Soil Moisture-Based Irrigation System with OLED Display and Audio player

# Introduction

* **Overview of the Project:**

This project aims to create an automated irrigation system using an ESP32, a soil moisture sensor, an OLED display, and a Player Mini. The system monitors soil moisture levels and controls water pump accordingly. Additionally, it provides visual feedback on the OLED display and audio alerts using the DF Player Mini. This system is designed to help maintain optimal soil moisture levels for plants, reducing manual watering efforts and conserving water.

* **Objectives:**

By the end of the project, students will be able to,

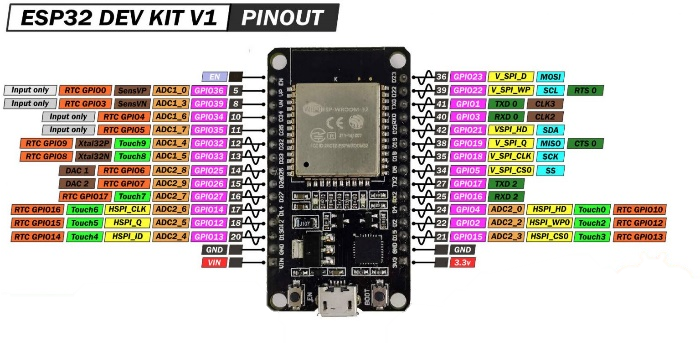
1. Automate the irrigation process based on real-time soil moisture data
2. Provide visual and audio feedback to indicate the watering status
3. Conserve water and reduce manual irrigation efforts

* **Benefits of the Project:**

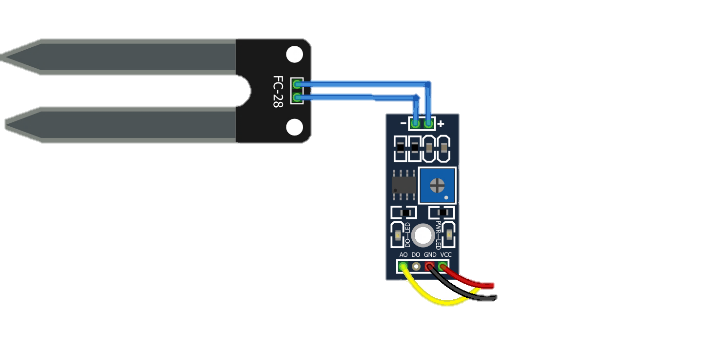
1. Reduces water wastage by watering only when necessary
2. Minimizes the need for manual intervention, making gardening/farming easier
3. Enhances plant growth by maintaining optimal soil moisture levels

# Components Used

1. **ESP32**: A powerful microcontroller with Wi-Fi and Bluetooth capabilities, used as the brain of the project.



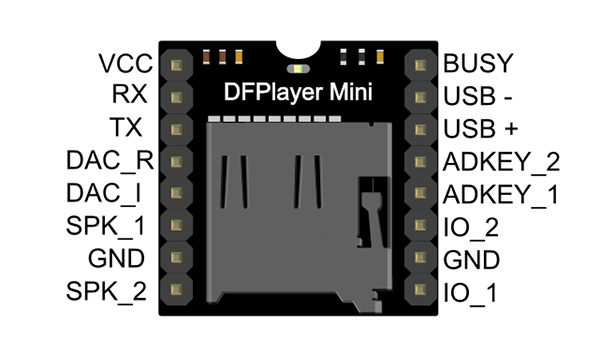
1. **Soil Moisture Sensor**: Measures the moisture level in the soil and provides analog values corresponding to the moisture content.



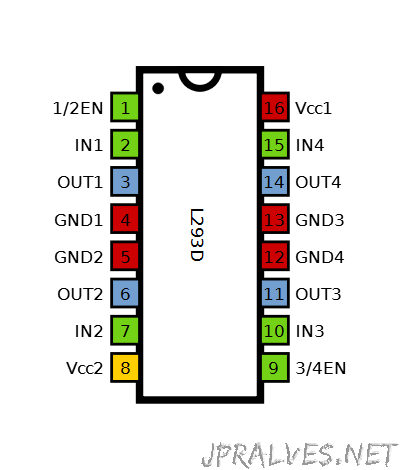
1. **Adafruit SSD1306 OLED Display** (128x64 pixels): Displays animations and text information about the soil moisture status.



1. **DF Player Mini**: A small and low-cost MP3 module with a simple serial interface, used for playing audio files.



1. **L293D Motor Driver**: Controls the water pump based on the signals from the ESP32.



1. **Water Pump**: Pump used to water the plants when the soil moisture level is low. (DC 3V – 12V Mini Submersible Water Pump)



# Hardware Connection

* **Wiring Diagram :**

(add image of wiring /connections made)

* **Pin connections for each component:**

1. **Soil Moisture Sensor:**
   * Signal(A0) pin to ESP32 pin 34
   * VCC to 3.3V
   * GND to GND
2. **OLED Display:**
   * VCC to 3.3V
   * GND to GND
   * SCL to SCL (GPIO 22)
   * SDA to SDA (GPIO 21)
3. **DFPlayer Mini:**
   * VCC to 5V
   * GND to GND
   * RX to ESP32 pin 16
   * TX to ESP32 pin 17
4. **L293D Motor Driver:**
   * EN1 to ESP32 pin 5
   * IN1 to ESP32 pin 25
   * IN2 to ESP32 pin 26
   * VCC1 to 5V
   * VCC2 to 5V
   * GND to GND
5. **Water Pump: DC (3V – 12V Micro Pump)**
   * Pump pin 1 connected to (M1)IN1
   * Pump pin 2 connected to (M1)IN2

# Software Requirements

* IDE and software setup instructions:

1. Download and install the Arduino IDE from [Arduino's website](https://downloads.arduino.cc/arduino-1.8.19-windows.exe)
2. Install the required libraries via the Library Manager in the Arduino IDE
3. Open the Library Manager: Tools > Manage Libraries...>Library Manager Window[Search for the required library name and Install]
4. Search for each of the following library and install them

* Required Libraries

1. Adafruit GFX Library by Adafruit
2. Adafruit SSD1306 by Adafruit
3. DFPlayerMini\_Fast by PowerBroker2
4. EspSoftwareSerial by Dirk Kaar, Peter Lerup Version 8.1.0

# Circuit Diagram

(wire to wire schematic diagram)

# Code

|  |
| --- |
| #include <Adafruit\_GFX.h>    // Core graphics library  #include <Adafruit\_SSD1306.h> // Hardware-specific library  #include <DFPlayerMini\_Fast.h>  #include <SoftwareSerial.h>  #define SCREEN\_WIDTH 128  #define SCREEN\_HEIGHT 64  #define OLED\_RESET    -1  #define SOIL\_MOISTURE\_PIN 34  #define CH1 5  #define PUMP\_1 25  #define PUMP\_2 26  #define DF\_PLAYER\_RX\_PIN 16           // DF-player RX pin  #define DF\_PLAYER\_TX\_PIN 17           // DF-player TX pin  #define FRAME\_DELAY (42)  #define FRAME\_WIDTH (48)  #define FRAME\_HEIGHT (48)  #define FRAME\_COUNT (sizeof(frames1) / sizeof(frames1[0]))  #define FRAME\_COUNT (sizeof(frames2) / sizeof(frames2[0]))  Adafruit\_SSD1306 display(SCREEN\_WIDTH, SCREEN\_HEIGHT, &Wire, OLED\_RESET);  SoftwareSerial DF\_Player\_Serial(DF\_PLAYER\_RX\_PIN, DF\_PLAYER\_TX\_PIN); // For MP3 audio RX, TX  DFPlayerMini\_Fast df\_player; //INITIALIZE  // Bitmap data (replace with actual data)  //Cry animation  const byte PROGMEM frames1[][288] = {    {0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,0,0,0,0,96,12,15,224,7,240,48,12,60,248,31,60,48,24,48,24,24,12,24,24,0,0,0,0,24,24,0,0,0,0,24,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,15,240,0,12,48,0,63,252,0,12,48,0,120,30,0,12,48,0,224,7,0,12,48,1,192,3,128,12,48,3,128,1,192,12,48,3,0,0,192,12,24,3,0,0,192,24,24,6,0,0,96,24,24,6,0,0,96,24,12,7,255,255,224,48,12,7,255,255,224,48,6,0,0,0,0,96,6,0,0,0,0,224,3,0,0,0,0,192,1,128,0,0,1,128,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0},    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{0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,7,192,3,224,96,12,31,240,15,248,48,12,56,56,28,28,48,24,32,24,24,4,24,24,0,0,0,0,24,24,0,0,0,0,24,48,0,0,0,0,12,48,0,0,0,0,12,48,112,0,0,0,12,49,240,0,0,0,12,51,240,31,248,0,12,55,240,60,60,0,12,55,96,224,7,3,140,62,96,192,3,3,236,62,97,128,1,129,252,60,99,0,0,193,188,28,99,0,0,193,156,31,230,0,0,97,140,31,198,0,0,97,140,15,134,31,248,97,134,12,7,255,255,225,134,6,7,224,7,225,134,6,0,0,0,1,198,3,0,0,0,0,252,1,128,0,0,1,248,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0},    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{0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,0,0,0,0,96,12,0,0,0,0,48,12,0,0,0,0,48,24,0,0,0,0,24,24,3,128,1,192,24,24,31,224,7,248,24,48,60,248,31,60,12,48,48,24,24,12,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,24,6,0,0,96,24,24,7,0,0,224,24,24,3,128,1,192,24,12,1,224,7,128,48,12,0,127,254,0,48,6,0,31,248,0,96,6,0,0,0,0,224,3,0,0,0,0,192,1,128,0,0,1,128,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0},    {0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,0,0,0,0,96,12,0,0,0,0,48,12,0,0,0,0,48,24,0,0,0,0,24,24,3,128,1,192,24,24,31,224,7,248,24,48,60,248,31,60,12,48,48,24,24,12,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,24,6,0,0,96,24,24,7,0,0,224,24,24,3,128,1,192,24,12,1,224,7,128,48,12,0,127,254,0,48,6,0,31,248,0,96,6,0,0,0,0,224,3,0,0,0,0,192,1,128,0,0,1,128,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0},    {0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,0,0,0,0,96,12,0,0,0,0,48,12,0,0,0,0,48,24,0,0,0,0,24,24,3,128,1,192,24,24,31,224,7,248,24,48,60,248,31,60,12,48,48,24,24,12,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,24,6,0,0,96,24,24,7,0,0,224,24,24,3,128,1,192,24,12,1,224,7,128,48,12,0,127,254,0,48,6,0,31,248,0,96,6,0,0,0,0,224,3,0,0,0,0,192,1,128,0,0,1,128,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0},    {0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,0,0,0,0,96,12,0,0,0,0,48,12,0,0,0,0,48,24,0,0,0,0,24,24,3,128,1,192,24,24,31,224,7,248,24,48,60,248,31,60,12,48,48,24,24,12,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,24,6,0,0,96,24,24,7,0,0,224,24,24,3,128,1,192,24,12,1,224,7,128,48,12,0,127,254,0,48,6,0,31,248,0,96,6,0,0,0,0,224,3,0,0,0,0,192,1,128,0,0,1,128,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0},    {0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,0,0,0,0,96,12,0,0,0,0,48,12,0,0,0,0,48,24,0,0,0,0,24,24,3,128,1,192,24,24,31,224,7,248,24,48,60,248,31,60,12,48,48,24,24,12,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,24,6,0,0,96,24,24,7,0,0,224,24,24,3,128,1,192,24,12,1,224,7,128,48,12,0,127,254,0,48,6,0,31,248,0,96,6,0,0,0,0,224,3,0,0,0,0,192,1,128,0,0,1,128,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0},    {0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,0,0,0,0,96,12,0,0,0,0,48,12,0,0,0,0,48,24,0,0,0,0,24,24,3,128,1,192,24,24,31,224,7,248,24,48,60,248,31,60,12,48,48,24,24,12,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,24,6,0,0,96,24,24,7,0,0,224,24,24,3,128,1,192,24,12,1,224,7,128,48,12,0,127,254,0,48,6,0,31,248,0,96,6,0,0,0,0,224,3,0,0,0,0,192,1,128,0,0,1,128,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0},    {0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,0,0,0,0,96,12,0,0,0,0,48,12,0,0,0,0,48,24,0,0,0,0,24,24,3,128,1,192,24,24,31,224,7,248,24,48,60,248,31,60,12,48,48,24,24,12,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,24,6,0,0,96,24,24,7,0,0,224,24,24,3,128,1,192,24,12,1,224,7,128,48,12,0,127,254,0,48,6,0,31,248,0,96,6,0,0,0,0,224,3,0,0,0,0,192,1,128,0,0,1,128,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0},    {0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,0,0,0,0,96,12,0,0,0,0,48,12,0,0,0,0,48,24,0,0,0,0,24,24,3,128,1,192,24,24,31,224,7,248,24,48,60,248,31,60,12,48,48,24,24,12,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,24,6,0,0,96,24,24,7,0,0,224,24,24,3,128,1,192,24,12,1,224,7,128,48,12,0,127,254,0,48,6,0,31,248,0,96,6,0,0,0,0,224,3,0,0,0,0,192,1,128,0,0,1,128,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0},    {0,0,0,0,0,0,0,0,0,0,0,0,0,0,15,240,0,0,0,0,255,255,0,0,0,3,192,3,192,0,0,15,0,0,240,0,0,28,0,0,56,0,0,112,0,0,12,0,0,224,0,0,7,0,0,192,0,0,3,0,1,128,0,0,1,128,3,0,0,0,0,192,6,0,0,0,0,96,6,0,0,0,0,96,12,0,0,0,0,48,12,0,0,0,0,48,24,0,0,0,0,24,24,3,128,1,192,24,24,31,224,7,248,24,48,60,248,31,60,12,48,48,24,24,12,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,48,0,0,0,0,12,24,6,0,0,96,24,24,7,0,0,224,24,24,3,128,1,192,24,12,1,224,7,128,48,12,0,127,254,0,48,6,0,31,248,0,96,6,0,0,0,0,224,3,0,0,0,0,192,1,128,0,0,1,128,0,192,0,0,3,0,0,224,0,0,7,0,0,48,0,0,12,0,0,28,0,0,56,0,0,15,0,0,240,0,0,3,224,7,192,0,0,0,255,255,0,0,0,0,15,240,0,0,0,0,0,0,0,0,0,0,0,0,0,0}  };  bool audioPlayed = false; // Flag to track if audio has been played  void setup() {      // Initialize the serial communication      Serial.begin(115200);      // Initialize the OLED display      if (!display.begin(SSD1306\_SWITCHCAPVCC, 0x3C)) {          Serial.println(F("SSD1306 allocation failed"));          for(;;); // Don't proceed, loop forever      }      display.display();  // Show initial display contents      delay(2000);        // Pause for 2 seconds      display.clearDisplay(); // Clear the buffer      // Initialize the soil moisture sensor and pump pins      pinMode(SOIL\_MOISTURE\_PIN, INPUT);      pinMode(CH1, OUTPUT);      pinMode(PUMP\_1, OUTPUT);      pinMode(PUMP\_2, OUTPUT);      digitalWrite(CH1, LOW);      digitalWrite(PUMP\_1, LOW);      digitalWrite(PUMP\_2, LOW);      // Initialize the DFPlayer Mini      DF\_Player\_Serial.begin(9600); // for the DF player      df\_player.begin(DF\_Player\_Serial, true);  }  int frame = 0;  void loop() {      // Read the soil moisture value      int soilMoistureValue = analogRead(SOIL\_MOISTURE\_PIN);      // Print the soil moisture value      Serial.print("Soil Moisture Value: ");      Serial.println(soilMoistureValue);      // Check the soil moisture value and control the pump      if (soilMoistureValue > 2000) {          digitalWrite(CH1, HIGH);          digitalWrite(PUMP\_1, HIGH);          digitalWrite(PUMP\_2, LOW);          Serial.println("Pump State: ON");              // Play audio if not already played          if (!audioPlayed) {              Serial.println("Play pour water .....");              df\_player.playFolder(1, 001); // Play track 49 in folder 1              audioPlayed = true; // Set flag to true          }          // Display the Sad bitmap for low moisture          display.clearDisplay();          display.drawBitmap(40, 8, frames1[frame], FRAME\_WIDTH, FRAME\_HEIGHT, 1);      } else {          digitalWrite(CH1, LOW);          digitalWrite(PUMP\_1, LOW);          digitalWrite(PUMP\_2, LOW);          Serial.println("Pump State: OFF");          // Reset audio played flag when moisture level is sufficient          audioPlayed = false;            // Display the Smile bitmap for sufficient moisture          display.clearDisplay();          display.drawBitmap(40, 8, frames2[frame], FRAME\_WIDTH, FRAME\_HEIGHT, 1);      }      display.display();  // Display the bitmap      frame = (frame + 1) % FRAME\_COUNT; // Update frame for animation      delay(FRAME\_DELAY); // Delay for animation  } |

# How the Project Works

This project is an automated irrigation system designed to monitor soil moisture levels and control water pump based on real-time data. The system uses an ESP32 microcontroller, a soil moisture sensor, an OLED display, and a DF Player Mini MP3 player. Here's a detailed breakdown of how each component interacts and functions within the system:

## 1. System Initialization

When the system is powered on, the following initialization steps occur:

* **Serial Communication:** The ESP32 starts by initializing serial communication at a baud rate of 115200 for debugging purposes. This allows the microcontroller to send and receive data via the USB connection to a computer, which is useful for monitoring sensor readings and system status during development.
* **OLED Display Initialization:** The OLED display is initialized with a specific I2C address (0x3C) and configured for a 128x64 pixel resolution. If the display initialization fails (e.g., due to wiring issues), the system enters an infinite loop, halting further execution to prevent undefined behaviour.
* **Soil Moisture Sensor and Motor Driver Configuration:** The soil moisture sensor pin (GPIO 34) is set as an input to read analog values representing soil moisture levels. The motor driver pins (CH1, PUMP\_1, PUMP\_2) are configured as outputs to control the water pump. Initially, all outputs are set to LOW, ensuring that the pump are turned off until the system detects a need for watering.
* **DF Player Mini Initialization:** The DF Player Mini is initialized using software serial communication on GPIO 16 (RX) and GPIO 17 (TX). This module is responsible for playing audio files stored on an SD card when specific conditions are met.

## 2. Continuous Soil Moisture Monitoring

Once the system is initialized, it enters the main loop where it continuously monitors the soil moisture level:

* **Analog Read:** The ESP32 reads the analog value from the soil moisture sensor connected to GPIO 34. The sensor outputs a value that varies with the moisture content in the soil; higher values typically indicate drier soil, while lower values indicate more moisture.
* **Serial Output:** The soil moisture value is printed to the serial monitor for debugging and monitoring purposes. This helps in understanding the current state of the soil and ensures that the sensor is functioning correctly.

## 3. Decision-Making Based on Moisture Levels

The system makes decisions based on the moisture level detected:

* **Low Moisture Condition:**
  + If the soil moisture value exceeds a predefined threshold (2000 in this case), the system determines that the soil is too dry and needs watering.
  + The motor driver is activated, turning on the water pump (PUMP\_1) while keeping the other pump (PUMP\_2) off.
  + An audio file stored on the DF Player Mini is played to indicate that watering is in progress. The system ensures that the audio is played only once during each watering cycle by using a flag (audio Played) to track whether the audio has already been played.
* **Sufficient Moisture Condition:**
  + If the soil moisture value is below the threshold, the system determines that the soil has sufficient moisture.
  + The motor driver is deactivated, turning off the water pump.
  + The audio played flag is reset, allowing the audio to play again during the next watering cycle if the soil becomes dry.

## 4. Visual Feedback via OLED Display

Throughout the operation, the OLED display provides visual feedback to the user:

* **Cry Animation for Low Moisture:**
  + When the soil is too dry and the pump is activated, a "crying" animation is displayed on the OLED screen. This visual cue indicates that the soil moisture level is low, and that watering is in progress.
  + The animation consists of multiple frames that are displayed in sequence to create the illusion of motion.
* **Smile Animation for Sufficient Moisture:**
  + When the soil moisture level is sufficient, the OLED displays a "smiling" animation, indicating that the soil is in good condition and the pump is off.

The animation is updated in each loop cycle, with a slight delay (FRAME\_DELAY) to control the speed of the animation.

## 5. Continuous Operation and System Reset

* The loop function continuously executes, allowing the system to monitor the soil moisture level and control the pump in real-time.
* The frame variable is incremented in each cycle to animate the display, ensuring smooth transitions between frames.

## 6. System Behaviour in Different Scenarios

* **Dry Soil:** The system turns on the pump, plays audio, and shows the crying animation.
* **Moist Soil:** The system turns off the pump, resets the audio flag, and shows the smiling animation.
* **Debugging and Monitoring:** The serial output allows continuous monitoring of soil moisture levels and system status.

# Troubleshooting Tips

## Pump Configuration:

* + The project uses a single pump controlled by the L293D motor driver. The two pins, **PUMP\_1** and **PUMP\_2**, are connected from ESP32 to driver terminals, allowing the ESP32 to control the operation of the pump. In this setup, the motor is driven in one direction for pumping water when the soil moisture is low.
  + **Pump Not Turning On:** Verify the connections to the L293D motor driver and ensure that the CH1 pin is being set high when the soil moisture level is low. Double-check the power supply to the motor.
  + **Pump Always On:** Check the code logic to ensure the pump is turned off when soil moisture levels are adequate, and confirm that the L293D is functioning correctly.

## Change the Moisture Threshold:

* + Adjust the moisture level at which the pump will turn on.

**Code Change:**

|  |
| --- |
| if (soilMoistureValue > 2000) // Change 2000 to your desired threshold |

## Change the Audio File:

* + Replace the audio files on the SD card in the DFPlayer Mini according to your preference. Ensure they are in the correct format and folder structure.

**Code Change:**

|  |
| --- |
| df\_player.playFolder(1, 001); // Change 001 to the desired track number |

## Customize the Display Animation:

* + Update the display animations for dry and wet soil. Replace the bitmap data in the frames1 and frames2 arrays with your new bitmap data. Ensure the new data fits the required format.

## Change the Pump Control Logic:

* + Modify the pump control for different actions, such as running for a specific time.

**Code Change:**

|  |
| --- |
| digitalWrite(PUMP\_1, HIGH); // Adjust the logic here to control pump timing delay(5000); // Change this value to run the pump longer or shorter digitalWrite(PUMP\_2, LOW); |

## Add More Sensors or Pumps:

* + Integrate additional soil moisture sensors or pumps for more extensive coverage. Add new sensor variables and modify the control logic in the loop accordingly.

## OLED Display Issues:

* + **Blank Screen:** Check the connections, ensure that the correct I2C address (0x3C) is being used in the code, and verify that the display is powered correctly.
  + **Flickering or Distorted Display:** Ensure a stable power supply and check the wiring for loose connections.

## DFPlayer Mini Problems:

* + **No Sound:** Ensure the DFPlayer Mini is powered with 5V and that the RX/TX connections are correct. Confirm that the microSD card is formatted correctly and the audio files are in the correct folder.
  + **Distorted Sound:** Ensure the speaker connections are secure and the volume settings in the code are appropriate.

## Soil Moisture Sensor Inaccuracies:

* + **Incorrect Readings:** Check the sensor's placement in the soil, making sure it's not too deep or too shallow. Clean the sensor probes if they are dirty or corroded.
  + **Constant High/Low Values:** Verify that the sensor is connected correctly, and if necessary, replace the sensor if it appears damaged.

## General ESP32 Issues:

* + **No Serial Output:** Check the connection of the ESP32 to your computer and ensure that the correct COM port is selected in the Arduino IDE.
  + **Random Resets or Freezing:** This may indicate power supply issues. Ensure the ESP32 has a stable 3.3V supply and that the system is not drawing too much current.

# Conclusion

The Soil Moisture-Based Irrigation System is an innovative and efficient solution for maintaining healthy plants. By utilizing a soil moisture sensor, the system automatically monitors the moisture levels in the soil and controls a water pump to ensure plants receive water only when needed. When the soil is too dry, the pump activates, and an audio alert from the DF Player Mini plays a customizable sound, such as "water time," providing auditory feedback. Simultaneously, the OLED display shows visual feedback with a sad face to indicate low moisture, while a happy face appears when the soil is adequately moist, enhancing user interaction.

This project not only saves water and reduces manual labour but also offers options for customization, allowing users to change audio files and adjust moisture thresholds to fit their gardening needs. Overall, this automated irrigation system combines technology and simplicity, making it an enjoyable and practical tool for gardeners as well as farmers.