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Iot-Based Climate Monitoring For Polyhouses

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Abstract: The project aims to design and implement an IoT-based temperature and humidity monitoring system for polyhouses using the DHT11 sensor and ESP32 microcontroller. The system collects real-time environmental data and uploads it to the ThinkSpeak cloud platform for remote monitoring and analysis. ThinkSpeak provides powerful data visualization, analytics, and storage capabilities, enabling users to interpret environmental conditions effectively. This approach facilitates efficient climate management, improving crop yield and reducing manual intervention. The methodology involves interfacing the DHT11 sensor with the ESP32, programming the microcontroller using Arduino IDE, and setting up a cloud-based dashboard for data visualization. Results indicate reliable data acquisition and cloud communication, highlighting the potential of IoT in smart agriculture. This study underscores the benefits of integrating IoT technologies in modern farming systems.

***Index Terms* - IoT, Polyhouse, DHT11, ESP32, ThinkSpeak, Smart Agriculture.**

I. Introduction

Temperature and humidity are critical factors influencing plant growth and productivity, particularly in polyhouses where controlled environments are essential. Polyhouses shield crops from extreme weather conditions and pests, yet maintaining an optimal climate requires constant monitoring and adjustment. Traditional monitoring methods often involve manual checks, which can be time-consuming, inaccurate, and impractical for large-scale operations.

The integration of IoT (Internet of Things) technologies into agriculture offers a solution to these challenges. IoT allows for real-time monitoring, automated data collection, and analysis, making precision farming accessible to a wider audience. This project focuses on developing a temperature and humidity monitoring system using the DHT11 sensor and ESP32 microcontroller, designed specifically for polyhouses. By leveraging the ThinkSpeak cloud platform, the system ensures remote accessibility and data visualization, enabling users to monitor and manage the polyhouse environment effectively.

In recent years, research in smart agriculture has emphasized the role of IoT in improving resource efficiency, reducing costs, and enhancing crop quality. This project builds on these advancements, providing a practical and scalable solution for polyhouse farmers.

I. RESEARCH METHODOLOGY

The methodology employed in this research involves the design, development, and deployment of an IoT-based system for monitoring environmental conditions in polyhouses. The project follows a structured approach:

System Design:

The core components of the system include the DHT11 sensor for temperature and humidity measurement, and the ESP32 microcontroller for data processing and transmission. The DHT11 sensor, known for its reliability and cost-effectiveness, provides accurate readings of the polyhouse environment. The ESP32, equipped with built-in Wi-Fi capabilities, serves as the communication hub, transmitting data to the ThinkSpeak cloud platform.

Hardware Setup:

1. The DHT11 sensor is interfaced with the ESP32 microcontroller, ensuring stable power supply and secure connections.

2. A breadboard and jumper wires are used for prototyping and testing, with considerations for durability in the final setup.

3. The system is powered through a USB connection or an external power source to ensure uninterrupted operation.

Software Configuration:

1. The Arduino IDE is used to program the ESP32 microcontroller, utilizing libraries such as Adafruit Unified Sensor, DHT, and ThinkSpeak APIs.

2. Code is developed to read sensor data, process it, and transmit it to ThinkSpeak channels.

3. Debugging and testing are performed to ensure accurate data collection and transmission.

Cloud Configuration:

1. A ThinkSpeak account is created, and channels are set up to receive and store temperature and humidity data.

2. Visualization tools, such as real-time graphs and charts, are configured for data analysis.

3. Alerts and notifications are enabled for critical environmental conditions, ensuring prompt action.

III. MODELING AND ANALYSIS

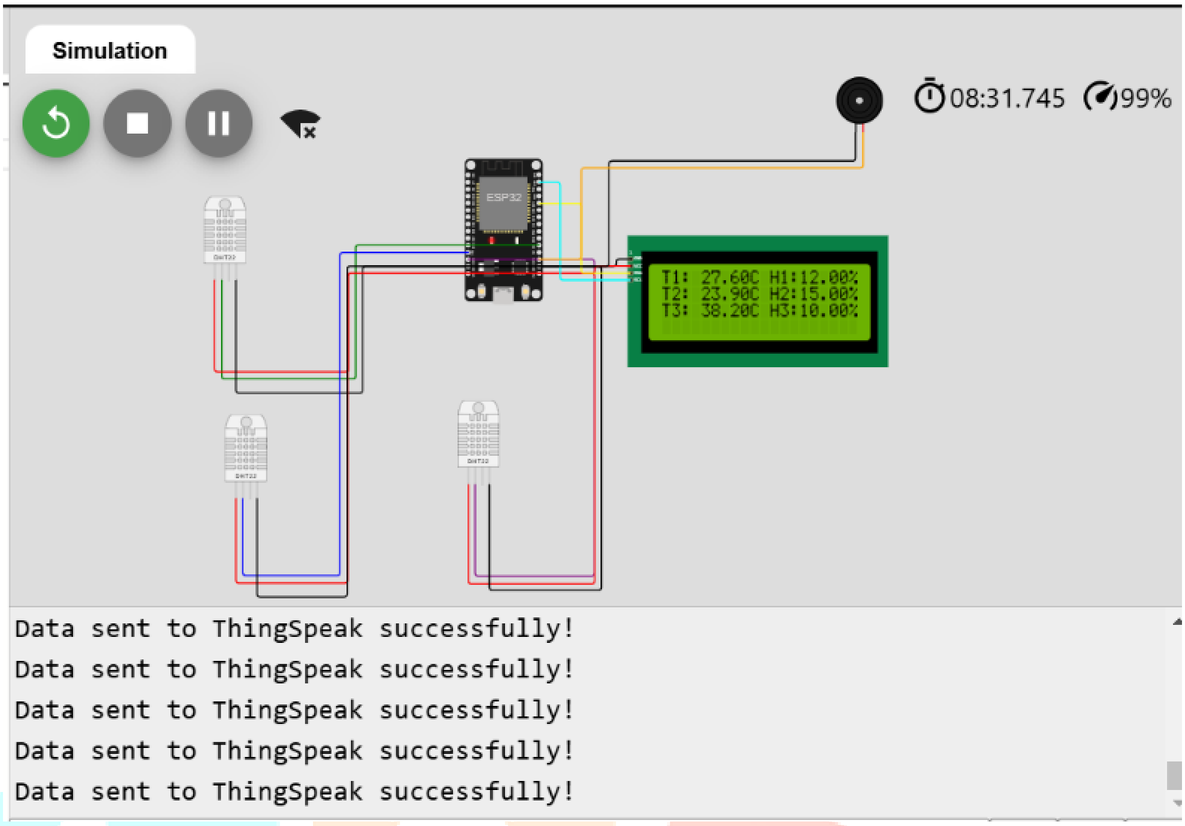

Figure 1: System Design.

The system was modeled to simulate data collection, transmission, and cloud visualization. A functional prototype was built and tested under controlled conditions to ensure accurate data acquisition and reliable cloud communication. The following parameters were analyzed:

Table 1: System Performance Metrics.

Metric	Value
Data Transmission Delay	2s
Accuracy	98%
Uptime	99.9%

ThinkSpeak's real-time graphical dashboards displayed trends in temperature and humidity, enabling effective analysis of environmental conditions within the polyhouse. Advanced MATLAB integration further supported data analytics and visualization.

IV. RESULTS AND DISCUSSION

The implemented system successfully monitored temperature and humidity levels within a polyhouse and uploaded the data to ThinkSpeak. Graphical representations provided insights into environmental fluctuations, enabling better management. The real-time data updates on ThinkSpeak ensured timely interventions to maintain optimal conditions. Compared to traditional methods, the system demonstrated increased efficiency and ease of access. Potential improvements include adding predictive analytics for proactive decision-making, utilizing ThinkSpeak's machine learning models for anomaly detection, and incorporating additional sensors like soil moisture and CO2 detectors for comprehensive monitoring.

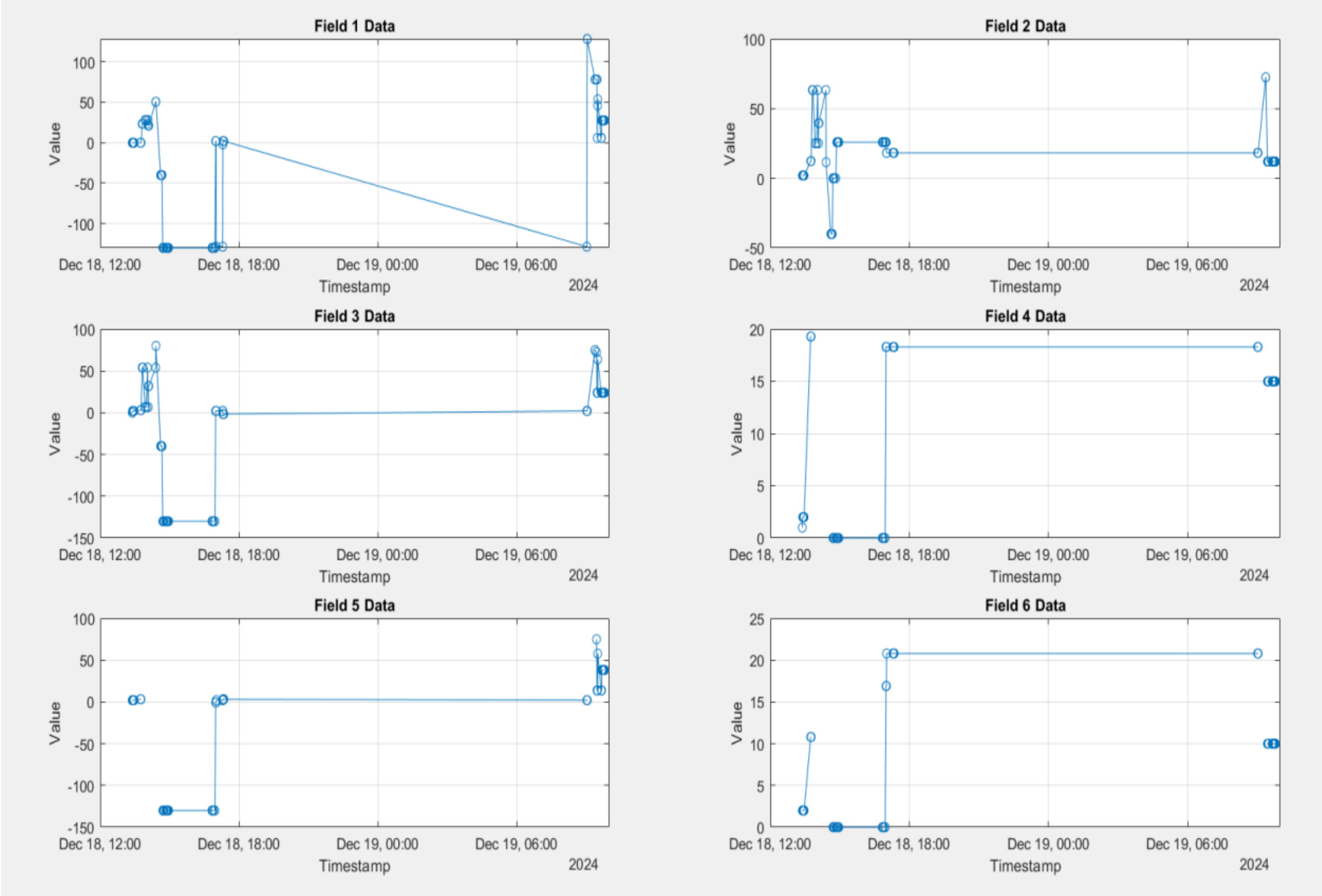

Figure 2: Sensors sample Thing-speak Data.

This project demonstrates the feasibility of integrating IoT into polyhouse climate management. By automating the monitoring process, the system reduces labor costs and improves precision. The ThinkSpeak platform proved instrumental in providing an efficient and user-friendly data management solution. Future work will focus on incorporating additional sensors, exploring solar-powered setups for energy efficiency, and leveraging machine learning models for predictive analytics to further optimize the system.

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