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Smart Agriculture Monitoring System Using IoT

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Abstract - *The growing need for food security during climate change and diminishing resources requires a revolution in conventional agriculture practices. This paper proposes an all-encompassing Internet of Things (IoT)-based Smart Agriculture Monitoring System that can automate environmental monitoring and irrigation control. The system uses the ESP32 microcontroller and combines various sensors to sense temperature, humidity, soil moisture, soil pH, and water level. The collected data is transmitted to a cloud-based Blynk mobile application via GSM, enabling remote decision-making by farmers. The system also incorporates an automatic water pump operated through sensor limits, which greatly decreases labor, increases the efficiency of water use, and encourages sustainable agriculture. Field testing reaffirmed the effectiveness of the system for real-time use and remote data access.*

***Key Words*:** IoT, Precision Agriculture, ESP32, Automated Irrigation, Smart Farming, GSM Communication, Soil Monitoring, Climate Adaptive Farming

1. INTRODUCTION

Agriculture continues to be the lifeline of economies, particularly those in developing nations such as India, where over 60% of the population relies on it. Yet unpredictable weather, poor irrigation, and a lack of real-time data heavily impact crop yield. Internet of Things (IoT) comes to the rescue by making real-time monitoring and automation of farm activities possible.

This study targets the creation of a smart agriculture system that can monitor environmental parameters and automate irrigation decisions based on sensor data and IoT technologies. The system seeks to enhance productivity, minimize labor and water wastage, and improve decision-making capacity through mobile-based feedback.

2. Literature Survey

Several research works highlight the transformative impact of IoT in agriculture, M. Ayaz et al. (2019) proposed an IoT-based architecture that allowed remote monitoring of soil and climate conditions. Their work laid the foundation for “talking fields” where farms communicate their status in real-time., Gavade and Bhoi developed a PIC microcontroller-based NPK detection system to automate fertilizer application., Pusatkar and Gulhane demonstrated the use of wireless sensor networks to gather and transmit agricultural data, proving real-time applications were feasible even in rural setups.

These studies underscore the need for a multi-sensor, mobile-integrated IoT system, particularly one that leverages cloud-based analytics and GSM communication to enable reach even in remote areas.

3. System Design and Architecture

3.1. Hardware Components

Component	Function
ESP32	Microcontroller with Wi-Fi and Bluetooth
DHT11	Measures ambient temperature and humidity
Soil Moisture Sensor	Determines soil wetness
pH Sensor	Detects soil nutrient acidity/alkalinity
Float Sensor	Monitors water tank level
GSM Module	Sends data via SMS or mobile network
Water Pump	Irrigates based on sensor feedback
Power Supply	Battery and regulated DC adapter

3.2. Software Components

Arduino IDE for porgramming the ESP32

Blynk App for real-time mobile data visualization

Firebase (optional) for cloud-based data logging.

3.3. Architecture Overview

Sensors are connected to the ESP32, which reads and processes their values. If the sensor readings cross threshold values, the system activates the pump. Simultaneously, the values are pushed to the Blynk app via the GSM module, providing remote access to data.

5. Methodology

The system follows a structured process:

1. **Initialization**: ESP32 boots up, checks connectivity, and initializes all sensors.
2. **Data Collection**: Periodic sensor readings are taken every 30 seconds.
3. **Condition Evaluation**:
   - If temperature > 40°C, humidity > 70%, and moisture < 50%
     - If float sensor indicates water level > 30%, activate pump.
     - Else, deactivate pump and alert user via SMS/app.
4. **Data Transmission**: Values are sent to the cloud/mobile application.
5. **User Feedback Loop**: User can override settings via the mobile app if required.
6. **Loop Repeats** every minute for real-time responsiveness.

6. Implementation and Results

The system was assembled and tested on a prototype farm plot. Key observations:

- **Temperature Readings**: Accurate within

±2°C.

- **Soil Moisture and pH**: Responsive to watering and fertilizer changes.

- **Pump Automation**: Triggered correctly based on multiple sensor inputs.
- **Remote Monitoring**: Seamless data transmission through Blynk app.

7. Conclusion

The Smart Agriculture Monitoring System is a viable solution for mitigating wastage of water and inefficiency in conventional farming processes. With IoT integration, farmers are provided with vital insights into field conditions in real-time and can automate irrigation, saving precious time, manpower, and resources. Field testing confirmed the reliability and user-friendliness of the system and project large-scale potential for real-world implementation.

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