Smart Agriculture Monitoring Using IOT for Real-Time Field Data Analysis

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Abstract - Agriculture plays very important to support the economic growth for developing countries but in traditional farming real time monitoring and data driven decision making are often lack. this project helps farmers to focus on important environmental factors. This paper presents an IOT -based Smart Agriculture Monitoring System designed to improve better water usage and enhance crop productivity. The system integrates a Node MCU (ESP8266) with various sensors like rainfall, Ultrasonic ,soil Moisture, Temperature, and Humidity sensors. It automates irrigation by controlling a water pump based on soil moisture and rainfall detection. Additionally, it manages the microclimate using a fan controlled by temperature thresholds. Real-time data is monitored and controlled via the Blynk IOT App and a web application using WiFi , while an LCD 16x2 i2c provides local visualization. This system reduces manual labor and prevents water wastage.

***Keywords**: internet of things (Iot) ,smart agriculture,Node MCU,(ESP 8266),Environmental Monitoring DHT11 Sensor ,Rain sensor ,Wireless sensor Networks, Real-Time Monitoring ,Precision farming*

1. INTRODUCTION

Agriculture is the backbone of the economy, but traditional methods often lead to resource depletion, With the help of the Internet of Things (IoT), precision farming has become essential.The mainly concept of the IOT-based smart agriculture monitoring system is to continuously monitor environmental conditions of agricultural fields and make the data available remotely in real time using the Internet of Things (IoT) .In this system, various sensors are used such as a temperature and humidity sensor (DHT11) ,rain sensor ,soil moisture ,ultrasonic, are deployed in the farm to collect real-time environmental data. These sensors are interfaced with a Node MCU (ESP8266) microcontroller, which acts as the central controller and data processing unit. The Node MCU processes the sensor readings and displays the measured values display on a 16×2 LCD for on-site monitoring. This project focuses on creating an intelligent environment for crops where human efforts is minimized. By using Node MCU as the central controller, we can connect physical sensors and cloud-based monitoring, ensuring that the farmer is always connected to their field through the Blynk IoT platform. Simultaneously, using its built-in Wi-Fi module, the collected data is transmitted to a web application and Android mobile application. This enables farmers to monitor field conditions remotely from anywhere and at any time. By providing real-time environmental data, the system helps farmers take quick decisions related to irrigation, crop protection, and weather-based planning. The concept focuses on reducing manual labor, conserving water, improving crop yield, and enabling precision farming. Overall, the system offers a cost-effective, adaptable, and efficient smart farming solution suitable for modern agriculture.

2. LITERATURE SURVEY

Recent developments in **Internet of Things (IoT)** and **Wireless Sensor Networks (WSN)** have developed efficient and automated agricultural systems. In [1], a WSN-based irrigation system was proposed to monitor soil parameters such as moisture, temperature, and humidity. The system helps in reducing water wastage and improving crop productivity, but it mainly focuses on monitoring without advanced decision-making.

In [2], an IoT-based smart agriculture system integrates multiple sensors and cloud platforms to provide real-time monitoring and automatic irrigation control. It enhances efficiency, reduces labor, and allows farmers to access data remotely. However, the system depends on continuous internet connectivity and cloud services.

In [3], an IoT-based irrigation system uses sensors to monitor soil moisture, pH, and environmental conditions, supporting precision agriculture and better resource management. The study highlights improved irrigation efficiency but also identifies challenges such as capacity, energy consumption, and data security.

Overall, these studies show that while existing systems effectively monitor agricultural parameters, there is still a need for intelligent, automated decision-making systems that can optimize irrigation and improve overall efficiency.

3. PROBLEM STATEMENT

Traditional agricultural practices dependent upon on manual field inspection and farmer experience to monitor environmental conditions such as temperature, humidity, and rainfall. It is very time-consuming, manual, and chances inaccurate due to the absense of real-time data. As a result, farmers are unable to face sudden environmental changes, as result inefficient irrigation, poor crop health, and reduced agricultural productivity.In many areas, the absence of automated monitoring systems causes excessive water usage during irrigation and improper crop management, especially under unpredictable climatic conditions.

Everytime physical presence in agricultural fields impossible, and the lack of remote monitoring tools limits effective decision-making. . Therefore, there is a critical need for a low-cost, reliable, and real-time smart agriculture monitoring system that can continuously monitor environmental parameters and provide real time data to farmers. Such a system should utilize IoT technology to enable real-time data , wireless communication, and user-friendly mobile and web interfaces. fixing this problem will help improve resource use, reduce manual effort, minimize crop losses, and support sustainable agricultural .

4. PROPOSED METHODOLOGY

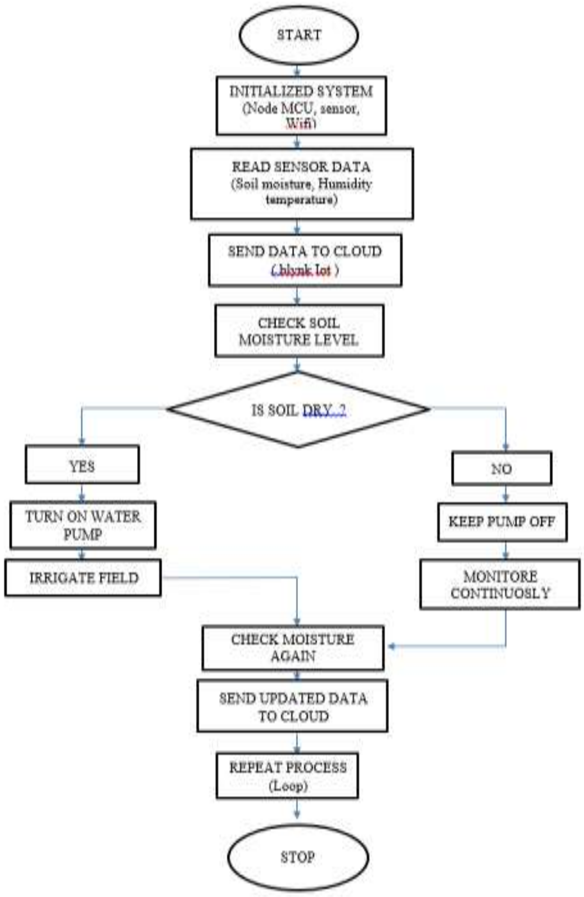

Figure 1.sytem flowchart

The proposed system is an IoT-based Smart Agriculture Monitoring System designed to provide real-time monitoring of agricultural field conditions and provide Remote access to critical environmental data. The system use a different environmental sensors, like a temperature and humidity sensor and a rain sensor, which are arranged in the field to continuously collect data related to climatic conditions. These sensors are interfaced with a Node MCU (ESP8266) micro controller which acts as a central processing and control unit. The Node MCU processes the sensor data and displays the real-time values on a 16×2 LCD, allowing farmers to observe field conditions directly at the site. Also it built-in Wi-Fi capacity of Node MCU allows wireless transmission of sensor data to a cloud-based platform. This cloud platform stores the data and makes it using a web application and an Android mobile application, It helps farmers to monitor field conditions remotely from anywhere. The proposed system focuses on low-cost, energy-efficient and adaptable, making it suitable for small and medium-scale agricultural applications. By providing continuous real-time monitoring and remote accessibility, the system helps farmers take quickly decisions related to irrigation planning, crop management, and resource used. Overall, the proposed system reduces manual effort, minimizes water wastage, improves crop productivity, and supports sustainable and precision agriculture practices.

1.Real time data collection

The system keeps collecting important agriculture field information using sensors:

- DHT11 sensor
- Ultrasonic sensor
- Soil moisture sensor

The signals from these sensors are converted from analog to digital using a 10-bit ADC. Water Pump will ON if there will be no rain and dryness in the soil .Temperature rise then the FAN will be ON. Water Pump will OFF if there is low water in the tank .

2.Soil Moisture Calculation

The soil moisture is found using the value from the microcontroller's analog-to-digital converter (ADC). The soil moisture sensor gives an analog value (0–1023).higher value by sensor shows dryness in soil and lower value shows wet presence in soil.

$$soil\ moisture\ (\%) = \frac{Vdry - Vcurrent}{Vdry - Vwet}$$

Where , Vdry=sensor value in completely dry soil.

Vwet=sensor value in wet soil.

Vcurrent = Current sensor reading

Temperature monitoring is used to maintain a suitable environment for crops. The system reads temperature using a DHT11 sensor and compares it with a predefined threshold value.

If T>T threshold then fan will on

If T< T threshold then fan will off

4 .water level calculation

The ultrasonic sensor measures the distance between the sensor and water surface using sound waves.This distance is then used to calculate the water level in the tank.

Water Level=Tank Height−Measured Distance
or

$$water\ level(\%) = \frac{current\ level}{tank\ level} \times 100$$

5.Irregation time calculation

Irrigation time determines how long the water pump should run to supply the required amount of water to the field.
It depends on:Water requirement of soil/crop,Flow rate of the pump

$$Irrigation\ time = \frac{Water\ required}{Pump\ flow\ rate}$$

5.RESULTS AND IMPLEMENTATION

The proposed IoT-based Smart Agriculture Monitoring System involves the integration of sensors and a microcontroller. The wireless communication and software applications to achieve real-time monitoring of agricultural field conditions. Environmental sensors such as the DHT11 temperature and humidity sensor and the rain sensor are interfaced with the Node MCU (ESP8266) microcontroller. These sensors continuously collect data from the field and the Node MCU processes the sensor values into meaningful information. The processed data is displayed on a 16×2 LCD, allowing farmers to view real-time field conditions directly at the site.

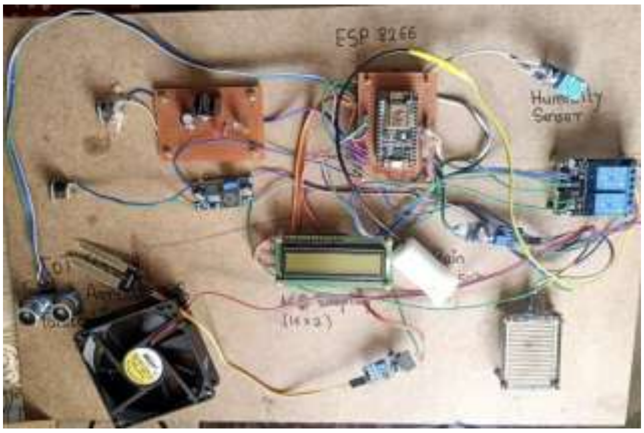

Figure 2. Hardware Setup

Simultaneously, the Node MCU uses its built-in Wi-Fi capability to transmit the sensor data to a cloud-based IoT platform. The data stored on the cloud can be accessed through a web interface or an Android mobile application, able to remote monitoring from anywhere. software programs are developed using the Arduino IDE to handle sensor reading, data processing, LCD display and wireless data transmission. The system is powered through a regulated power supply, ensuring stable operation. h

this integrated implementation, the project successfully demonstrates real-time environmental monitoring, reduced manual effort and improved decision-making support for smart and sustainable agricultural practices.

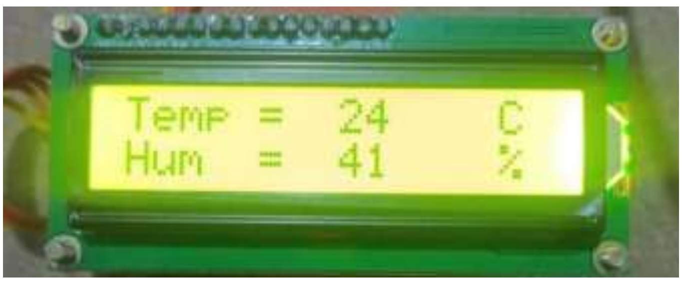

Figure 3. LCD Output of Temperature and Humidity

Figure 4. LCD Output of Rain

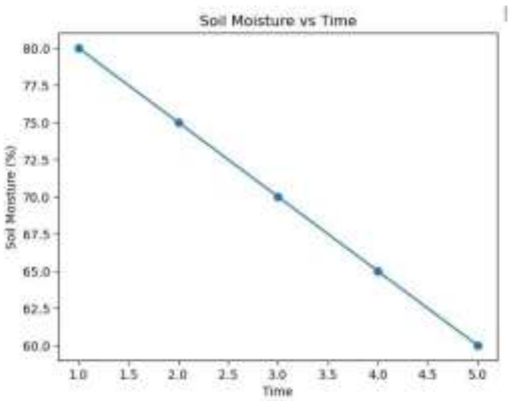

Figure 6. State of Soil Moisture vs Time Graph

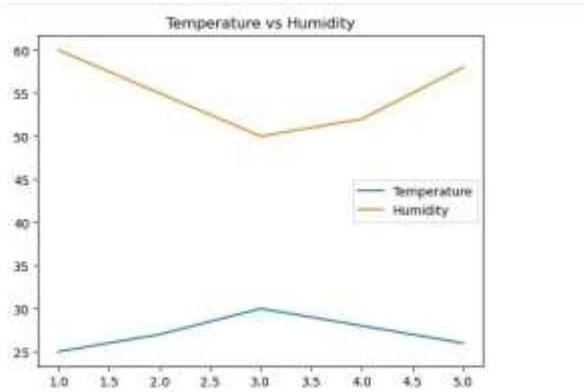

Figure 7. State of Temperature vs Humidity

TABLE 1.

Sr. No.	Date	Time	Soil Moisture (%)	Temperature (°C)	Humidity (%)	Light Intensity (Lux)	Pump Status	Remark
1	10/02/2026	08:00 AM	32%	26°C	68%	520	ON	Soil dry
2	10/02/2026	10:00 AM	45%	28°C	60%	850	OFF	Moisture normal
3	10/02/2026	12:00 PM	30%	32°C	55%	1100	ON	High temp, low moisture
4	10/02/2026	02:00 PM	52%	33°C	50%	1050	OFF	Moisture adequate
5	10/02/2026	04:00 PM	29%	31°C	58%	700	ON	Soil dry
6	10/02/2026	06:00 PM	48%	27°C	65%	300	OFF	Normal condition

Figure 8. **Real time monitoring of IoT-Based Smart Agriculture reading form in Case Study**

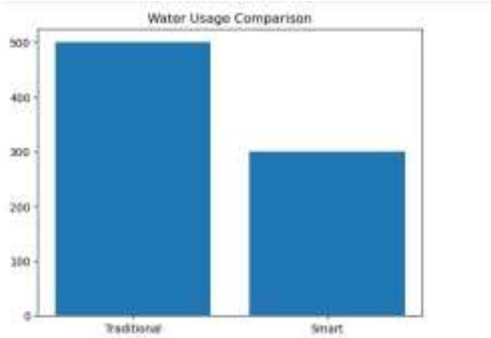

Figure 9 . State of water usage comparison

7. FUTURE SCOPE

The system can be fully automatic using pump,valves for automatic irrigation through AI and machine learning farmers can predict the water level or yield . atmospheric condition can be identify ,can use weather forecasting . By using LoRaWAN or NB-IoT we can control the system from distance . for fertilizers we can add the sensors like NPK ,Wind sensor, Gas sensor, water pump motor control from moisture sensor . Edge computing decrease delays and dependence on the internet. Solar power can be use to reduce the energy in remote areas . in future the web application or movile apps can be modified like alert and SMS system this make people to check the condition from far away and smart choices . we can use drones and automated machines for spraying fertilizers and monitoring crops .farmer can manage large farms from the distance using this system

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