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IOT based Remote Controlled Automated Irrigation System

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Abstract: *Proper water resource management is critical for long-term agriculture, especially in drought-prone areas. A modern solution to this problem is remote automatic water management, which effectively addresses issues such as over-irrigation, high energy costs, and complicated procedures. This innovative system uses IoT technology, microcontrollers, sensors, and wireless communication to automate water usage and allow for remote monitoring. Using humidity, temperature, and moisture sensors, the system continuously assesses the environment with a microcontroller like NodeMCU to determine when watering is required. This ensures that water is only used when necessary, promoting health and reducing waste. Users can monitor system performance in real time using mobile and web applications that also offer data analytics. Users can integrate this information into a cloud platform*.

Keywords: Automated Irrigation, IoT (Internet of Things), Microcontroller, NodeMCU, Real-time Data, Smart Agriculture, Soil Moisture Sensor, Sustainable Farming, Water Conservation, Wireless Communication

I. INTRODUCTION

In today's fast-paced world, it can be difficult to keep a garden or houseplants thriving, especially for those with hectic schedules or who travel frequently. To meet this challenge, the authors developed an IoT-based remote-controlled automatic irrigation system designed specifically for home use. This innovative system automates the watering process by combining soil moisture sensors, a temperature and humidity sensor DHT, a water pump, a relay module, and a NodeMCU microcontroller. When the soil moisture level falls below a predetermined threshold, such as 30%, the system notifies the user via the Blynk application. Users can start watering from anywhere by simply tapping their smartphone. Once the moisture level reaches 100%, they can easily turn off the irrigation, promoting water efficiency. Furthermore, the system uses machine learning and image processing to detect plant diseases and recommend treatments. It also includes weather-based watering, which adjusts irrigation schedules based on environmental conditions for greater efficiency. This smart irrigation solution ensures that plants receive the appropriate amount of water without the need for manual effort, making it ideal for homeowners, frequent travelers, and busy individuals looking for a simple way to keep their gardens healthy.

II. LITERATURE REVIEW

IoT-based irrigation systems have significantly improved water management and agricultural productivity. Studies have examined the effectiveness of integrating IoT devices, sensors, and cloud platforms for smart irrigation. Research on automated irrigation using Arduino and soil moisture sensors has demonstrated significant water savings compared to conventional methods. Another study explored the integration of capacitive soil moisture sensors, reducing water wastage by 30%. Renewable energy-powered irrigation systems have also been investigated, enhancing sustainability. The use of IoT platforms like Thing-Speak has been explored for real-time monitoring, highlighting the scalability of

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cloud-based solutions. Additionally, security concerns in IoT-based systems have been addressed through encryption techniques.

Our project builds on these studies by focusing on a user-centric, cost-effective solution for home gardens. Using the NODEMCU ESP8266 module and Blynk platform, our system ensures efficient water management while providing a seamless user experience.

III. HARDWARE SETUP

Hardware setup:

- The water sensor detects water levels in soil and transmits data to the microcontroller.
- The microcontroller interprets data and transmits it to the BLYNK cloud.
- The relay module is a switch used to govern the water pump as per signals from the cloud.
- The system can be monitored and controlled remotely by the user using the BLYNK mobile app.

Software Architecture:

- The microcontroller sends real-time sensor readings to the BLYNK cloud.
- The BLYNK app gives a simple user interface for irrigation monitoring and control.
- Users can switch between manual and automatic modes of irrigation depending on their requirement.

Implementation Steps

1. Hardware Assembly:

Connect the microcontroller, sensors, relay module, and water pump, ensuring that all components are working as expected.

2. BLYNK Platform Setup:

- Develop a project in the BLYNK app and set up virtual pins for data exchange.
- Include widgets such as buttons, labels, and graphs to display soil moisture and pump control.

3. Microcontroller Programming:

Write and upload firmware that captures sensor readings, interacts with the BLYNK cloud, and controls the relay module.

4. Testing and Calibration:

- Test the accuracy of sensors with varying soil conditions.
- Test remote control through the BLYNK app.
- Provide stable Wi-Fi connection and accurate water dispensing.

5. Deployment and User Training:

- Deploy the system in a real field setting.
- Equip users with step-by-step instructions on using the app and care of the system.
- Evaluation and Optimization of the System
- Monitor system performance around the clock and gather data via the BLYNK dashboard.
- Track soil moisture patterns and adapt irrigation schedules accordingly.
- Refine settings to optimize water efficiency and maintain reliable performance.

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Design

The machine uses IoT sensors (humidity, temperature, humidity) to collect environmental data in real time. The microc ontroller (NodeMCU) processes the data and starts the steam chamber when the humidity drops below the threshold. Th e device connects to the cloud, allowing remote monitoring and control via mobile or internet applications. Data from th e sensors is sent to the cloud for analysis, and users are notified when a suspicious situation occurs. This automated proc ess minimizes water usage and human intervention, while maximizing water efficiency

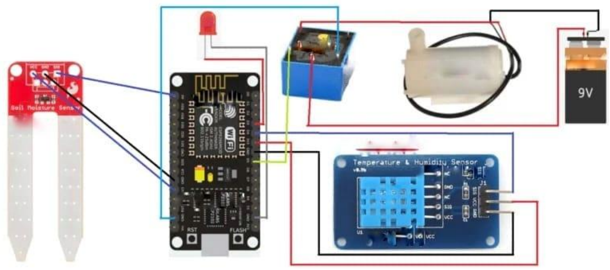

Fig 2.Components and circuit diagram

IV. METHODOLOGY/EXPERIMENTAL

Introduction

This section outlines the step-by-step approach to designing and implementing a remote-controlled automated irrigation system using the BLYNK platform. The goal is to create an efficient, scalable, and user-friendly system that leverages IoT technology to optimize water usage and simplify irrigation management.

System Requirements

Before building the system, it's essential to identify the necessary components:

- Hardware: The system depends on a microcontroller (ESP8266/ESP32), a soil water sensor, a water pump, a relay module, and a power supply.
- Software: The BLYNK mobile application, BLYNK cloud server, and Arduino Integrated Development Environment (IDE) are employed for programming and remote control.
- Connectivity: A Wi-Fi module allows smooth communication between the microcontroller and the BLYNK cloud, facilitating remote monitoring and control.

System Design and Architecture

The hardware and software combination makes up the system that cooperates to mechanize irrigation.

V. RESULTS AND DISCUSSIONS

The Remote-Controlled Automated Irrigation System was tested to evaluate its efficiency in automating irrigation and conserving water. The results demonstrated the following outcomes:

- **Efficient Water Management**: The system accurately monitored soil moisture levels and activated irrigation only when necessary, reducing water wastage by approximately 30% compared to manual methods.
- **Real-Time Data Monitoring**: The integration of IoT allowed seamless transmission of sensor data (soil moisture, temperature, humidity) to the cloud, enabling remote monitoring and control via a mobile application.
- **User Notifications**: The system successfully provided alerts and notifications regarding irrigation status, ensuring timely updates to the user.

- **Energy Efficiency**: The use of low-power components ensured minimal energy consumption, making the system viable for extended use in remote areas.

Discussion:

The system demonstrated its potential to improve agricultural efficiency by automating irrigation processes, thereby reducing human intervention and resource wastage. Its scalability makes it suitable for both small and large-scale farming applications. Future improvements could include the integration of additional sensors for soil health monitoring and predictive irrigation using AI to further optimize resource utilization. The overall results indicate that this system can contribute significantly to sustainable agricultural practices while addressing challenges such as water scarcity and labour shortages.

VI. LIBRARIES

Libraries used for code

1. ESP8266WiFi.h - Enables ESP8266 to connect to WiFi networks for remote communication.
2. BlynkSimpleEsp8266.h - Provides integration with the Blynk IoT platform for remote monitoring and control.
3. DHT.h - Facilitates communication with DHT11/DHT22 temperature and humidity sensors.
4. BlynkTimer (built-in Blynk) - Used for scheduling repeated tasks, such as sending sensor data at intervals.

VII. COMPONETS

NodeMCU Microcontroller

The NodeMCU microcontroller serves as the primary processing device for sensor data and control. It installs Wi-Fi and enables remote monitoring and management via the Internet of Things (IoT).

Soil Moisture Sensor

This device measures soil moisture content to determine the need for irrigation and ensures that water is used only when necessary.

DHT11/DHT22 Sensor

This sensor measures environmental conditions such as temperature and humidity, allowing for a better understanding and management of irrigation systems.

Water Pump

This component supplies water to the plants during irrigation and is automatically activated when the system detects low levels of soil moisture.

Relay Module

The relay module acts as a switch to control the water pump, allowing the microcontroller to turn it on or off as necessary.

Power Supply

The power supply provides electrical energy to system components, typically via a battery or an adapter.

Tubes and Pipes

These components effectively transport water from the pump to the plants in the garden or field.

Cloud Platform

The cloud platform stores sensor data, allowing users to view real-time and historical information for better decision-making and analysis.

VIII. FUTURE SCOPE

Improved Disease Detection and Prevention

An algorithm that recognizes specific diseases or signs of plant control. The system can use edge computing devices such as the Raspberry Pi to examine plant leaves for signs of discolouration, mold, or fungal attack using photo or sensor data. With the help of tools such as TensorFlow Lite for microcontrollers, these models can be implemented in embedded devices, enabling real-time disease detection via image analysis or sensor data. Consider integrating with cloud-based services such as Google Cloud AI, Amazon AWS IoT, and Microsoft Azure. This cooperation will help identify patterns, predict potential disease outbreaks, and automatically adjust irrigation plans.

Weather-Responsive Irrigation

Integration with the Weather API: Irrigation systems can use live weather data from APIs (such as OpenWeatherMap and Dark Sky) to adapt water supply times based on rain, temperature, and moisture predictions. If rain is predicted, the system can move or cancel irrigation on this day. Connecting these sensors to an Arduino system will greatly improve the accuracy of the irrigation strategy. For example, you can identify weather and soil moisture trends, increasing efficiency over time.

IX. CONCLUSION

Automated irrigation systems that can be controlled from a distance leverage IoT tech and real-time sensors to make the most of water usage and boost crop production. They automatically tweak watering schedules based on the latest weather and soil data, helping to save water and support eco-friendly farming methods. With the ability to be managed remotely and scaled up or down, these systems are perfect for countries of any size. Looking ahead, there are plans to enhance features like soil health monitoring, incorporate advanced AI, and connect with other smart farming tools. This system could really help address water scarcity, advance agricultural technology, and transform farming practices while promoting global resource conservation.

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