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IOT BASED SMART IRRIGATION SYSTEM

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Abstract

With the increasing demand for efficient water management in agriculture, the integration of the Internet of Things (IoT) in irrigation systems has become crucial. This paper presents an IoT-based Smart Irrigation System using the ESP32 microcontroller, which optimizes water usage by monitoring soil moisture, temperature, and environmental conditions. The system employs sensors to collect real-time data, which is processed by the ESP32 and transmitted to a cloud platform for remote monitoring and control. Based on predefined thresholds, the system automatically activates or deactivates the irrigation process, reducing water wastage and enhancing crop yield. Additionally, a mobile or web-based application provides farmers with real-time insights and manual control options. The proposed system offers an efficient, cost-effective, and scalable solution for precision agriculture, improving resource utilization and sustainability.

Keywords: IOT, Smart irrigation, ESP32, Crop yield enhancement.

1. INTRODUCTION

Agriculture is one of the most water-intensive sectors, and inefficient irrigation practices lead to significant water wastage. Traditional irrigation methods often rely on manual operation, which can result in over-irrigation or under-irrigation, negatively impacting crop health and productivity. With the advancement of Internet of Things (IoT)

technology, smart irrigation systems have emerged as an effective solution for optimizing water usage and improving agricultural efficiency. This paper presents an IoT-based Smart Irrigation System using the ESP32 microcontroller, which automates irrigation based on real-time soil moisture, temperature, and environmental conditions. The ESP32 collects sensor data and processes it to determine the optimal watering schedule. The system is integrated with a cloud-based platform, enabling farmers to monitor field conditions remotely through a mobile or web application. Automatic and manual control options provide flexibility, ensuring efficient water management while reducing labor efforts.

The proposed system enhances precision agriculture by minimizing water wastage, conserving energy, and improving crop yield. By leveraging IoT and automation, this smart irrigation system offers a cost-effective and scalable solution for sustainable farming practices.

2. LITERATURE SURVEY

A water system is a technique for delivering water to plants to support their growth and development. Irrigation has been practiced for centuries and has evolved significantly with technological advancements. In the 1980s, irrigation was primarily done using furrows and ridges, but today, modern irrigation systems use advanced sensors and automation. Plants absorb water from the soil and release moisture into the air through evapotranspiration. When soil moisture drops below a critical level, plants struggle to absorb water and nutrients. To prevent this, it is crucial to

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supply water to the root zone before reaching the threshold. The optimal water level depends on plant type, soil conditions, and climate, requiring continuous monitoring through sensors placed in the soil.

Given the importance of agriculture in India's economy, modernization of irrigation methods is essential. The Internet of Things (IoT) plays a significant role in improving irrigation efficiency. In smart irrigation systems, soil moisture sensors collect real-time data from agricultural fields and transmit it through wireless networks to cloud-based platforms. This data is processed and analyzed, and farmers receive notifications on their smartphones, enabling them to monitor soil conditions and reduce water wastage.

Automated irrigation systems incorporate IoT, cloud computing, and optimization tools to enhance efficiency. These systems deploy low-cost sensors to measure variables like soil moisture, pH levels, and weather conditions. Data is stored in cloud services such as ThingSpeak and transmitted via WiFi or GSM networks. An optimization model determines the ideal irrigation rate, and solenoid valves controlled by microcontrollers automate the process. This approach reduces water consumption, enhances data availability, and provides visualization tools for farmers.

India's increasing population poses a challenge for food security, making agricultural advancements crucial. Farmers face water scarcity and irregular rainfall, making automation a necessity. Traditional irrigation techniques require manual intervention, whereas automated systems detect temperature and humidity changes using sensors and adjust irrigation accordingly. Center pivot irrigation, combined with IoT applications, further enhances efficiency by automating water distribution based on real-time data analysis. This smart system enables better decision-making, labor efficiency, and precise water management, ultimately improving agricultural productivity.

3. COMPONENTS

3.1 Soil moisture sensor
3.2 DHT11 sensor
3.3 Rain sensor
3.4 Relay module
3.5 ESP32
3.6 Motor

4. PROPOSED SYSTEM

The proposed system as shown in the figure 4.1 is build by using ESP32 microcontroller, DHT11 sensor, soil moisture sensor, rain sensor, motor pump

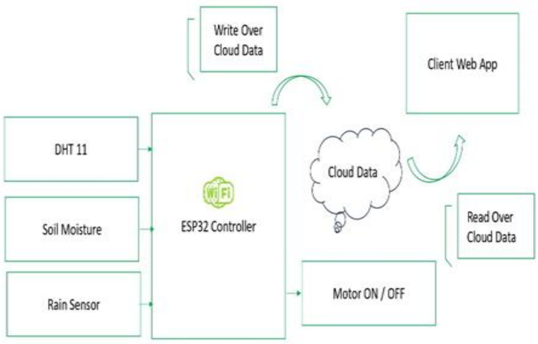

Fig 4.1 block diagram of proposed system

The DHT11 is a low-cost digital sensor used for measuring temperature and humidity in the environment. It is widely used in weather monitoring, smart agriculture, and IoT-based automation systems. The sensor consists of a capacitive humidity sensor and a thermistor to measure environmental conditions. It processes data using an internal 8-bit microcontroller and sends the readings as a digital signal. The sensor communicates with the ESP32 microcontroller through a single-wire protocol, reducing the number of required pins.

A Soil Moisture Sensor is used to measure the water content in soil. It helps determine whether the soil is dry, moist, or wet, making it useful for automated irrigation systems, smart agriculture, and environmental monitoring.

A Rain Sensor is used to detect the presence and intensity of rainfall. It helps in automated irrigation systems, weather monitoring, and smart home applications by determining whether it is raining

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and taking appropriate actions, such as stopping irrigation or closing windows. Write Over Cloud Data refers to the process of sending or uploading sensor data from the ESP32 controller to a cloud platform. This allows remote monitoring, data logging, and automation in IoT-based applications like smart irrigation, weather monitoring, and home automation.

Cloud Data refers to the information collected from sensors and devices, which is stored and processed on a remote server instead of being kept locally on a physical device. In an IoT-based system, like the one using ESP32, cloud data is crucial for real-time monitoring, automation, and remote control of devices.

Read Over Cloud Data refers to the process of retrieving stored sensor data from a cloud platform for monitoring, automation, and decision-making in IoT systems. This allows users to remotely access real-time or historical data and control connected devices based on cloud-stored information.

A Client Web App is a user-friendly web-based application that allows users to monitor, analyze, and control IoT devices remotely by interacting with cloud data. It acts as a bridge between the cloud and the user, displaying real-time sensor readings and enabling remote control of connected devices.

5. CONCLUSION

In an IoT-based system, components like sensors (DHT11, soil moisture, rain sensor), cloud data, client web apps, and motors work together to create a smart, automated solution for applications such as smart agriculture, weather monitoring, and home automation.
By writing and reading data over the cloud, users can monitor real-time sensor readings remotely and control devices via a web application. The ESP32 processes data, automates actions (e.g., turning on a water pump when soil moisture is low), and ensures efficient operation.

6. FUTURE SCOPE

6.1. AI-Powered Automation:

Machine learning algorithms can predict trends from sensor data (e.g., forecasting rainfall or soil moisture levels). Smart irrigation systems can self-adjust watering schedules based on weather predictions.

6.2 Edge Computing for Faster Processing

Instead of relying solely on cloud servers, edge devices (ESP32, Raspberry Pi) will process data locally. Reduces latency and bandwidth usage, making real-time decisions more efficient.

6.3 Smart City & Industrial IoT Applications

Automated traffic control using cloud-monitored sensors. Precision farming using drones, IoT sensors, and AI-driven analysis. Industrial automation with cloud-connected robotic systems.

6.4 Renewable Energy & Sustainability

IoT can optimize solar panel and wind turbine efficiency.

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