Plant Moisture Monitoring System Using Arduino

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Abstract

The Plant Moisture Monitoring System using Arduino Uno is a low-cost, automated solution designed to track soil moisture in real-time. It utilizes a soil moisture sensor interfaced with an Arduino Uno board to trigger visual alerts and optionally automate watering via a motor. This project promotes water conservation and supports smart agriculture practices. Its simplicity, affordability, and effectiveness make it suitable for homes, greenhouses, and educational purposes.

1. Introduction

In recent years, technological advancements have increasingly been applied to solve everyday problems in agriculture and gardening. One such innovation is the Plant Moisture Monitoring System using Arduino, which addresses the challenge of maintaining appropriate soil moisture levels for plant health. Proper watering is crucial for plant growth, as both overwatering and underwatering can negatively impact crop yield and overall plant health. Traditionally, monitoring soil moisture requires manual checks, which can be inconsistent, labor-intensive, and prone to human error.

This project introduces a smart and automated solution that leverages the Arduino Uno microcontroller to continuously monitor soil moisture levels in real-time. A soil moisture sensor is embedded in the soil, which sends data to the Arduino. Based on the moisture reading, the system can trigger a visual alert using an LED or even activate a motorized pump to irrigate the soil automatically. This automation significantly reduces the need for human intervention and ensures plants receive water precisely when needed.

The goal is to promote efficient water usage, especially in regions facing water scarcity, by preventing unnecessary watering. This system is ideal for home gardens, greenhouses, terrace farming, and educational projects, offering a low-cost and beginner-friendly solution. It not only supports sustainable agriculture but also demonstrates the potential of embedded systems and IoT in everyday life. Furthermore, it provides a foundation for future expansions, such as IoT connectivity or integration with weather forecasting systems for predictive irrigation.

2. Proposed Work

The proposed project aims to develop an Arduino-based automated system that monitors the moisture content in soil and ensures timely irrigation. The system will use a soil moisture sensor to collect real-time data, which is then processed by the Arduino Uno to determine if watering is necessary. When the soil is detected to be dry based on a predefined threshold, the Arduino will activate an alert mechanism (LED or buzzer) and optionally control a motor to initiate watering. The circuit will be designed for simplicity and cost-efficiency, using basic components such as jumper wires, relays, and a water pump. The overall objective is to build a compact, userfriendly solution that can be deployed in home gardens, educational setups, or small-scale agricultural fields to reduce manual effort and optimize

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water usage.

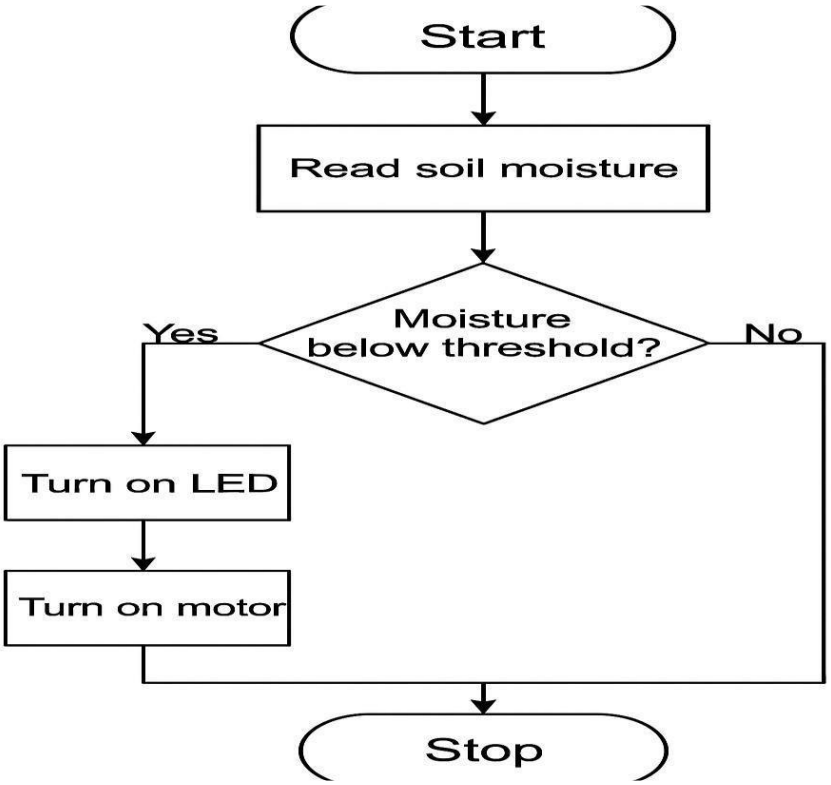

Fig.1.work flow diagram of Plant Moisture Monitoring System Using Arduino

Fig(1) The above figure is a flowchart illustrating the workflow of the Plant Moisture Monitoring System using Arduino. It begins with the "Start" block, initiating the system's operation. The Arduino reads data from the soil moisture sensor to assess the current moisture level. A decision block checks whether the moisture is below a predefined threshold. If the soil is too dry (Yes), the system activates an LED as a visual alert and then turns on a motor to simulate or perform irrigation. If the soil is adequately moist (No), the system skips activation and moves toward the end. Finally, the process loops or ends at the "Stop" block, ensuring continuous or conditional monitoring.

3. **Block Diagram**

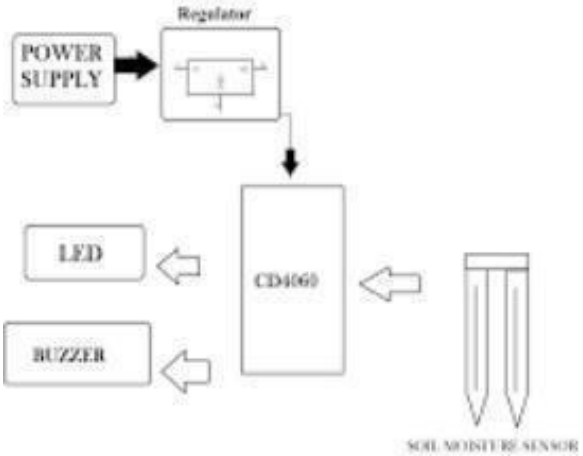

Fig. 2 Block diagram of Plant Moisture Monitoring System Using Arduino

This diagram represents a soil moisture monitoring and alert system. The system begins with a power supply, which provides electricity to the circuit. A voltage regulator ensures that the voltage is stable and safe for the components.

The regulated power is supplied to a CD4069 IC, which acts as a signal processor. A soil moisture sensor is inserted into the soil to detect moisture levels. When the soil is dry, the sensor sends a signal to the CD4069 IC. The IC processes this signal and triggers output devices. An LED is turned on as a visual alert to indicate dryness. A buzzer is also activated to provide an audible alert. This system helps ensure plants are watered on time by notifying the user when moisture is low.

4. **Experimental Input**

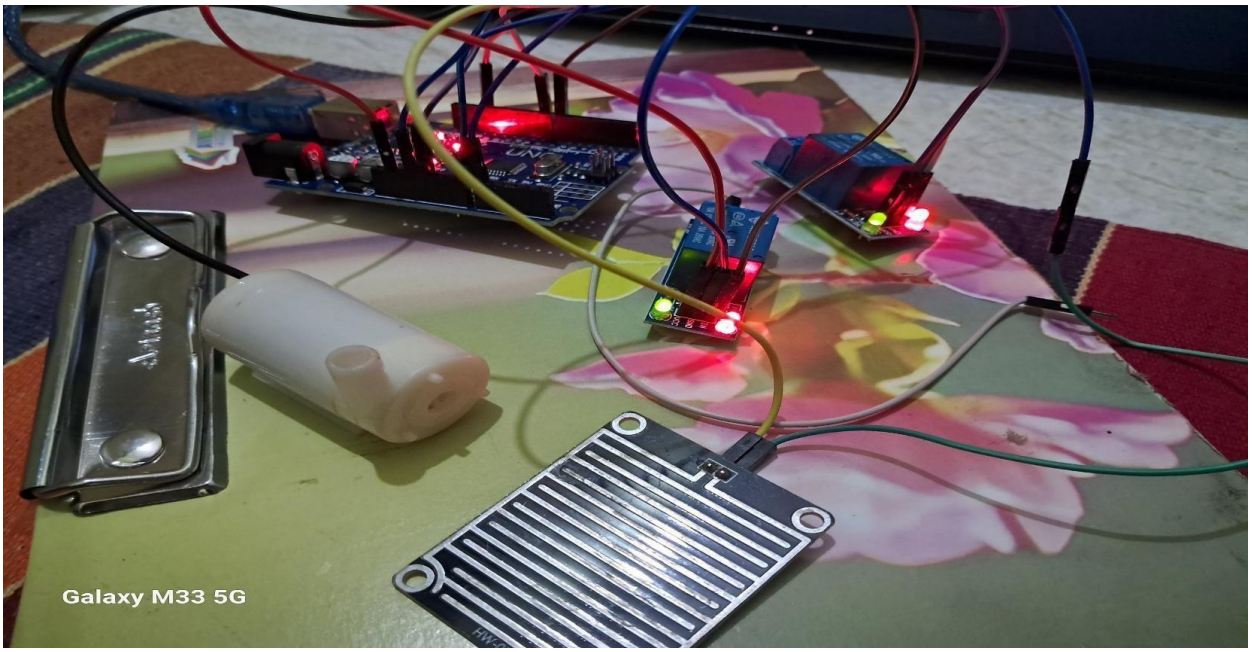

Fig. 3. Experimental output

4.1 Experimental Output Explanation :

The experimental output of the Plant Moisture Monitoring System using Arduino demonstrates how the system responds to varying soil moisture levels in real -time. When the soil is sufficiently moist , the moisture sensor sends a low signal to the Arduino, which then keeps the LED and motor off , indicating no need for watering. However, when the soil becomes dry , the sensor's output value increases beyond a predefined threshold. The Arduino detects this and activates the LED, providing a visual alert, and simultaneously turns on the motor , which represents the watering mechanism (like a pump). This ensures that the plant receives water only when required, preventing both overwatering and underwatering. The entire process can be observed through the serial monitor in the Arduino IDE, which continuously displays live sensor readings. The system successfully performs automatic watering when dry conditions are detected and returns to standby once moisture is restored. This outcome confirms that the circuit and program function correctly, making it suitable for home gardening and small-scale farming applications.

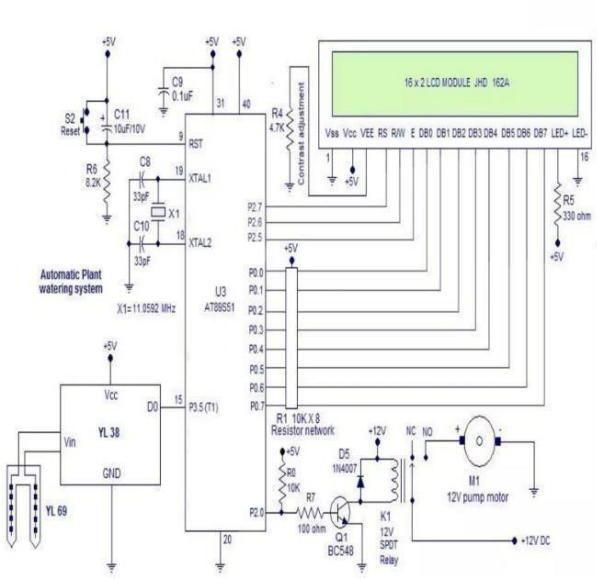

Fig. 4. Circuit Diagram

This circuit diagram represents an **Automatic Plant Watering System** using the **AT89S51 microcontroller**. The system utilizes a **YL-69 soil moisture sensor** (connected through the YL-38 module) to detect soil moisture levels. The digital output (D0) from the sensor is fed to **pin P3.5 (T1)** of the microcontroller for processing. An **LCD module (16x2 JHD162A)** is connected to display soil moisture status and watering actions. When dry soil is detected, the microcontroller sends a signal through **pin P2.0** to activate a **BC548 NPN transistor**, which in turn energizes a **12V SPDT relay**. This relay controls a **12V pump motor (M1)** to irrigate the soil automatically. A **freewheeling diode (1N4007)** is connected across the relay coil to prevent voltage spikes during switching. Crystal oscillator X1 (11.0592 MHz) with capacitors C8 and C10 provides the clock signal necessary for the microcontroller's operation. The reset circuitry, including capacitor C11 and resistor R6, ensures proper microcontroller initialization. Overall, this system automates irrigation based on soil moisture and provides realtime feedback through the LCD display.

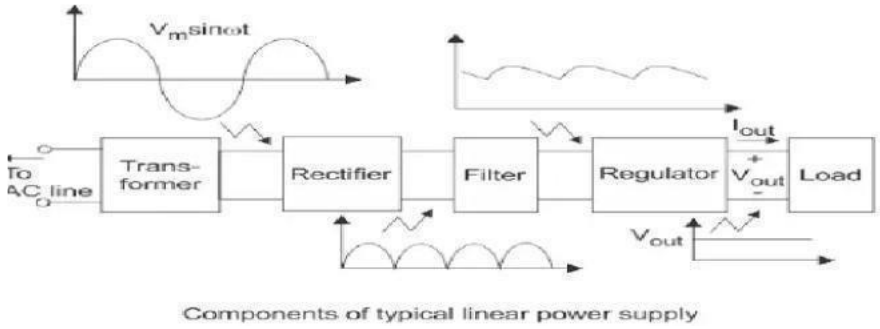

Fig. 5. Block diagram of power supply

A power supply is a critical component in electrical and electronic systems, providing the necessary electrical power to drive circuits, devices, or systems. It converts electrical energy from one form to another, typically transforming an input voltage into a regulated output voltage that is suitable for the application.

AC Input (AC Mains):

• The input power supply is typically from the mains AC (alternating current) line, commonly 110V or 220V AC depending on the region. This block represents the raw input power.

Rectifier (Bridge Rectifier):

• The rectifier converts the AC input into pulsating DC (direct current) by using diodes (typically a bridge rectifier circuit) that allow current to flow in one direction only. This step is essential because most electronics use DC power, while the mains supply is AC.

Filter (Smoothing Capacitor):

• The output from the rectifier is pulsating DC, which still has ripples. A filter, usually capacitor or a combination of inductors and capacitors, smoothens the ripple by reducing fluctuations in voltage, providing a more stable DC signal.

Voltage Converter:

• Depending on the required output, the voltage converter either steps up (boosts) or steps down (buck) the voltage. If the input DC is too high or too low, a DC-DC converter is used to adjust the voltage to the desired level. This could involve switching regulators or transformer-based designs

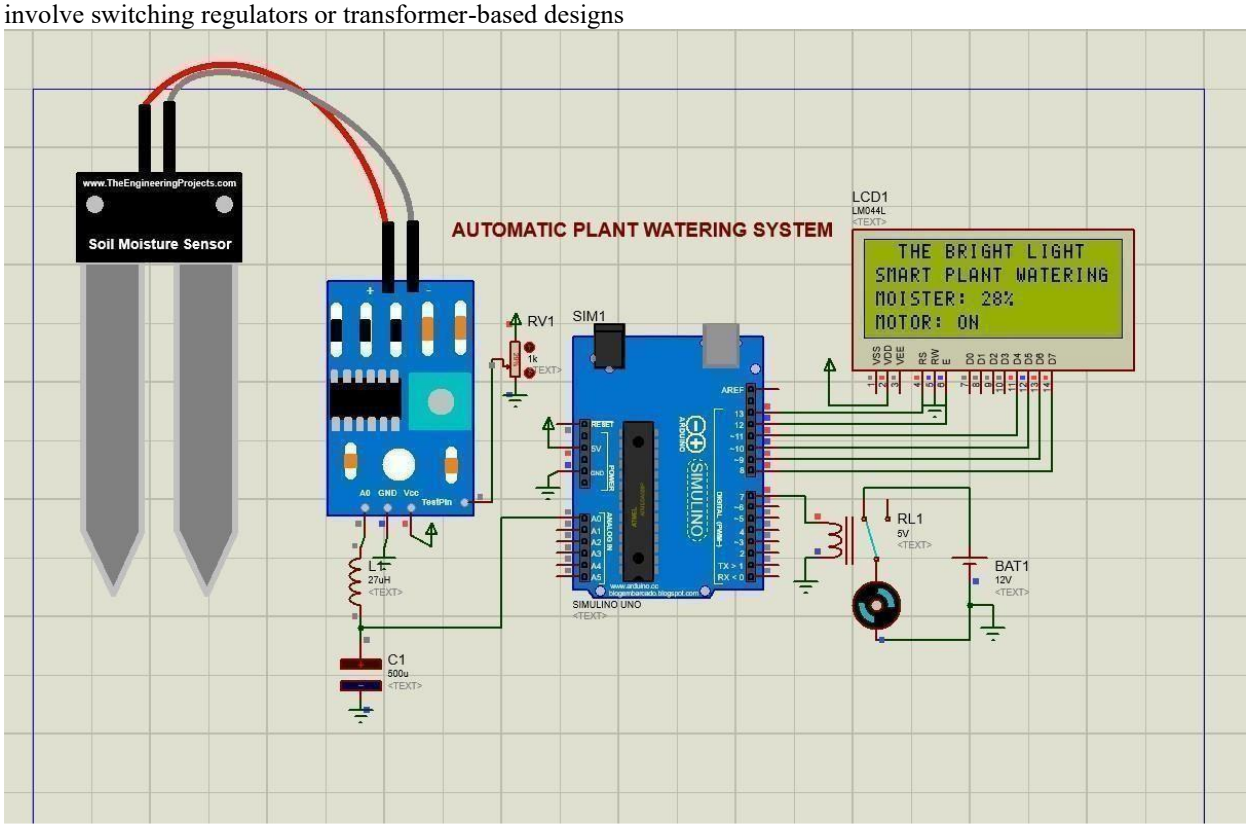

Fig. Simulation

The Plant Moisture Monitoring System using Arduino Uno successfully demonstrates an automated and real- time solution for monitoring soil moisture levels and responding accordingly.

• Real-Time Monitoring:
The system continuously monitors the soil moisture using a soil moisture sensor connected to the Arduino Uno.

• Visual Alert via LED:
When the soil is too dry, the Arduino receives the sensor signal and turns ON the LED, alerting the user that the plant needs watering.
When the soil is sufficiently moist, the LED remains OFF.

• Motor Activation (Optional Feature):
A submarine motor or small pump can be activated to automatically water the plant when the moisture level drops below a certain threshold, demonstrating automated irrigation.

• Energy Efficient and Simple:
The system uses minimal components and power, making it cost-effective and suitable for home or school garden automation**.**

5. Conclusion

The presented circuit successfully demonstrates a reliable and efficient **automatic plant watering system** based on the **AT89S51 microcontroller** and a **soil moisture sensor (YL-69)**. It effectively monitors soil moisture in real-time and activates a **12V pump motor** through a **relay mechanism** when the soil becomes dry. The inclusion of a **16x2 LCD display** provides clear visual feedback, allowing users to monitor system status and soil conditions easily. By automating the irrigation process, the system minimizes human intervention, prevents overwatering or underwatering, and promotes **optimal water usage**. The use of low-cost and readily available components makes the system highly suitable for **home gardening, educational projects**, and **small-scale agricultural applications**. Overall, this project proves to be a practical and scalable solution for **smart irrigation** and **resource-efficient plant care**.

6. Conflict of Interest

The authors declare that they have no conflict of interest.

7. Funding Declaration

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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Mr. Bhosale Ruturaj Sahebrao is currently pursuing a Bachelor's Degree in Electronics and Telecommunication Engineering at Dr. Babasaheb Ambedkar Technological University. His academic and research interests lie in the fields of machine learning, artificial intelligence, and healthcare technologies.

With a strong inclination toward innovation and problem-solving, Ruturaj aims to contribute to the development of intelligent systems that can address real-world challenges, particularly in the healthcare sector. He aspires to build a career that integrates advanced technology with meaningful social impact through research and development.