

IoT-Based Temperature Humidity and Plants Monitoring and Precision Fertigation Enhanced by Drone-Assisted Crop Stress Detection

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Abstract: Agriculture plays a vital role in the Indian economy, yet traditional farming methods often lack real-time monitoring and efficient resource utilization. The IoT Based Smart Agriculture Monitoring System aims to overcome these challenges by integrating Internet of Things (IoT) technology with modern sensor networks. The system continuously monitors critical environmental parameters such as soil moisture, temperature, humidity, light intensity, air quality, and rainfall. Using an ESP32 microcontroller and long-range Lora WAN communication, the collected data is transmitted to a centralized monitoring platform where farmers can access real-time information remotely.

This system helps farmers make data-driven decisions, optimize irrigation and fertilizer usage, reduce manual labour, and improve crop productivity. The use of renewable energy sources such as solar power further enhances sustainability. The proposed solution promotes precision agriculture and supports smart farming initiatives.

I. INTRODUCTION

Agriculture is the backbone of India's economy, but it faces challenges such as climate change, water scarcity, and inefficient resource utilization. Traditional farming methods rely heavily on manual observation, which is timeconsuming and inaccurate. The advancement of IoT technology has enabled the development of smart agriculture systems that provide real-time monitoring and automation.

The proposed IoT-based Smart Agriculture Monitoring System uses sensors and wireless communication to continuously collect and analyse field data. This helps farmers take timely actions, reduce losses, and enhance productivity. The system aligns with smart village and digital agriculture initiatives.

II. OBJECTIVE

The main objectives of the IoT-Based Smart Agriculture Monitoring System are:

1. To develop a real-time agriculture monitoring system using IoT technology that continuously measures environmental parameters such as temperature, humidity, soil moisture, gas levels, light intensity, and rainfall.
2. To collect and transmit sensor data wirelessly using long-range communication technology like LoRaWAN for reliable monitoring of large agricultural fields.
3. To integrate microcontrollers such as Arduino Nano for sensor data collection and ESP32 for data processing and communication.

4. To provide real-time data visualization through an OLED Display and remote monitoring platform so farmers can easily access environmental conditions.
5. To support precision fertigation and irrigation decisions by analysing soil and environmental conditions, helping farmers supply water and fertilizers efficiently.
6. To detect crop stress conditions using drone-assisted monitoring, enabling early identification of plant health issues such as drought stress or disease.
7. To reduce manual labour and improve farm productivity by automating environmental monitoring and enabling data-driven farming practices.
8. To promote sustainable agriculture by optimizing water usage, reducing resource wastage, and supporting renewable energy integration such as solar power.

III. METHODOLOGY

- Deployment of sensors in the **Agricultural Drone**.
- Data collection using ESP32 microcontroller.
- Long-range data transmission using Lora WAN.
- Cloud-based data storage and processing.
- Real-time data visualization through dashboard/display.
- Alert generation for critical conditions.

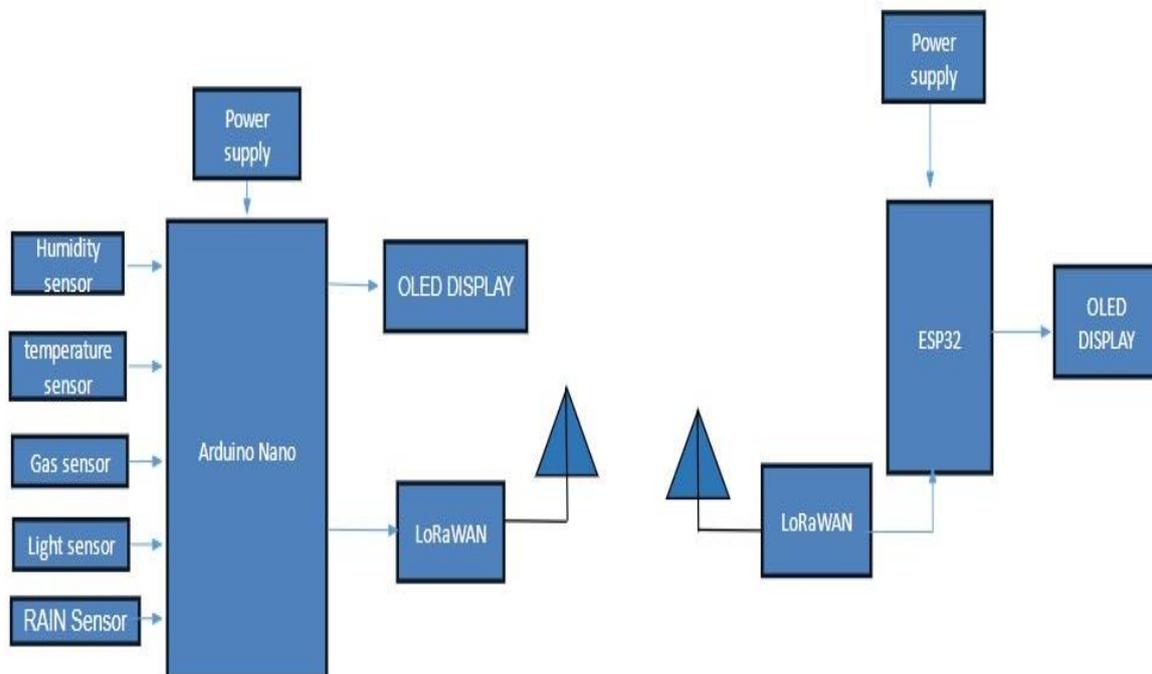


Fig. 1 Flowchart

IOT AGRICULTURE MONITORING SYSTEM FLOWCHART

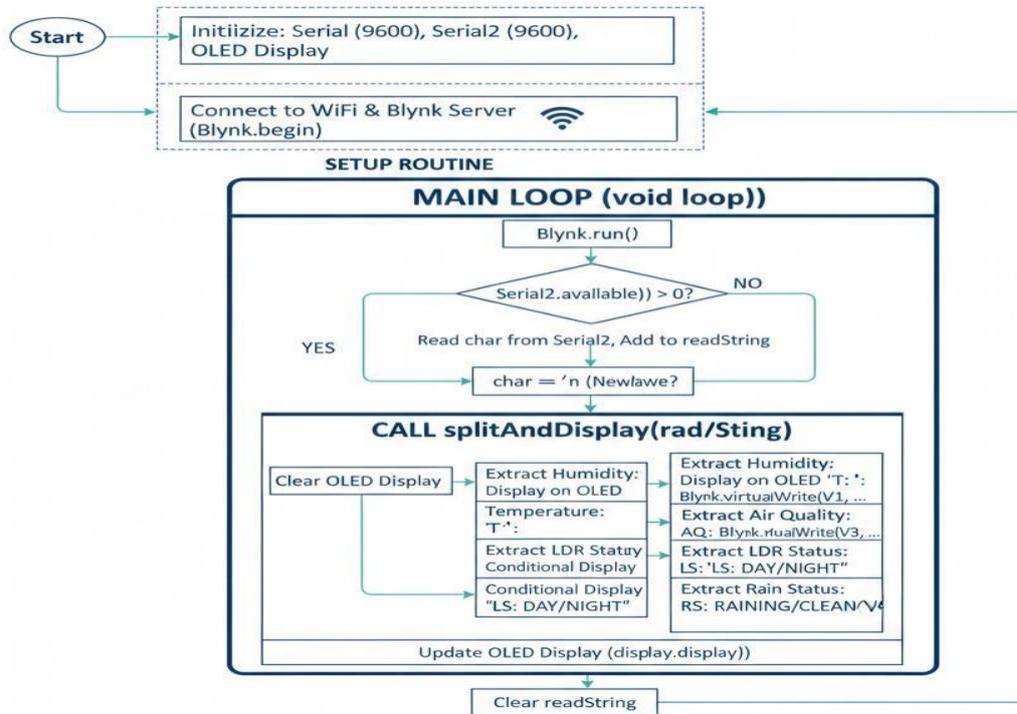


Fig. 2 Monitoring System Flowchart

IV. CONCLUSION

The IoT-Based Smart Agriculture Monitoring System successfully demonstrates how modern IoT technologies can improve agricultural productivity and resource management. By integrating multiple environmental sensors with microcontrollers such as Arduino Nano and ESP32, the system is able to continuously monitor important parameters including temperature, humidity, gas levels, light intensity, and rainfall.

Using long-range communication through LoRaWAN, the collected data can be transmitted over large farm areas and displayed on an OLED Display or remote monitoring platform. This allows farmers to access real-time field conditions and make informed decisions regarding irrigation, fertilization, and crop management.

The integration of precision fertigation techniques and drone-assisted crop stress detection further enhances the system’s capability by enabling early detection of plant stress and optimizing resource usage. As a result, the proposed system reduces manual monitoring, increases efficiency, improves crop yield, and supports sustainable farming practices.

Overall, this project highlights the potential of IoT-based smart agriculture solutions in transforming traditional farming into data-driven precision agriculture, which is essential for addressing challenges such as water scarcity, climate variability, and increasing food demand.

V. FUTURE SCOPE

The proposed IoT-Based Smart Agriculture Monitoring System provides an effective solution for monitoring environmental conditions in agricultural fields. However, the system can be further enhanced with advanced technologies to improve efficiency, scalability, and automation in the future.

One possible improvement is the integration of Artificial Intelligence and Machine Learning algorithms for predictive analysis. By analysing historical sensor data, the system can predict crop diseases, soil conditions, and irrigation requirements in advance, helping farmers take preventive measures.

Another important future enhancement is the development of a mobile or web-based application that allows farmers to monitor field conditions remotely. With real-time notifications and alerts, farmers can easily track parameters such as temperature, humidity, soil moisture, and rainfall using smartphones.

The system can also be expanded to include automated irrigation and fertigation control. Based on sensor data, the system can automatically activate water pumps and fertilizer supply systems, ensuring optimal use of resources while reducing manual intervention.

Integration with weather forecasting systems is another potential improvement. By combining real-time sensor data with weather predictions, farmers can plan irrigation schedules and crop protection strategies more effectively.

Additionally, the use of drone technology for crop monitoring and stress detection can be further developed. Drones equipped with cameras and sensors can capture aerial images of fields to detect plant diseases, nutrient deficiencies, and pest attacks at an early stage.

Future systems can also incorporate renewable energy sources such as solar-powered sensor nodes to make the system more sustainable and suitable for remote agricultural areas.

Overall, these advancements will transform the proposed system into a fully automated smart farming solution that supports precision agriculture, improves crop yield, reduces resource wastage, and promotes sustainable farming practices

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