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Smart Irrigation System Using Arduino Uno with IoT-Based Blynk Monitoring and Crop-Specific Thresholding

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ABSTRACT

The increasing demand for efficient water use in agriculture has necessitated the development of smart irrigation systems. This paper presents a cost-effective, automated irrigation system utilizing Arduino Uno, ESP-01 Wi-Fi module, soil moisture sensors, and the Blynk IoT platform. The system supports crop-specific thresholding and enables remote monitoring and control. Real-time sensor feedback ensures optimal water delivery, promoting resource conservation and enhancing crop productivity.

Keywords: Smart Irrigation, Arduino Uno, Soil Moisture Sensor, Blynk IoT, Crop-Specific Threshold, ESP-01, Precision Agriculture

1. Introduction

The agricultural sector consumes nearly 70% of global freshwater resources. Traditional irrigation methods, which rely on human judgment or fixed schedules, lead to inefficient water usage and poor crop yields. This research introduces a smart soil irrigation system leveraging IoT and embedded technology for precision agriculture.

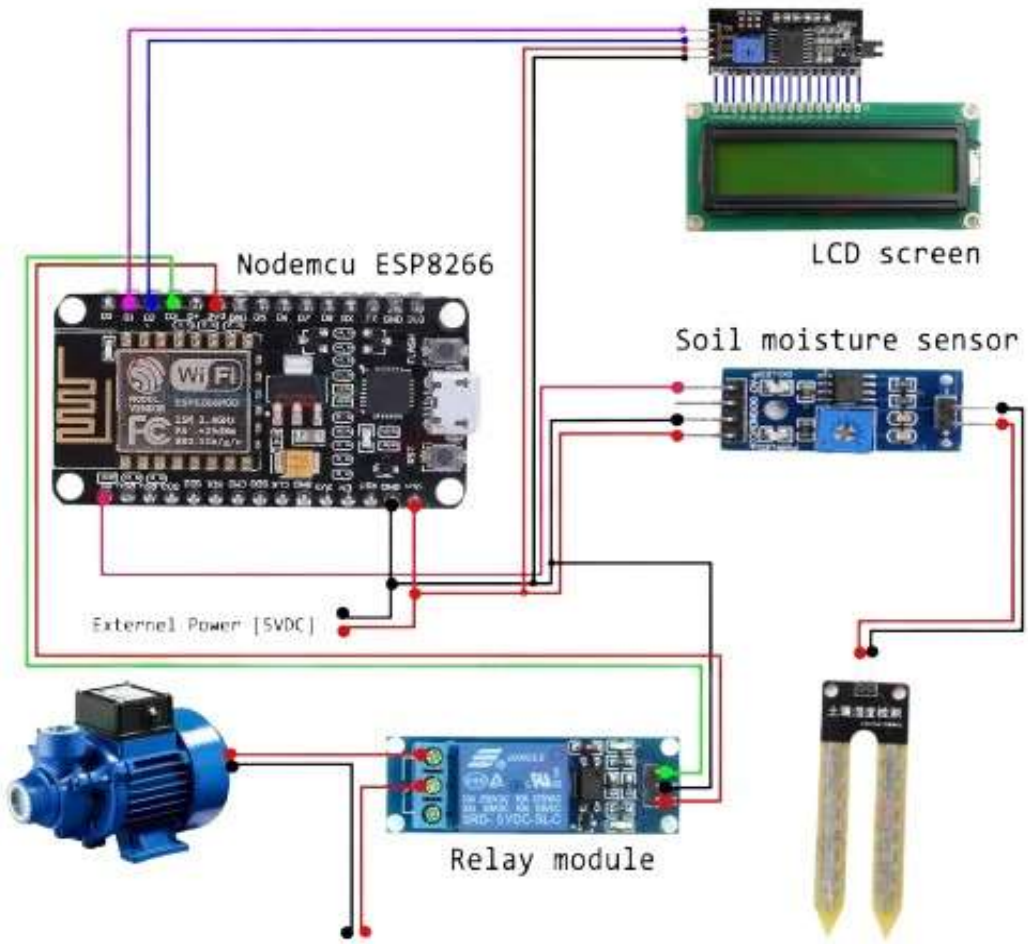
2. Literature Review

Several studies such as Patel & Parmar (2018) and Kumar & Rajan (2020) have highlighted the role of IoT in modern farming. Node MCU and Arduino-based solutions have been explored for their potential in real-time environmental monitoring and automated actuation. However, few systems integrate crop-specific thresholds and provide both local and remote control.

2.1 System Architecture Diagram

The architecture of the smart irrigation system includes the following components

- Node MCU (ESP8266) microcontroller
- Soil moisture sensor
- DHT11 sensor (temperature & humidity)
- Relay module
- Water pump
- LCD display
- Power supply



3. System Overview

3.1 Hardware Architecture

- **Microcontroller**: Arduino Uno
- **Wi-Fi Module**: ESP-01 (ESP8266)
- **Sensors**: Soil Moisture Sensor, DHT11 for temperature and humidity
- **Actuators**: Relay and Submersible Water Pump
- **Display**: 16x2 I2C LCD

3.2 Software Framework

- **Arduino IDE**: Programming and deployment
- **Libraries**: Blynk, DHT.h, LiquidCrystal_I2C
- **Blynk App**: For crop selection, pump control, and real-time monitoring

4. Methodology

A structured development cycle was adopted involving:

- Hardware assembly

- Embedded software programming
- IoT integration with Blynk
- Unit, integration, and system testing

Crop selection influences moisture thresholds, affecting pump activation logic. Real-time values are visualized on the LCD and Blynk dashboard.

5. Implementation

5.1 Logic Flow

- Read soil moisture
- Compare with crop-specific threshold
- If dry, activate pump via relay
- Display data on LCD and update Blynk

5.2 Threshold Values (Mapped Analog for 0–1023)

- Tomato: 55%
- Rice: 75%
- Wheat: 45%
- Cotton: 35%

5.3 Communication

- ESP-01 module handles Wi-Fi communication
- Blynk V0–V3 virtual pins for UI interaction

6. Testing and Results

6.1 Test Cases Summary

Test Case	**Condition**	**Expected Outcome**	**Result**
TC01	Dry Soil < Threshold	Pump ON	Pass
TC02	Moist Soil ≥ Threshold	Pump OFF	Pass
TC03	Sensor Reading Accuracy	LCD Update	Pass
TC04	Node MCU Restart	Stable Reboot	Pass
TC05	Rapid Soil Condition Fluctuation	Stable Logic Response	Pass

6.2 Advanced Testing

- **10-Day Run Test**: Verified stability
- **Climatic Simulation**: ±3% RH variation
- **Soil Variety Test**: Valid across loamy, clay, and sandy soil

7. Discussion

This system bridges gaps in traditional irrigation with automation and IoT. Its independence from cloud connectivity makes it ideal for remote farming areas. Crop-specific adaptability ensures tailored water usage.

Limitations

- No water level detection
- Soil sensor corrosion risk
- No rainfall prediction integration

8. Future Enhancements

- Fertilizer dispensing via NPK sensors
- Solar power and battery backup
- Weather API integration
- LoRa/GSM communication
- AI-based irrigation prediction
- Dedicated mobile app and voice control

9. Conclusion

The proposed Smart Irrigation System significantly enhances irrigation efficiency and crop yield by combining sensor automation, real-time monitoring, and IoT control. The modular design allows scalability and future integration of AI and renewable energy.

10. References

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