ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 11| Issue: 12| December 2025|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2025: 8.691 || ISI Value: 1.188

SMART WATER IRRIGATION SYSTEM

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Article DOI: https://doi.org/10.36713/epra25469
DOI No: 10.36713/epra25469

ABSTRACT

The project aims to enhance conventional irrigation methods through an Automated Watering and Irrigation System applicable to both agriculture and residential/commercial settings. Leveraging ESP32 microcontroller and Thingspeak Cloud, the system automates watering based on soil moisture levels, offers remote monitoring, and optimizes water usage for improved plant health and water conservation, addressing modern agricultural challenges effectively.

KEYWORDS: *Automation, Irrigation, ESP 32, Soil Moisture Sensor, thingspeak cloud,*

I. INTRODUCTION

The traditional approach to watering plants often leads to inefficiencies. Overwatering can waste precious water resources and damage plants, while underwatering can stunt growth and even lead to plant death water stands as a vital factor determining growth and vitality. However, conventional irrigation methods often fall short, leading to either water wastage or insufficient hydration for optimal plant development. Recognizing this challenge, this paper introduces a sophisticated solution: a Smart Water Irrigation System. Combining the prowess of ESP32 microcontroller, Thingspeak Cloud platform, and advanced sensors like Capacitive Soil Moisture Sensor V2.0 and DHT11, this system revolutionizes traditional practices. It enables precise monitoring of soil conditions, remote control via the Thingspeak app, and real-time feedback through an OLED display. By seamlessly integrating technology with agriculture, this system promises to enhance water efficiency, promote healthier plant growth, and optimize crop yield, thereby reshaping modern irrigation practices.

A. Need of the System

The main need of this system is for both agriculture and residential/commercial sector arises because farms lose a lot of crops because they aren't watered correctly. This ESP32-based system with Thingspeak cloud and advanced sensors promotes healthy plants, water conservation, and efficient management for residential and commercial landscapes. This smart irrigation system helps by giving plants the exact amount of water they need. A Smart Water Irrigation System with ESP32, Thingspeak Cloud, and advanced sensors addresses these shortcomings.

1. Water Conservation: Precise watering based on real-time soil moisture (Capacitive Soil Moisture Sensor V2.0) prevents water waste from overwatering and ensures plants receive what they need.
2. Optimal Plant Growth: Environmental monitoring (DHT11 sensor) allows informed decisions to create ideal growing conditions, promoting healthy plant growth and maximizing yield.
3. Remote Management: Thingspeak Cloud enables remote monitoring and control of the system (ESP32) through a user-friendly smartphone app, offering flexibility and timely adjustments based on changing conditions.
4. Efficiency and Scalability: The system easily scales to accommodate multiple plants or zones with additional sensors and solenoid valves, streamlining irrigation processes and reducing labor costs.

B. Literature Survey

1. **JOURNAL**-IEEE Access

TOPIC- IoT-Based Smart Irrigation System
AUTHOR- M. K. Islam et al.
CONCEPTS USED- Internet of Things (IoT), Wireless Sensor Network (WSN), Data Analytics.
KEY FINDINGS-Improved water efficiency by up to 40%, reduced water usage, increased crop yield, and real-time monitoring of soil moisture and weather conditions.

2. **JOURNAL-**Journal of Hydroinformatics

TOPIC-Smart Water Management
AUTHOR-S. Singh et al.
CONCEPTS USED-Data Analytics, Internet of Things (IoT), Decision Support System (DSS)
KEY FINDINGS-Enhanced water distribution efficiency, reduced water loss, and improved decision-making through the integration of IoT and data-driven analytics.

3. **JOURNAL-** Sustainability

TOPIC- Smart Agriculture Irrigation System
AUTHOR-K.Patel etal.
CONCEPTS USED- Remote Sensing, Internet of Things (IoT), Cloud Computing

KEY FINDINGS-Achieved optimal water allocation, minimized environmental impact, and improved crop

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productivity through remote sensing and cloud-based irrigation control.

II. SYSTEM DESIGN AND FUNCTIONING

A. System Overview

This system automates plant watering based on real-time soil moisture using an ESP32 microcontroller. The ESP32 reads data from a capacitive soil moisture sensor and a DHT11 sensor measuring temperature and humidity. By comparing soil moisture to user-defined thresholds, the system triggers a solenoid valve for targeted watering. The Thingspeak cloud platform enables remote monitoring and control via a smartphone app, allowing users to view sensor readings, adjust watering thresholds, and manually control irrigation. This intelligent system conserves water, promotes healthy plant growth, and offers convenient remote management.

B.Construction

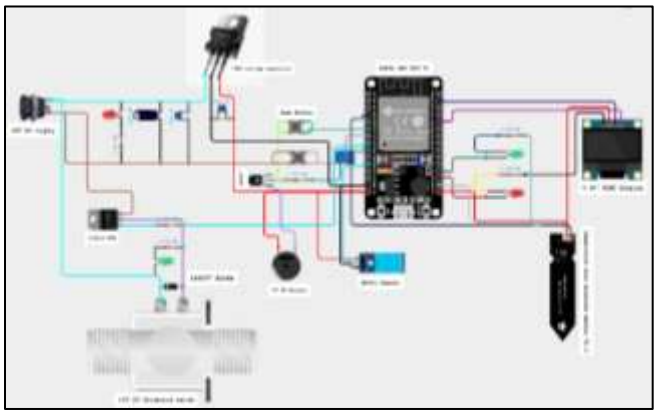

Fig a. Smart Water Irrigation System

To construct the Smart Water Irrigation System, follow these steps:

1. ESP32 DEV KIT V1: This serves as the brain of the system, controlling data processing and communication. Connect it to power and ensure it's programmed with the necessary code to interface with the sensors and display.

2. Capacitive Soil Moisture Sensor V2.0: This sensor measures soil moisture levels. Connect its output to one of the analog pins of the ESP32, and power it appropriately.

3. DHT11 Sensor: This sensor measures temperature and humidity. Connect its data pin to another digital pin of the ESP32, and power it as needed.

4. 0.96" OLED Display: This display provides real-time feedback. Connect its pins to appropriate GPIO pins on the ESP32 and ensure it's powered adequately.

5. 1k 0.25watt Resistors (R1-R6): These resistors are used for current limiting and voltage division purposes in various parts of the circuit, as per the circuit diagram.

6. 1N4007 Diode, BC547 NPN Transistor, TIP122 NPN Transistor with heatsink: These components are used for switching the solenoid valve or pump based on the ESP32's control signals.

7. LEDs 5mm: These LEDs indicate different system states or alerts. Connect them to GPIO pins on the ESP32 through appropriate resistors.

8. 7805 Voltage Regulator with heatsink: This regulator ensures stable voltage supply to components requiring 5V.

9. 2-pin Push Button: These buttons can be used for manual control or system configuration. Connect them to GPIO pins on the ESP32.

10. 2-pin and 3-pin Terminal Connectors: These connectors are used for easy and secure connections between components and power sources.

11. 5V DC Buzzer: This buzzer provides audible alerts. Connect it to a GPIO pin on the ESP32 through a transistor for switching.

12. Capacitors (C1, C2): These capacitors are used for filtering and stabilizing voltage in the circuit, as per the circuit diagram.

13. 12V DC Solenoid Valve: This component delivers water to the plants. Connect it to the TIP122 transistor for switching, and ensure it's powered by a 12V DC supply.

14. 12V DC Supply: This supply powers components requiring 12V, such as the pump or solenoid valve.

C.*Internet of Things (IoT) Integration*

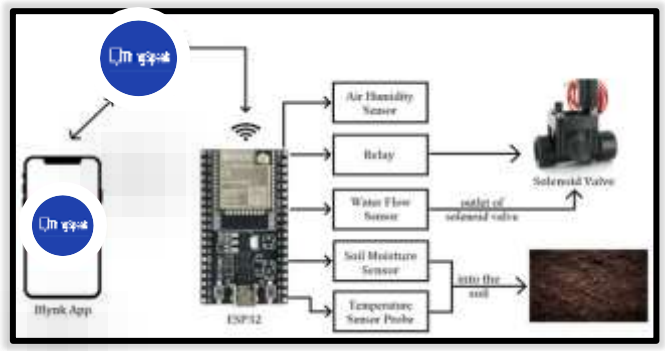

Fig b. Smart Water Irrigation System using ESP32

The Smart Water Irrigation System seamlessly integrates IoT technologies, specifically ESP32 microcontroller and Thingspeak Cloud platform. ESP32 facilitates data collection from advanced sensors, ensuring precise monitoring of soil moisture, temperature, and humidity. Thingspeak Cloud enables remote access to real-time data and control functionalities via a user-friendly mobile app. This integration empowers users to optimize irrigation schedules, conserve water, and maximize crop yield with ease and efficiency, ushering in a new era of smart agriculture.

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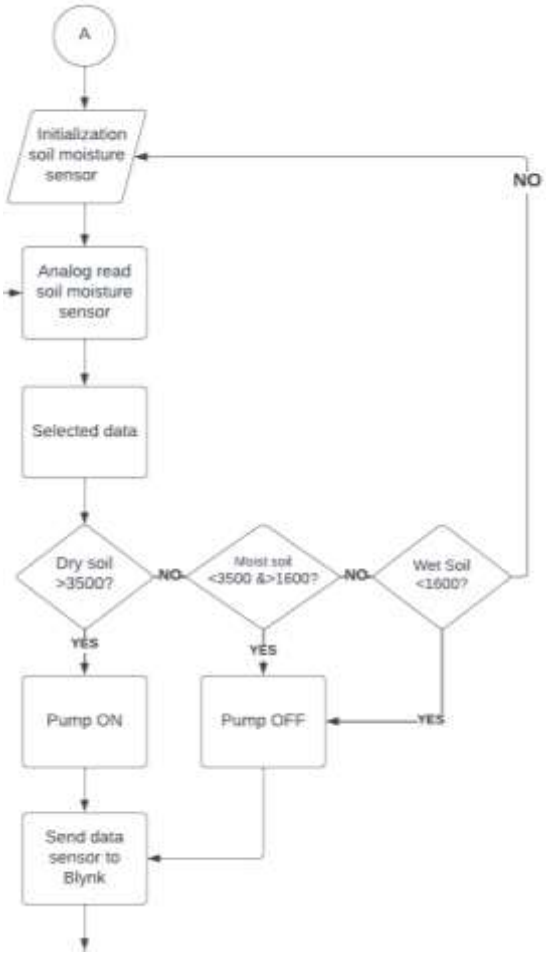
*D. **Dataflow Diagram and Sample Code***



E .Working Principle:

Start: The process starts here.

Initialization: The system first initializes the soil moisture sensor. This could involve calibrating the sensor or setting up its communication protocols.

Connect Wi-Fi: The system attempts to connect to a Wi-Fi network. This is likely for the purpose of sending data to a cloud platform or app for monitoring and control. If the system is connected to Wi-Fi, it proceeds to the next step. If not, it may attempt to reconnect or enter a different mode of operation.

Read Analog Soil Moisture Sensor: The system takes a reading from the soil moisture sensor. This value will be used to determine if irrigation is needed.

Dry Soil (>3500)? If the soil moisture sensor reading is above 3500 (which is likely a unitless value representing a dry reading), the system proceeds to turn on the pump.

Moist Soil (<=3500 &>1600)? If the soil moisture sensor reading is between 3500 and 1600 (inclusive), the system reads the temperature and humidity.

Wet Soil (<1600)? - If the soil moisture sensor reading is below 1600, the system does not turn on the pump and proceeds to display the data on the LCD.

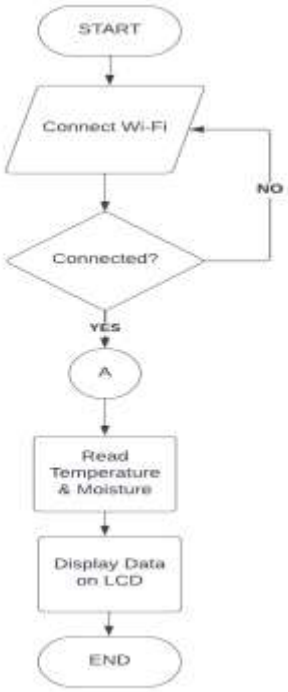
Read Temperature & Humidity: If the soil moisture sensor reading is between 3500 and 1600, the system reads the temperature and humidity from additional sensors.

Pump On: If the soil moisture sensor reading is dry (>3500) or the temperature and humidity readings indicate that irrigation is needed, the system turns on the pump to deliver water to the plants.

Display Data on LCD: The system displays the soil moisture, temperature, and humidity readings on an LCD screen. This allows the user to monitor the system's operation and the current conditions.

Send Data to Thingspeak : If the system is connected to Wi-Fi, it sends the sensor data to a cloud platform or app called Thingspeak. This allows the user to remotely monitor the system and potentially control it from their smartphone or other device.

End: The process ends here.



Overall, this flowchart depicts a basic smart water irrigation system that uses soil moisture, temperature, and humidity sensors to determine when to water plants. The system can be monitored and controlled remotely via a Wi-Fi connection and an app.

III. RESULT

The implementation of the Smart Water Irrigation System utilizing ESP32 and Thingspeak Cloud has yielded promising outcomes in optimizing plant irrigation practices. Through real-time monitoring of soil moisture, temperature,

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and humidity levels, the system effectively regulates water delivery, promoting water conservation and enhancing plant health.

The integration of the ESP32 microcontroller facilitated seamless data collection and processing, enabling precise control over irrigation schedules. Leveraging the Thingspeak Cloud platform provided convenient remote access to monitor and adjust irrigation parameters from anywhere via a user-friendly mobile application.

By utilizing advanced sensors such as the Capacitive Soil Moisture Sensor V2.0 and DHT11, the system accurately assessed soil conditions, ensuring that water was supplied only when necessary. This approach not only minimized water wastage but also optimized plant growth by providing the ideal moisture levels.

Furthermore, the inclusion of a solenoid valve acted as a reliable mechanism for controlling water flow based on sensor readings and user input, contributing to efficient water management.

Overall, the Smart Water Irrigation System demonstrated significant improvements in water conservation, plant health, and user convenience. Its successful implementation showcases the potential of integrating IoT technology into agricultural practices to achieve sustainable and efficient irrigation solutions.

IV. ADVANTAGES

Water Conservation: The system enables precise irrigation by monitoring soil moisture levels in real-time, thus conserving water by only watering when necessary.

Improved Crop Yield: By ensuring plants receive the right amount of water at the right time, the system can enhance crop yield and quality.

Remote Monitoring and Control: Integration with Thingspeak Cloud allows users to remotely monitor and control the irrigation system using a smartphone or web interface, providing convenience and flexibility.

Data-driven Insights: The system collects data on soil moisture, temperature, and humidity, providing valuable insights for optimizing irrigation practices and crop management.

Customizable Alerts: Users can set up alerts and notifications to receive warnings about low soil moisture levels or other abnormal conditions, allowing for timely intervention.

Scalability: The modular design of the system allows for scalability, enabling expansion to monitor and control multiple fields or zones within a farm.

Environmental Sustainability: By optimizing water usage and reducing runoff and soil erosion, the system contributes to environmental sustainability in agriculture.

V. LIMITATIONS

Initial Cost: The setup cost of implementing a smart irrigation system with all the components can be relatively high, which may deter some farmers, especially those with limited financial resources.

Power Requirements: The system requires a power source to operate, which may pose challenges in areas with limited access to electricity or unreliable power supply.

Sensor Accuracy: The accuracy of sensors such as the capacitive soil moisture sensor and DHT11 sensor may vary, affecting the precision of irrigation scheduling and data interpretation.

Maintenance Requirements: Regular maintenance and calibration of sensors and components are necessary to ensure accurate readings and reliable operation of the system.

Compatibility Issues: Integrating different components and technologies (e.g., ESP32, Thingspeak Cloud, sensors) may present compatibility issues or require technical expertise for setup and troubleshooting.

Security Concerns: Connecting the system to the internet for remote access introduces cybersecurity risks, such as unauthorized access or data breaches, which need to be addressed through proper security measures., which need to be addressed through proper security measures.

VI. FUTURE ENHANCEMENT

The smart irrigation system goes beyond gardens! Large farms can use it for precise watering, greenhouses can automate ideal growing conditions, and cities can manage public gardens efficiently. Future advancements include even more sensors for plant health, machine learning for predicting water needs, and cloud storage for better decision-making. This system has the potential to transform agriculture and water management.

VII. CONCLUSION

The smart water irrigation system using ESP32, Thingspeak Cloud, and various sensors offers a promising solution for sustainable agriculture. It combines real-time monitoring, remote control, and data analysis to optimize water usage, improve crop yield, and promote environmentally friendly practices. While some limitations exist in sensor accuracy, reliance on internet, and initial setup complexity, advancements in technology are likely to address these concerns. Overall, this system has the potential to revolutionize irrigation and empower farmers with data-driven decision-making for a more efficient and sustainable future.

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