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IOT Based Smart Irrigation System

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ABSTRACT

The IoT-Based Smart Irrigation System is an advanced agricultural automation solution designed to improve water efficiency and reduce human effort in irrigation practices. With increasing water scarcity and the growing need for sustainable farming, this system offers an intelligent approach by utilizing real-time soil and environmental data. It helps in optimizing water usage, ensuring that crops receive the right amount of water at the right time, thereby enhancing productivity and conserving valuable resources.

The system is built around the NodeMCU (ESP8266) microcontroller, which acts as the central processing and communication unit. A soil moisture sensor continuously monitors the moisture level in the soil and sends data to the controller. Based on predefined threshold values, the NodeMCU automatically controls a water pump through a relay module. When the soil becomes dry, the system turns the pump ON, and when sufficient moisture is detected, it turns the pump OFF, preventing over-irrigation. Additionally, a DHT11 sensor is used to measure temperature and humidity, providing a better understanding of environmental conditions.

Furthermore, the system is integrated with IoT technology, allowing users to monitor and control irrigation remotely through mobile applications or web platforms such as Blynk or ThingSpeak. Farmers can view real-time data, receive alerts, and even manually control the system from anywhere. Overall, this smart irrigation system ensures efficient water management, reduces wastage, minimizes manual labor, and improves crop yield, making it a reliable and cost-effective solution for modern agriculture.

INTRODUCTION

Agriculture is a vital sector of the economy, especially in countries like India, where efficient water management is essential for crop productivity. Traditional irrigation methods, such as manual watering and fixed schedules, often lead to problems like overwatering, underwatering, and uneven water distribution, resulting in water wastage and reduced efficiency.

With advancements in technology, smart irrigation systems using the Internet of Things (IoT) have been developed to overcome these challenges. These systems use sensors to monitor soil moisture and environmental conditions in real time

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and automatically control irrigation without human intervention, ensuring optimal water usage.

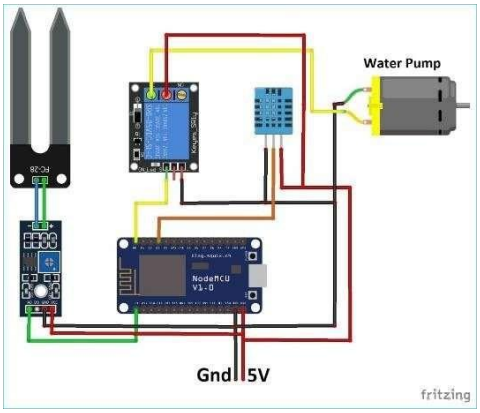
The integration of IoT allows farmers to remotely monitor and manage irrigation through smartphones or computers. This system is useful for smart farming, greenhouses, and gardens, and represents a modern, efficient, and sustainable approach to agriculture.

LITERATURE SURVEY

The development of smart irrigation systems has increased due to the need for efficient water management in agriculture. Earlier irrigation systems were manual, requiring high labor and resulting in water wastage and lack of precision. To overcome this, timer-based systems were introduced, but they lacked feedback from soil conditions and often led to inefficient water usage.

Later, microcontroller-based systems such as Arduino-based irrigation improved automation using soil moisture sensors. GSM-based systems enabled remote control through SMS, but they had limitations like delayed communication and no real-time monitoring. Modern sensor-based systems use multiple sensors for better accuracy; however, they still lack proper IoT integration and cloud-based monitoring.

The proposed IoT-Based Smart Irrigation System overcomes these limitations by combining soil moisture sensing, temperature and humidity monitoring, IoT-based remote access, and automatic pump control. This ensures efficient water management, real-time monitoring, and reduced manual effort, making it a more advanced and reliable solution for modern agriculture.



Architecture Diagram

PROPOSED SYSTEM

The proposed IoT-Based Smart Irrigation System is designed to automate the irrigation process by using real-time data from soil and environmental sensors. The main objective of this system is to provide an efficient and intelligent solution for water management in agriculture while reducing human effort and water wastage.

The system is built around the NodeMCU (ESP8266) microcontroller, which acts as the central control unit. A soil moisture sensor is used to continuously monitor the moisture level of the soil. The sensor sends data to the NodeMCU, which compares it with predefined threshold values. If the soil moisture is below the required level, the system automatically activates the relay module to turn ON the water pump. Once the soil reaches the desired moisture level, the pump is turned OFF, ensuring proper irrigation without overwatering.

In addition to soil monitoring, a DHT11 sensor is used to measure temperature and humidity. The system is integrated with IoT technology, allowing users to monitor and control irrigation remotely through a mobile application. This ensures

efficient water usage and makes the system suitable for smart farming applications.

IMPLEMENTATION

The implementation of the IoT-Based Smart Irrigation System focuses on creating an automated solution that monitors soil and environmental conditions in real time and controls irrigation accordingly. The system operates by continuously collecting data from sensors and processing it to

make intelligent decisions about watering crops.

In this system, soil moisture is continuously monitored to determine the water content in the soil. The collected data is analyzed and compared with predefined threshold values to identify whether the soil is dry or sufficiently moist. Based on this analysis, the system automatically controls the irrigation process by turning the water pump ON or OFF. This ensures that water is supplied only when required, preventing both over-irrigation and under-irrigation.

Along with soil moisture monitoring, environmental parameters such as temperature and humidity are also observed to better understand crop conditions. The system works continuously in a loop, ensuring real-time response and efficient operation. Additionally, the integration of IoT technology allows the collected data to be transmitted to a remote platform, enabling users to monitor the system and control irrigation from anywhere.

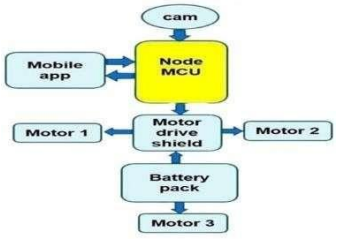


Fig: 1: Block Diagram

HARDWARE IMPLEMENTATION

The hardware setup consists of a NodeMCU (ESP8266) microcontroller, soil moisture sensor, DHT11 sensor, relay module, water pump, and a regulated power supply.

The NodeMCU (ESP8266) acts as the main controller and IoT communication device. It is responsible for reading sensor data, processing it, and controlling the relay module. The built-in Wi-Fi capability allows it to connect to the internet for real-time monitoring.

The soil moisture sensor is used to measure the water content in the soil. It is inserted into the soil and provides analog output, which is connected to the A0 pin of the NodeMCU. The sensor continuously sends moisture level data to the controller.

The DHT11 sensor is used to measure temperature and humidity. It is connected to a digital GPIO pin of the NodeMCU and helps monitor environmental conditions that affect plant growth.

The relay module acts as an electronic switch to control the water pump. Since the NodeMCU operates at low voltage (3.3V), it cannot directly drive high-power devices. The relay allows safe switching of the water pump using control signals from the NodeMCU.

The water pump is used to supply water to the plants. It is connected through the relay module so that it can be automatically turned ON or OFF based on soil moisture conditions.

A regulated power supply (5V) is used to power the entire system. Proper grounding is maintained to ensure stable operation.

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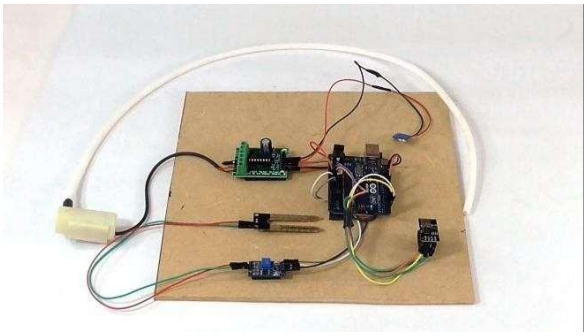
Fig. 2: Hardware Implementation



SOFTWARE IMPLEMENTATION

The software for the system is developed using the Arduino IDE with Embedded C/C++ programming language. The NodeMCU is programmed to read inputs from sensors, process the data, and control the output devices.

The program continuously reads the analog value from the soil moisture sensor and converts it into a meaningful moisture level. This value is compared with a predefined threshold set in the code.

If the moisture value is below the threshold (dry soil), the NodeMCU sends a signal to the relay to turn ON the water pump.

If the moisture value is above the threshold (wet soil), the pump is turned OFF.

At the same time, the DHT11 sensor provides temperature and humidity data, which is also processed and displayed on the IoT platform.

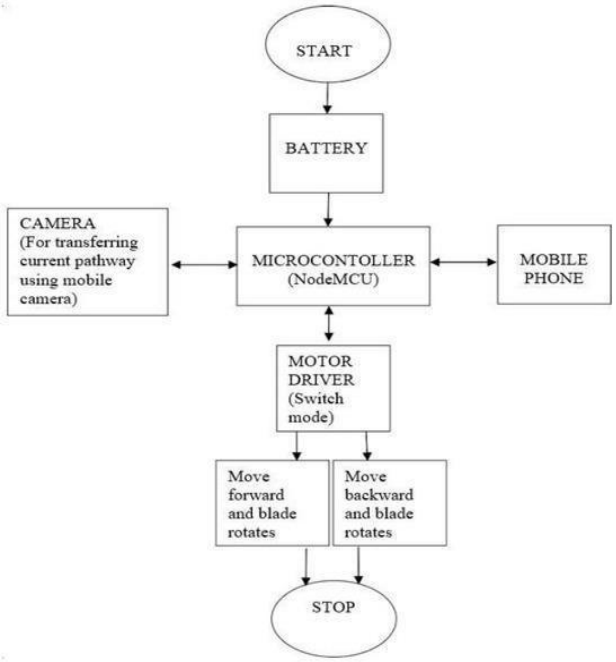
The program runs in a loop, ensuring continuous monitoring and control.

The sensor data is updated at regular intervals to maintain accuracy.

Wi-Fi connectivity is established to send real-time data to the cloud platform.

The system can also receive commands from the IoT application for manual control.

Fig: 3: Flowchart



CONCLUSION

The IoT-Based Smart Irrigation System provides an efficient and automated solution for modern agriculture by integrating sensor technology and IoT. It continuously monitors soil moisture and environmental conditions such as temperature and humidity to ensure accurate and timely irrigation. The system significantly reduces water wastage by supplying water only when required, thereby promoting efficient water management.

It minimizes human effort by eliminating the need for manual monitoring and operation, which in turn improves overall productivity and saves time. The integration of IoT enables real-time monitoring and remote control through mobile or web applications, allowing farmers to manage irrigation from anywhere.

Additionally, the system is cost-effective, easy to install, and scalable for different types of agricultural fields, gardens, and greenhouses. It also helps in maintaining optimal soil conditions, which leads to better crop growth and higher yield. Overall, the project contributes to sustainable farming practices and the advancement of smart agriculture technologies.

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