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IoT Based Smart Irrigation System

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Abstract - In recent years, the integration of Internet of Things (IoT) technology into agriculture has shown great potential for enhancing irrigation practices, thereby improving crop yield and water efficiency. This paper presents the design, implementation, and performance evaluation of an IoT-based smart irrigation system tailored for agricultural applications. The proposed system employs various sensors to monitor soil moisture levels, weather conditions, and crop water requirements in real time. Data collected from these sensors are transmitted wirelessly to a central control unit, which utilizes an intelligent algorithm to optimize irrigation scheduling and water distribution. The system also incorporates remote monitoring and control capabilities, allowing farmers to access and manage irrigation operations from anywhere via a web or mobile interface. Experimental results demonstrate the effectiveness of the IoT-based smart irrigation system in conserving water, reducing energy consumption, and enhancing crop productivity. Moreover, the scalability, reliability, and cost-effectiveness of the proposed solution make it suitable for deployment in both small-scale and large-scale agricultural settings.

***Key Words*:** IoT, smart irrigation, agriculture, soil moisture sensor, wireless communication, optimization, remote monitoring

1. INTRODUCTION

In recent years, with the advancement of Internet of Things (IoT) technology, there has been a growing interest in leveraging its potential for enhancing agricultural practices. Among various applications, smart irrigation systems stand out as a promising solution for optimizing water usage in agriculture while maximizing crop yield. Traditional irrigation methods often lead to inefficient water usage, resulting in water wastage and increased operational costs. However, by integrating IoT capabilities with irrigation systems, it is possible to monitor and manage water usage in real time, leading to significant improvements in efficiency and productivity.

This paper focuses on the design and implementation of an IoT-based smart irrigation system utilizing ESP8266, a DHT11 sensor for measuring temperature and humidity, and a capacitive soil moisture sensor for monitoring soil moisture levels. The ESP8266, a low-cost Wi-Fi module, serves as the communication gateway, enabling the system to connect to the internet and transmit data to a cloud platform for further analysis and decision-making.

The DHT11 sensor is employed to measure environmental parameters such as temperature and humidity, which are crucial factors influencing plant growth and water requirements. By continuously monitoring these parameters, the system can adjust irrigation schedules dynamically to ensure optimal growing conditions for the crops. Additionally, the capacitive soil moisture sensor plays a vital role in determining the moisture content of the soil. Soil moisture levels directly impact plant health and growth, and maintaining an appropriate moisture level is essential for preventing both under and over-watering. By integrating this sensor into the irrigation system, the water application can be precisely controlled based on real-time soil moisture data, thereby avoiding water wastage and ensuring efficient water usage.

In this paper, we are building an IOT building irrigation system using an ESP8266 Node multipoint control unit (MCU) module and a digital temperature and humidity sensor (DTH11) sensor. Also, the server is used to track the land condition to receive the moisture level in the soil. A sprinkler system is also an irrigation-based system, where the water flows through the tubes and water the plants according to their needs. The necessary water based on the land environmental conditions such as Moisture, temperature and humidity can be identified by the smart system and the power will be switched on to provide enough water to the plants.

2. LITERATURE REVIEW

- **Smart Irrigation System using IoT(A.Anitha)**

The system incorporates a sprinkler system to water plants based on environmental conditions such as moisture, temperature, and humidity. Unlike existing systems, this project aims to store data permanently in the IoT cloud and includes features like rain alarms and soil moisture detector circuits for improved efficiency

- **IoT-based Soil Monitoring and Automatic Irrigation System(M.S.R. AL Nahinan)**

The system aims to overcome issues such as power outages and fuel scarcity for water pumps by utilizing IoT and Wireless Sensor Network (WSN) technologies. It employs sensors to monitor soil conditions and utilizes ThinkSpeak Cloud Server for data storage and real-time monitoring.

- **IoT-based Smart Irrigation System using Soil Moisture and Weather Prediction(Dr.S.Velmurugan)**

It introduces an open-source smart irrigation system that predicts field irrigation requirements based on ground parameters like soil moisture and temperature, along with environmental conditions and weather forecast data. The system utilizes a smart algorithm considering sensor data and weather forecast parameters to provide real-time insights via a web-based decision support system.

3. PROPOSED SYSTEM

IoT-based smart irrigation system designed to optimize water usage, improve crop yield, and minimize manual intervention. The system integrates sensor networks, data analytics, and actuators to monitor soil moisture levels, weather conditions, and plant requirements in real time. Through a centralized control mechanism, the system dynamically adjusts irrigation schedules and water flow to ensure optimal moisture levels for crops.

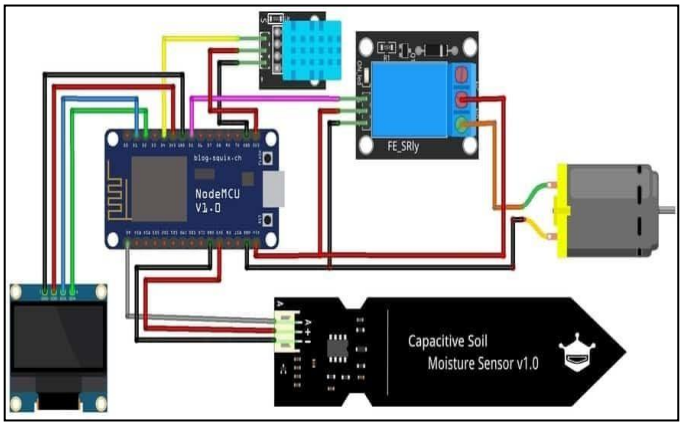


Fig-1: Smart Irrigation System Architecture

Connect the soil moisture sensor to A0 of NodeMCU and DHT11 to D4 Pin. The motor connects to Relay. To control the relay, we use the D5 Pin of NodeMCU. Connect the OLED display to the I2C pin of NodeMCU.Power the Motor and Relay using the 5V pin of NodeMCU. The DHT11 Sensor, Capacitive Soil Moisture Sensor, and OLED Display require a 3.3V Supply only.

4. DESIGN AND METHODOLOGY

Smart irrigation allows farmers to produce yields using minimum resources such as water, fertilizer and seeds. Farmers can deploy sensors to understand their crops, conserve resources and reduce the influences of the environment on crops.

In smart irrigation, one of the main sensors is the soil moisture sensor. Sensors work by detecting changes that alter electrical currents or temperature. To develop a wireless three-level controlled smart irrigation system to provide an irrigation system which is automatic for the plants which helps in saving water and money.

The main objective is to apply the system for the improvement of the health of the soil and hence the plant via multiple sensors. Here we have to build an IoT-based Irrigation System using the ESP8266 NODEMCU Module and Moisture Sensor. It will not only automatically irrigate the water based on the moisture level in the soil but also send the data to a dedicated server to keep track of the land condition.

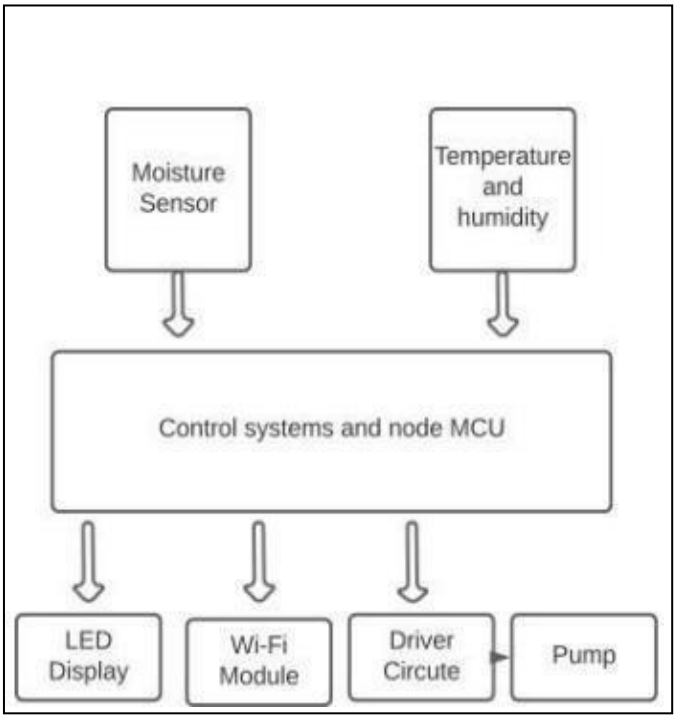
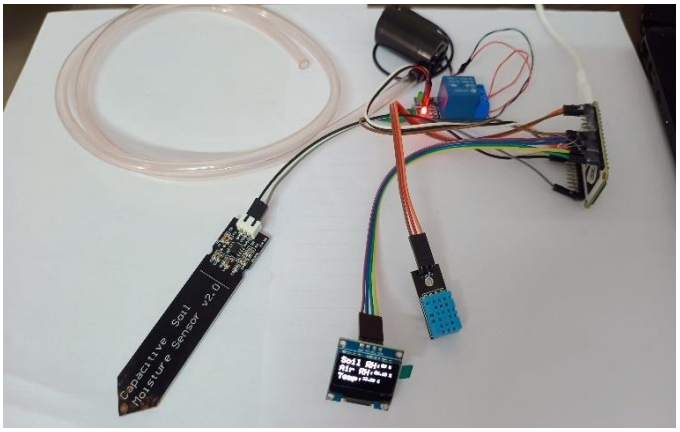


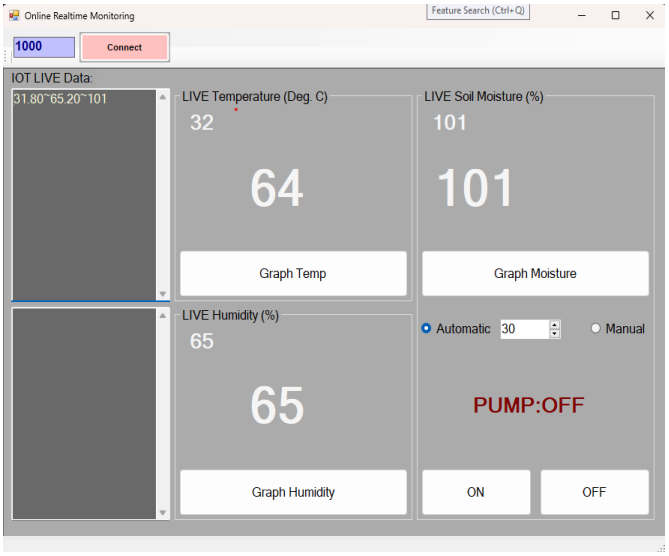
Fig-2: Flow chart of Smart Irrigation System

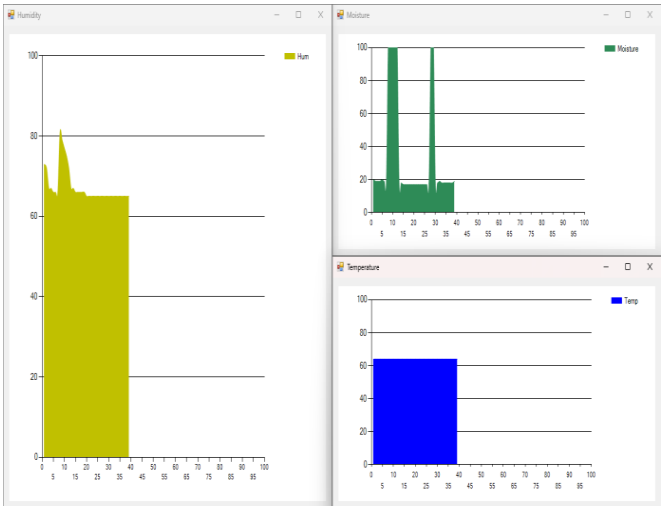
This water pump needs to be fully submerged in water. The outlet pipe is kept in a field for irrigation. Similarly, the soil Moisture sensor is dipped in soil

As soon as you power on the device, the OLED will start displaying the Soil Humidity, Air Humidity, and also Air Temperature. It shows the real-time Data. When the soil moisture content is reduced the water pumps turn on and irrigate the field until the required moisture is achieved.

5. RESULTS







6. CONCLUSION

The development and implementation of an IoT-based smart irrigation system utilizing ESP8266 present a significant advancement in agricultural technology. Through the integration of sensors, actuators, and cloud-based data analysis, the system effectively monitors soil moisture levels and weather conditions in real time, allowing for precise and efficient irrigation management. The system demonstrated notable benefits, including water conservation, increased crop yield, and reduced operational costs. By automating the irrigation process and providing remote, farmers can efficiently manage their irrigation schedules, optimizing resource utilization and maximizing productivity.

Furthermore, the scalability and versatility of the ESP8266 platform offer potential for future enhancements and adaptations to accommodate varying agricultural needs and environmental conditions. Additionally, the integration of machine learning algorithms could further improve the system's predictive capabilities, enhancing its overall performance and reliability.

Overall, the IoT-based smart irrigation system holds great promise in revolutionizing traditional farming practices, contributing to sustainable agriculture, and addressing challenges such as water scarcity and food security in an increasingly interconnected world. Further research and development in this area are crucial for realizing its full potential and ensuring widespread adoption across diverse agricultural landscapes

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