Smart Irrigation System Using Soil Moisture Sensor

To Optimize Water Usage in Agricultural Fields

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1. Aim of the Project

Design a smart irrigation system to optimize water usage in agricultural fields. The system should be capable of monitoring soil moisture levels and triggering irrigation when necessary, using TinkerCAD.

2. Abstract

Efficient water management is a major challenge in modern agriculture. Traditional irrigation methods often result in overwatering or underwatering, leading to water wastage, reduced crop yield, and increased operational costs. This project presents a Smart Irrigation System that automatically monitors soil moisture levels and controls irrigation accordingly. The system uses a soil moisture sensor connected to an Arduino Uno. Based on a predefined threshold value, the system activates or deactivates a water pump using an L293D motor driver. The real-time soil moisture percentage and pump status are displayed on a 16×2 LCD. LEDs and a buzzer provide additional alerts. The system was simulated using TinkerCAD and demonstrates how automation can significantly optimize water usage in agricultural applications.

3. Introduction

Agriculture is one of the largest consumers of freshwater resources. Efficient irrigation management plays a crucial role in ensuring sustainable farming practices. In many small and medium-scale farms, irrigation is manually controlled without monitoring actual soil moisture levels.

This manual approach results in:

- Excessive water usage
- Soil nutrient loss
- Increased electricity consumption
- Reduced crop productivity

Automation using embedded systems and sensors provides a practical solution. The Smart Irrigation System designed in this project ensures irrigation occurs only when necessary, conserving water and improving efficiency.

4. Problem Statement

Traditional irrigation systems rely heavily on manual observation and control. Farmers often irrigate fields based on assumptions rather than actual soil moisture levels.

This leads to:

- Over-irrigation → Water wastage and soil damage
- Under irrigation → Poor crop growth
- Increased labor dependency
- Inefficient resource utilization
- Therefore, there is a need for an automated irrigation system that monitors soil moisture and supplies water only when required.

5. Objectives

- To measure soil moisture using a moisture sensor
- To process sensor data using Arduino Uno
- To control a water pump automatically
- To display real-time moisture percentage
- To provide visual and sound alerts
- To reduce water wastage

6. Proposed Solution

The proposed system continuously reads soil moisture data from the sensor. The Arduino compares the sensor value with a predefined threshold (600 in this design).

Working Logic:

- If moisture value > threshold → Soil is dry → Pump ON
- If moisture value ≤ threshold → Soil is wet → Pump OFF

Additional features:

- Red LED indicates dry soil
- Green LED indicates sufficient moisture
- Buzzer alerts when soil is too dry
- LCD's moisture percentage and pump status

This ensures water is supplied only when necessary.

7. Components Required

Hardware (Simulated in TinkerCAD)

- Arduino UNO
- Soil Moisture Sensor
- L293D Motor Driver IC
- Water Pump / DC Motor
- 16×2 LCD Display
- Red LED
- Green LED
- Buzzer
- 220Ω Resistors
- 10kΩ Potentiometer
- Breadboard
- Jumper Wires

- Power Supply

Software

- TinkerCAD (Simulation)
- Arduino IDE
- Embedded C/C++

8. Circuit Diagram

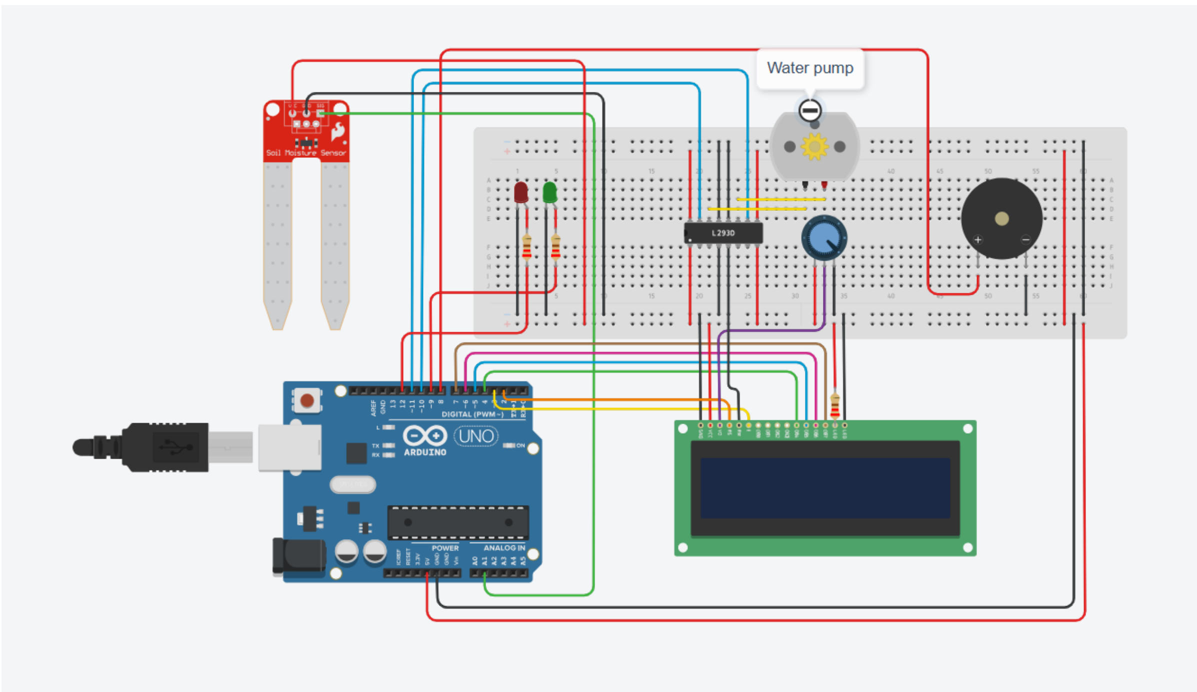


Figure 1: Smart Irrigation System Circuit Simulation in TinkerCAD

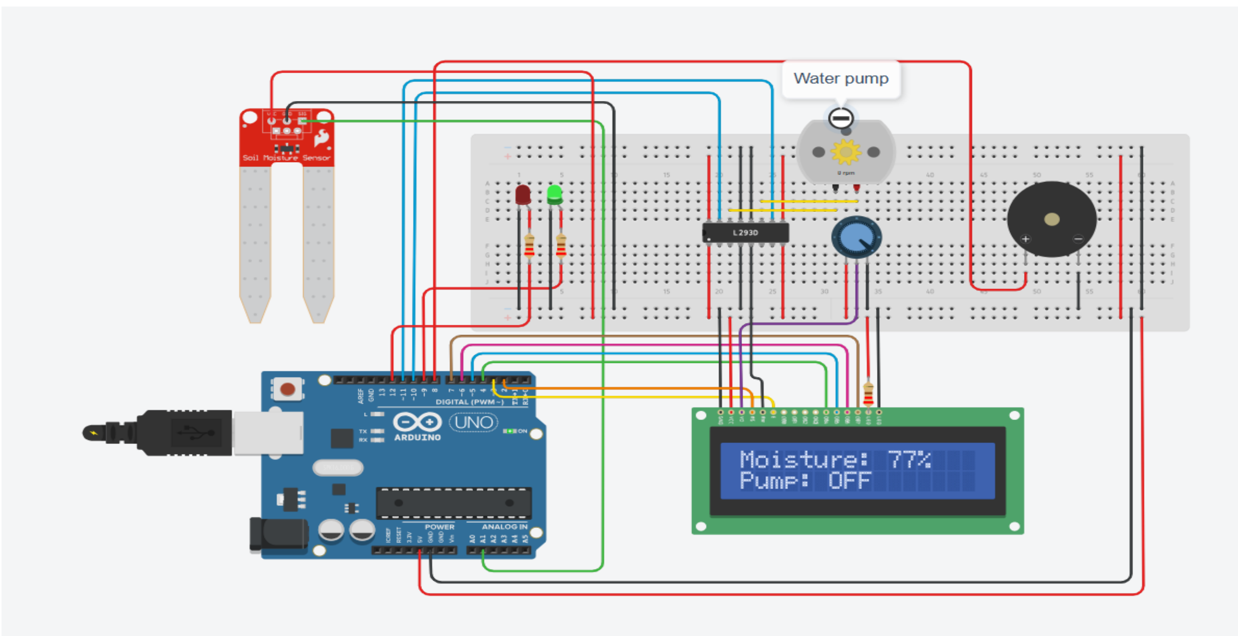
The circuit integrates the soil moisture sensor with Arduino's analog input. The L293D motor driver controls the water pump. LEDs and a buzzer are connected to digital output pins for indication. The LCD is interfaced in 4-bit mode for real-time display.

9. Working Principle

1. The soil moisture sensor detects water content in the soil.
2. The sensor outputs an analog voltage proportional to moisture.
3. Arduino reads this value using analogRead().
4. The value is converted into a percentage using the map() function.

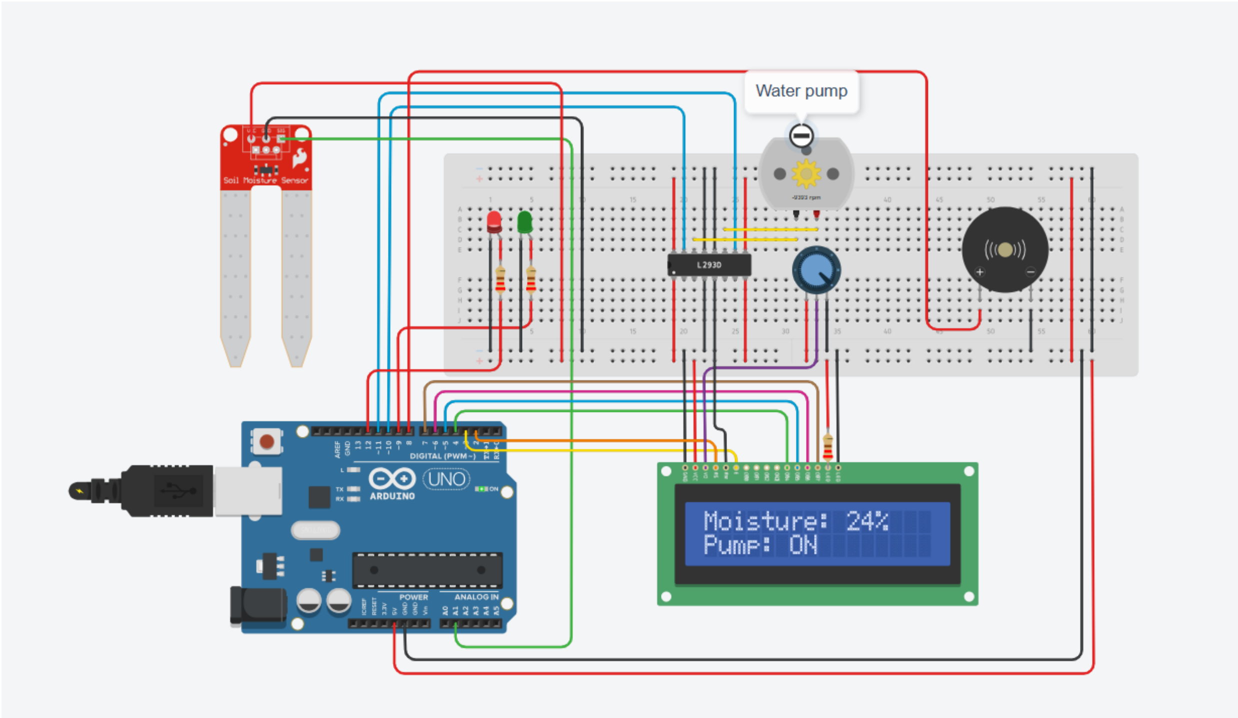
5. If the soil is dry:
    - Motor driver activates pump
    - Red LED turns ON
    - Buzzer sounds
    - LCDs “Pump: ON.”
6. If soil is wet:
    - Pump turns OFF
    - Green LED turns ON
    - LCDs “Pump: OFF.”
7. The process repeats continuously every second.

10. Output Results



Case 1: Soil Moisture High (77%)

Pump OFF, Green LED ON.



Case 2: Soil Moisture Low

Pump ON, Red LED ON, Buzzer activated.

The results confirm that the system successfully automates irrigation based on soil conditions.

11. Advantages

- Efficient water management
- Reduces human intervention
- Cost-effective solution
- Easy to implement
- Improves crop health
- Suitable for small-scale farming

12. Limitations

- Sensor may corrode over time
- Requires manual calibration of the threshold
- Does not consider rainfall

- No remote monitoring in the current design
- Suitable mainly for small-scale use

13. Future Enhancements

- Integration with WiFi/GSM module
- Cloud data logging
- Temperature and humidity sensors
- Multi-zone irrigation
- Solar-powered system
- Mobile application interface

These improvements can make the system suitable for large-scale smart farming.

14. Conclusion

The Smart Irrigation System successfully demonstrates automated irrigation based on soil moisture levels. By integrating a soil moisture sensor with Arduino, the system ensures that water is supplied only when required.

This reduces water wastage, improves agricultural efficiency, and promotes sustainable farming practices. The simulation in TinkerCAD confirms the effectiveness of the design. With further enhancements such as IoT integration, this system can be scaled for advanced agricultural applications.