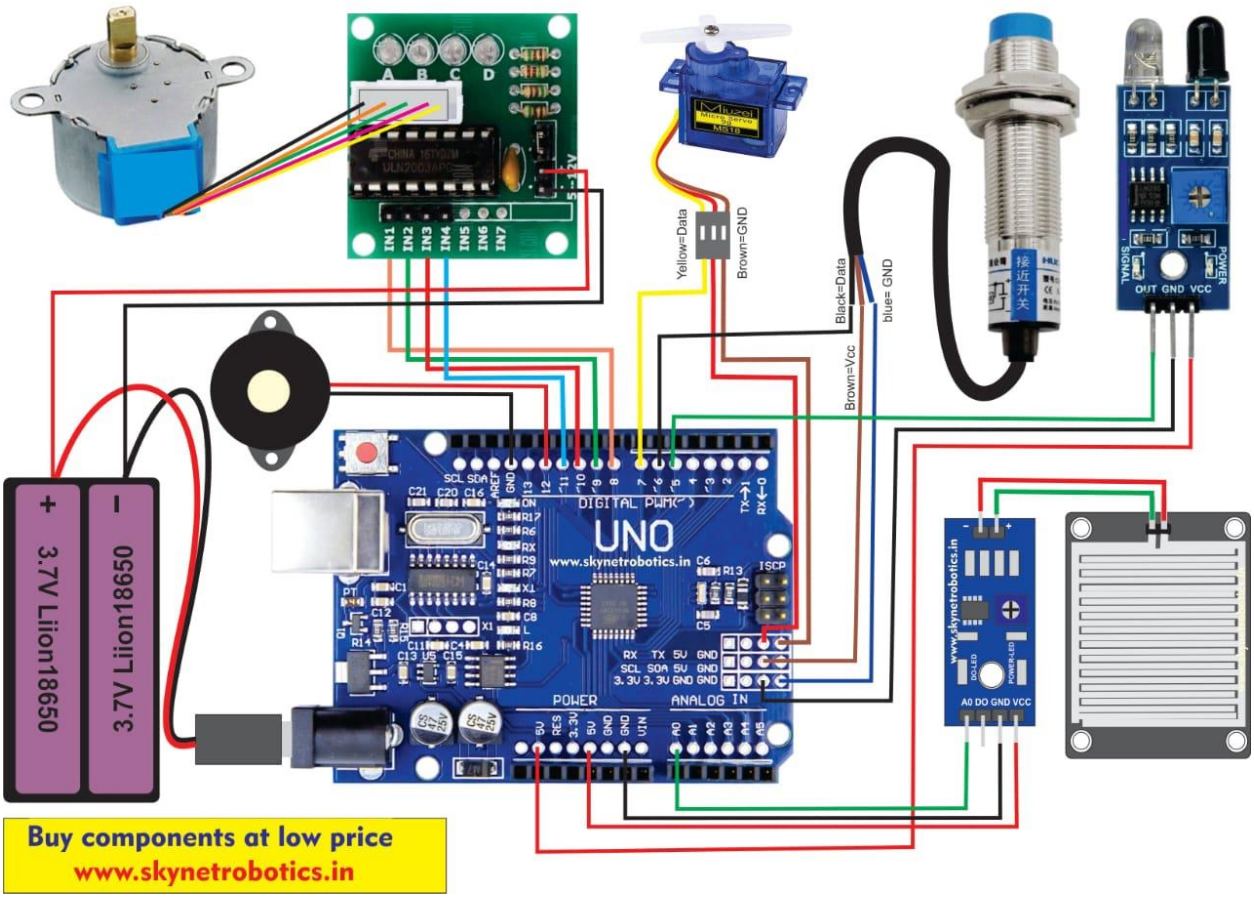
A. Economic and Environmental Benefits

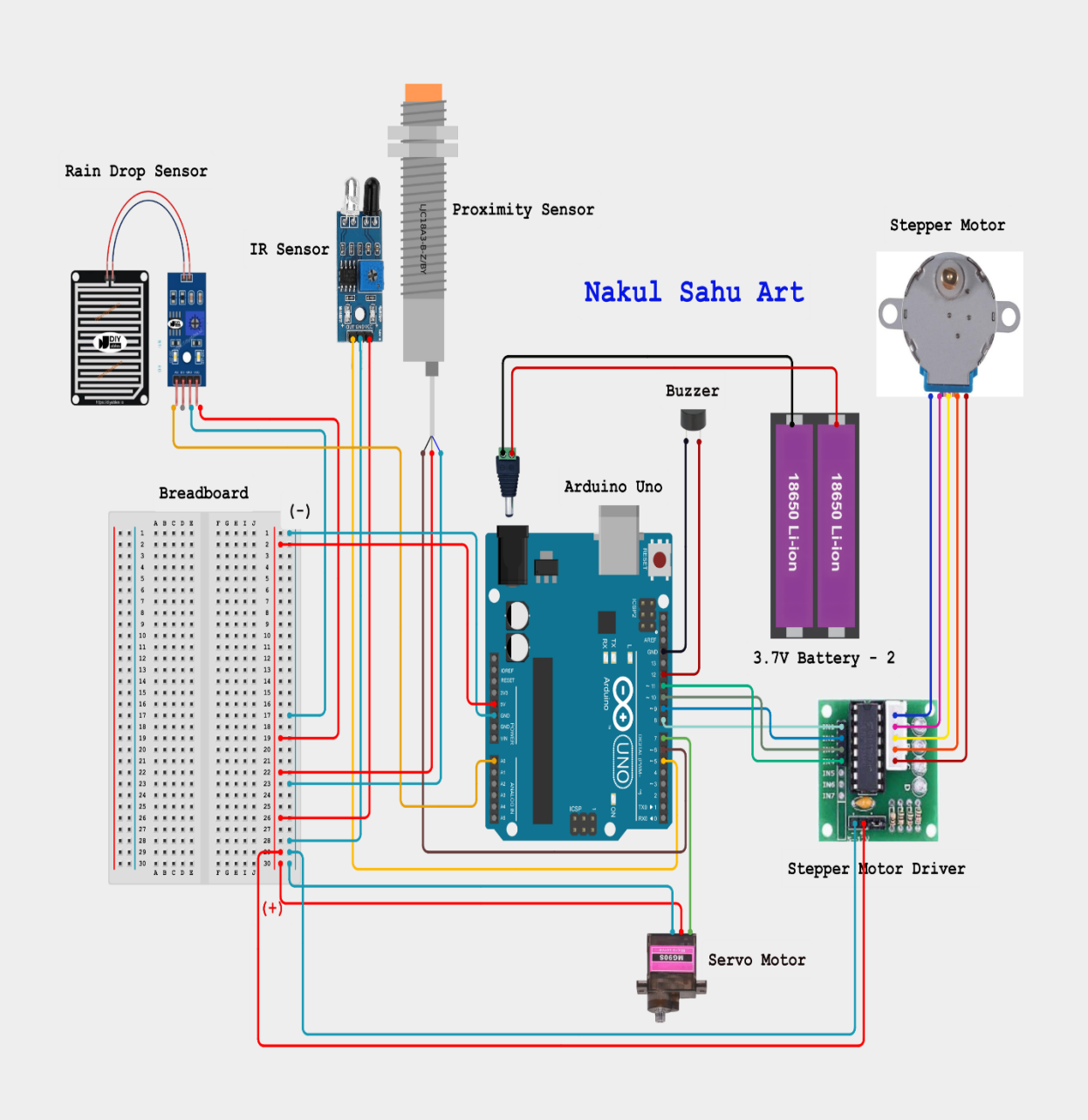
- **Organic Waste:** The organic/eating waste material will be sold to farmers by the government to be used as fertilizer.
- **Silver/Metal Waste:** The silver/metal waste can be sold by the government, which will generate additional revenue.
- **Plastic Waste for Infrastructure:** The plastic waste can be utilized for building materials, such as roads. For example, Islamabad is

making roads using plastic, and the use of plastic dustbins in rivers should be reviewed and avoided (to prevent pollution).

B. Public Health and Future Impact

- The system will help the community **avoid smoky/burning waste** practices.
- Selling sorted plastic and silver waste will allow people to buy the sorted materials, contributing to a circular economy and creating a better future for the world.




Rain Drop Sensor
IR Sensor
Proximity Sensor
Stepper Motor
Nakul Sahu Art
Buzzer
Breadboard
(-)
Arduino Uno
18650 Li-ion
18650 Li-ion
3.7V Battery - 2
(+)
Stepper Motor Driver
Servo Motor

```
#include <CheapStepper.h>
#include <Servo.h>
Servo servo1;
#define ir 5
#define proxi 6
#define buzzer 12
int potPin = A0; //input pin
int soil=0;
int fsoil;

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

void setup()
{Serial.begin(9600);
  pinMode(proxi, INPUT_PULLUP);
  pinMode(ir, INPUT);
  pinMode(buzzer, OUTPUT);
  servo1.attach(7);
  stepper.setRpm(17);
  servo1.write(180);
delay(1000);
servo1.write(70);
delay(1000);

}
```

```
void loop()
{
  fsoil=0;
  int L =digitalRead(proxi);
Serial.print(L);
if(L==0)
{
  tone(buzzer, 1000, 1000);
 stepper.moveDegreesCW (240);
delay(1000);
servo1.write(180);
delay(1000);
servo1.write(70);
delay(1000);
stepper.moveDegreesCCW (240);
delay(1000);
}

if(digitalRead(ir)==0)
{
   tone(buzzer, 1000, 500);
   delay(1000);
  int soil=0;
  for(int i=0;i<3;i++)
    {
    soil = analogRead(potPin) ;
```

```
  soil = constrain(soil, 485, 1023);
    fsoil = (map(soil, 485, 1023, 100, 0))+fsoil;
      delay(75);
  }
fsoil=fsoil/3;
Serial.print(fsoil);
Serial.print("%");Serial.print("\n");

if(fsoil>20)
      {
       stepper.moveDegreesCW (120);
       delay(1000);
         servo1.write(180);
         delay(1000);
         servo1.write(70);
           delay(1000);
         stepper.moveDegreesCCW (120);
           delay(1000);
         }

  else {
    tone(buzzer, 1000, 500);
      delay(1000);
       servo1.write(180);
         delay(1000);
         servo1.write(70);
```

```
        delay(1000);}
}

}
```