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Review on Smart IoT Based Polyhouse Management System Controlled and Visualized via Android Application

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A B S T R A C T

The review paper titled "Smart IoT based Polyhouse Management System Controlled and Visualized via Android Application explores the utilization of Realtime Firebase Database. In the context of intelligent iot-based polyhouse management systems polyhouses play a vital role in providing controlled environments for crop cultivation and the integration of iot technology mobile app and cloud-based databases has revolutionized agricultural practices. This comprehensive review delves into various aspects such as sensor networks data acquisition communication protocols and actuation mechanisms within the polyhouse ecosystem. The study investigates the implementation of realtime firebase database as a cloud-based server efficient storage and synchronization of sensor data engaging real-time updates and seamless integration with the android app. By leveraging the capabilities of firebase, the android app is able to retrieve and visualize data from the database enabling remote monitoring and control of essential environmental parameters. The review also discusses advanced features like data analytics and decision support systems while addressing challenges and future directions including scalability and security with its comprehensive coverage of iot, mobile app and cloud-based databases in the context of polyhouse management. This review serves as a valuable resource for researchers and practitioners seeking to enhance efficiency and productivity in agricultural practices.

Keywords: Polyhouse, Smart Farming, IoT technology, Firebase, NodeMCU, Sensors, Android App

INTRODUCTION

In recent decades the integration of internet of things technology mobile app and cloud-based databases has brought about significant advancements in the field of agriculture one such application is the management of polyhouse also known as greenhouse or controlled-environment agriculture structures which provide an ideal environment for cultivating crops by leveraging iot and mobile technologies. Smart polyhouse management system has emerged enabling farmers to remotely monitor and control various parameters within their polyhouses. This review paper aims to provide a comprehensive review of smart iot-based polyhouse management system focusing on their control and visualizing technique through an android application. A key aspect of this review is the integration of realtime firebase database a powerful cloud-based storage which enhances the efficiency and effectiveness of data storage and synchronization. The review begins by discussing the fundamental components of smart polyhouse management system including sensor networks data acquisition communication protocols and actuation mechanisms. Various sensors deployed within polyhouses such as temperature and humidity, soil moisture is examined highlighting their significance in monitoring and maintaining optimal environmental parameters for crop growth. Furthermore, the role of the android application is for real-time control and visualizing of data is explored. The android application allows farmers to remotely monitor and adjust critical parameters such as temperature and humidity and irrigation systems ensuring optimal growth conditions for crops. It also facilitates real-time data visualizing and analysing techniques for empowering farmers with insights for informed decision-making the integration of realtime firebase database is a key focus of this review as it provides a robust cloud-based platform for storing and synchronizing sensor data. The advantages of realtime firebase database including real-time values updates, seamless synchronization across more than one device and simplified integration with the android application are discussed in detail. Additionally, the review addresses advanced features like data analytics predictive models and decision support systems showcasing the potential of the system in optimizing crop yields and resource utilization. Challenges and future directions in the field such as scalability security and integration with emerging technologies are also explored in summary. This comprehensive review paper delves into the realm of smart iot-based polyhouse management system emphasizing their control and visualization through an android application. The integration of firebase realtime database enhances the efficiency of data storage and synchronization while the android application empowers farmers with remote monitoring and control capabilities by providing a detailed analysis of the components functionalities and challenges this review serves as a valuable resource for researchers.

PROBLEM REPRESENTATION

At present Polyhouses are used for cultivating crops due to its ability of creating the required environment for cultivation. But this also requires consistent involvement of the individual to maintain the optimal environment of the polyhouse which is a difficult task and results in reduced crop yields and resource wastage.

LITERATURE SURVEY

[1] Risodkar, Y. R.,& Ugale D. V.

In this paper authors explained the traditional methods have certain boundaries which are not appropriate for the polyhouse monitoring and controlling. So that there is a need to work on a system which can be used to increase the quality and productivity. Monitoring and controlling of field parameters provide a better environment for crop growth which ultimately causes product improvement. The delta PLC makes the system affordable to common people. This system simplifies the task of wiring, reducing the cost for the polyhouse provides an effective and intelligent wireless network solution. Thus, we have proposed a system based on PLC by using PID control to get reliable, cost-effective products to increase the production of many folds.

[2] Nagendra Reddy, Kumar Reddy, Kodanda Ramaiah, & Kishor S. N.

In this paper the authors have presented about controlling all the home appliances using android applications. All the appliances were controlled by Arduino Mega and Wi-Fi Module. In this we are using Wi-Fi Module to receive the commands from the smartphone and processed by Arduino. In this design an android application has developed by using Android SDK[13]. This proposed system can monitor and control all the home appliances. Due to the advancement of wireless technology, several different technologies were introduced such as RFID, ZIGBEE, Bluetooth, GSM and Wi-Fi. Each technology has their own unique specifications and applications. Considering the advantages of Wi-Fi an advanced automation system was developed to control the appliances in the house.

[3] Fountas S., Espejo-Garcia B., Kasimati A., Mylonas N., & Darra N.

In this paper authors have presented key technological advances in digital agriculture, which will have significant impact. Artificial intelligence-based techniques, together with big data analytics, address the challenges of agricultural production in terms of productivity and sustainability. Emerging new applications will transform agriculture from the traditional farm practices to a highly automated and data intensive industry.
Digital agriculture is developing rapidly, driven by many technological advances in the area of remote sensing, artificial intelligence, and robotic systems. These systems enable farmers to produce comprehensive, accurate, and transparent crop and livestock products, both at the national and regional levels and to get increased yield and quality, minimizing the environmental impact. However, several challenges and limitations, such as accuracy, interoperability, data storage, computation power, and farmers' reluctance to adopt, need to be addressed for effective use of these technologies and widespread digital transformation of agriculture.

[4] MSD A., Kuppili J., & Manga N. A.

Author concluded that the system proposed uses a microcontroller (NodeMCU) which has a Wi-Fi module (ESP8266) over it. Smartphones with blynk are used as a user interface. Soil moisture sensor, humidity and temperature sensor (DHT11) and rain detection sensors along with DC motor and deek robot are used. This DC motor is connected to a water pump which pumps water to the crops when the DC motor is ON. The soil moisture sensor senses the moisture level in the soil. Depending on the level of moisture, NodeMCU decides whether to water the crop or not. By using appropriate functions and conditional statements in the code written for the NodeMCU functioning, the watering of the crop starts by NodeMCU making DC motor ON when the moisture content is below a threshold value and is made OFF when there is enough moisture content in the soil. The humidity and temperature sensor gives the humidity and temperature values of the atmosphere which determine whether the crop is suitable for growth. Some crops grow only in particular weather conditions and some give better yield only for a particular temperature range. The raindrop sensor measures the intensity of rain. If there is enough rainfall to provide soil with required water, the crops are not watered. Even after raining, if the crops are not having sufficient water then water is pumped again by turning the DC motor ON. Data reaches the blynk cloud from NodeMCU through Wi-Fi from the Wi-Fi module present on NodeMCU.

[5] Zuraida Muhammad, Muhammad Azri Asyraf Mohd Hafez, Nor Adni Mat Leh

Authors concluded that the research has successfully implemented a water irrigation system which meets the target of water-saving purposes as it is equipped with self-intelligent capability. The findings revealed that the soil moisture state is under strong control because it is proven that the planned irrigation scheme did not conduct the watering process when the soil is above the level of excessive watering purposes or on a rainy day. The network thus helps to conserve water use and to avoid overwater or contamination of the plants. For future improvement, pH sensor, light detection, soil condition checker, and crop observation could be added to make the system more efficient by using image processing. Consequently, authorities should start to think that more research on agriculture-related projects is worthwhile.

COMPARISON:

In this section we briefly discuss existing literature reviews on smart farming and also discuss various methods applied along with the limitations and accuracy.

Reference Name	Technology Used	Description
[1] Risodkar, Y. R.,& Ugale D. V	**Study of Polyhouse Structure and environment variance**	**Monitoring and controlling of field parameters provide a better environment for crop growth which ultimately causes product improvement. The delta PLC makes the system affordable to common people. This system simplifies the task of wiring, reducing the cost for the polyhouse provides an effective and intelligent wireless network solution.**
[2] Nagendra Reddy, Kumar Reddy, Kodanda Ramaiah, & Kishor S. N.	**Use of Android Application to control IoT devices**	**All the appliances were controlled by Arduino Mega and Wi-Fi Module. In this we are using Wi-Fi Module to receive the commands from the smartphone and processed by Arduino. In this design an android application has been developed by using Android SDK. This proposed system can monitor and control all the home appliances. Due to the advancement of wireless technology, several different technologies were introduced such as RFID, ZIGBEE, Bluetooth, GSM and Wi-Fi. Each technology has their own unique specifications and applications.**
[3] Fountas S., Espejo-Garcia B., Kasimati A., Mylonas N., & Darra N.	**Digital Agriculture Techniques**	**Artificial intelligence-based techniques, together with big data analytics, address the challenges of agricultural production in terms of productivity and sustainability. Emerging new applications will transform agriculture from the traditional farm practices to a highly automated and data intensive industry. Digital agriculture is developing rapidly, driven by many technological advances in the area of remote sensing, artificial intelligence, and robotic systems.**
[4] MSD A., Kuppili J., & Manga N. A.	**Study of NodeMCU and with other sensor device and application**	**The system proposed uses a microcontroller (NodeMCU) which has a Wi-Fi module (ESP8266) over it. Smartphones with blynk are used as a user interface. Soil moisture sensor, humidity and temperature sensor (DHT11) and rain detection sensors along with DC motor and deek robot are used. This DC motor is connected to a water pump which pumps water to the crops when the DC motor is ON. The soil moisture sensor senses the moisture level in the soil.**
[5] Zuraida Muhammad, Muhammad Azri Asyraf Mohd Hafez, Nor Adni Mat Leh	**Smart Water Irrigation to save maximum water during rainy season.**	**Implemented a water irrigation system which meets the target of water-saving purposes as it is equipped with self-intelligent capability. The findings revealed that the soil moisture state is under strong control because it is proven that the planned irrigation scheme did not conduct the watering process when the soil is above the level of excessive watering purposes or on a rainy day.**

METHODOLOGY

The methodology for implementing the smart IoT-based polyhouse management system controlled and visualized via an Android application can be outlined as follows:

1. System Design: Begin by defining the system architecture and components. Determine the required sensors for monitoring environmental parameters within the polyhouse, such as temperature, humidity, light intensity, soil moisture, and CO2 levels. Design the communication network to facilitate data transmission between the sensors, central control unit, and Android application.
2. Sensor Integration: Install and integrate the sensors within the polyhouse environment. Calibrate and configure the sensors to ensure accurate and reliable data measurements. Establish the connectivity between the sensors and the central control unit using appropriate communication protocols, such as Wi-Fi, Zigbee, or LoRaWAN.
3. Central Control Unit Development: Develop the central control unit that acts as the hub for data acquisition, processing, and control. This unit receives data from the sensors, performs necessary computations or data filtering, and communicates with the Android application and actuators. Implement algorithms and logic to control environmental parameters based on desired setpoints and user inputs.
4. Cloud-based Database Integration: Integrate a cloud-based database, such as Firebase Realtime Database, for storing and synchronizing sensor data. Set up the database structure and establish secure connectivity with the central control unit. Implement appropriate data synchronization mechanisms to ensure real-time updates and seamless integration with the Android application.
5. Android Application Development: Design and develop an Android application that serves as the user interface for farmers. Implement features for real-time data visualization, remote monitoring, and control of environmental parameters. Establish secure and reliable communication channels between the Android application, central control unit, and cloud-based database.
6. Testing and Evaluation: Conduct extensive testing of the integrated system to ensure proper functionality, reliability, and scalability. Evaluate the system's performance under different scenarios and validate its effectiveness in enhancing polyhouse management. Collect feedback from users and stakeholders for further improvements.

By following this methodology, the smart IoT-based polyhouse management system can be effectively implemented, providing farmers with advanced control, visualization, and decision support capabilities through the Android application, while leveraging the power of cloud-based databases for efficient data storage and synchronization.

PROPOSED SYSTEM:

The proposed system aims to develop a comprehensive and advanced smart IoT-based polyhouse management system that can be controlled and visualized through an intuitive Android application. The system integrates various components to create an intelligent and efficient platform for monitoring and managing polyhouses.

The system begins with the deployment of sensor networks within the polyhouse environment. These sensors, including temperature, humidity, light intensity, soil moisture, and CO2 sensors, collect real-time data on key environmental parameters. The collected data is then transmitted to a central control unit for further processing and analysis.

The central control unit serves as the core processing unit of the system. It receives the data from the sensors and performs necessary computations and analysis to derive meaningful insights. Based on predefined setpoints and user inputs, the control unit controls various actuators such as irrigation systems, ventilation mechanisms, and shading devices to maintain optimal environmental conditions for crop growth.

To enable seamless communication and data exchange, appropriate communication protocols such as Wi-Fi, Zigbee, or LoRaWAN are implemented. These protocols facilitate reliable and efficient transmission of data between the sensors, central control unit, and the Android application.

A crucial aspect of the proposed system is the integration of a cloud-based database, such as Firebase Realtime Database. This database serves as a secure and scalable repository for storing and synchronizing sensor data. It enables real-time data updates and seamless integration with the Android application, allowing farmers to access and visualize the data remotely.

The Android application serves as a user-friendly interface that empowers farmers with real-time monitoring and control capabilities. It provides a visually appealing and intuitive dashboard that displays the sensor data, allowing farmers to monitor environmental parameters, receive notifications or alerts, and make informed decisions regarding irrigation, ventilation, or other interventions.

The proposed system also emphasizes data security and privacy by implementing appropriate authentication and encryption mechanisms to protect sensitive information.

Fig. 1: Structure of Polyhouse

Overall, the proposed smart IoT-based polyhouse management system, controlled and visualized via an Android application, offers a holistic and technologically advanced solution for efficient and sustainable polyhouse agriculture. By leveraging IoT, cloud-based databases, and mobile applications, the system enables farmers to monitor, control, and optimize environmental conditions within polyhouses, leading to improved crop productivity, resource utilization, and overall sustainability in agriculture.

HARDWARE REQUIREMENTS:

1. Sensors: Temperature, humidity, soil moisture and any additional sensors as per specific requirements.
2. Central Control Unit and Communication Module: Microcontroller or microcomputer board (e.g., Arduino, Raspberry Pi) with sufficient processing power, memory, input/output capabilities, and for wireless connectivity between the sensors, central control unit, and Android application. We will be using NodeMCU ESP8266
5. Android Device: Smartphone or tablet running the Android operating system for the Android application.

SOFTWARE REQUIREMENTS:

1. Operating System: Android operating system for the Android application development.
2. Integrated Development Environment (IDE): Android Studio or any other preferred IDE for Android application development.
3. Firmware/Software Development Tools: IDEs or software tools specific to the microcontroller or microcomputer board used for the central control unit. Here we will be using Arduino IDE.
4. Actuators: Irrigation System, Ventilation mechanism, shading devices, and any other required devices
5. Communication Protocols: Libraries or APIs for implementing communication protocols such as Wi-Fi.
6. Cloud-based Database: Firebase Realtime Database or any other suitable cloud-based database service.

PROGRAMMING LANGUAGES:

1. Android Application Development: Java or Kotlin, the primary programming languages for Android application development.
2. Firmware/Software Development: Programming languages supported by the selected microcontroller or microcomputer board, such as C/C++ for Arduino IDE.

SYSTEM REQUIREMENTS:

1. Central Control Unit: The microcontroller or microcomputer board should meet the minimum system requirements for running the firmware/software, including the required processing power, memory, and input/output capabilities.
2. Android Device: The Android device running the Android application should meet the minimum system requirements specified by the Android operating system and the selected IDE.

It is important to note that specific hardware, software, and system requirements may vary depending on the complexity and scale of the polyhouse management system being developed. It is recommended to refer to the documentation and guidelines provided by the hardware and software manufacturers for detailed requirements and compatibility.

SYSTEM ARCHITECTURE:

1. Sensor Layer:

The sensor layer consists of various sensors deployed within the polyhouse environment, including temperature, humidity, light intensity, soil moisture, and CO_2 sensors. These sensors capture real-time data on environmental parameters and transmit it to the central control unit for further processing.

2. Communication Layer:

The communication layer facilitates seamless connectivity between the sensor layer, central control unit, and Android application. It can employ different communication protocols such as Wi-Fi, Zigbee, or LoRaWAN, depending on the specific requirements and range of the system. This layer ensures reliable data transmission and communication between the different components.

3. Central Control Unit:

The central control unit acts as the core processing unit of the system. It receives data from the sensors through the communication layer and performs necessary computations and analysis. It controls the actuators based on predefined setpoints and user inputs to maintain optimal environmental conditions within the polyhouse. The central control unit also manages the communication with the cloud-based database and the Android application.

4. Cloud-based Database:

The cloud-based database, such as Firebase Realtime Database, serves as a secure and scalable repository for storing and synchronizing sensor data. It allows real-time updates and seamless integration with the Android application. The central control unit interacts with the cloud-based database to store sensor data, retrieve historical data, and ensure data synchronization across multiple devices.

5. Android Application:

The Android application serves as the user interface for farmers to interact with the system. It provides real-time data visualization, allowing farmers to monitor environmental parameters, receive notifications or alerts, and control actuators remotely. The Android application communicates with the central control unit and retrieves data from the cloud-based database to ensure up-to-date information and seamless user experience.

The system architecture ensures the integration and interaction of the different layers and components, enabling efficient monitoring, control, and visualization of the polyhouse environment. It establishes a seamless flow of data from the sensor layer to the central control unit, and further to the cloud-based database and the Android application, providing farmers with enhanced control and management capabilities for optimal crop growth and resource utilization.

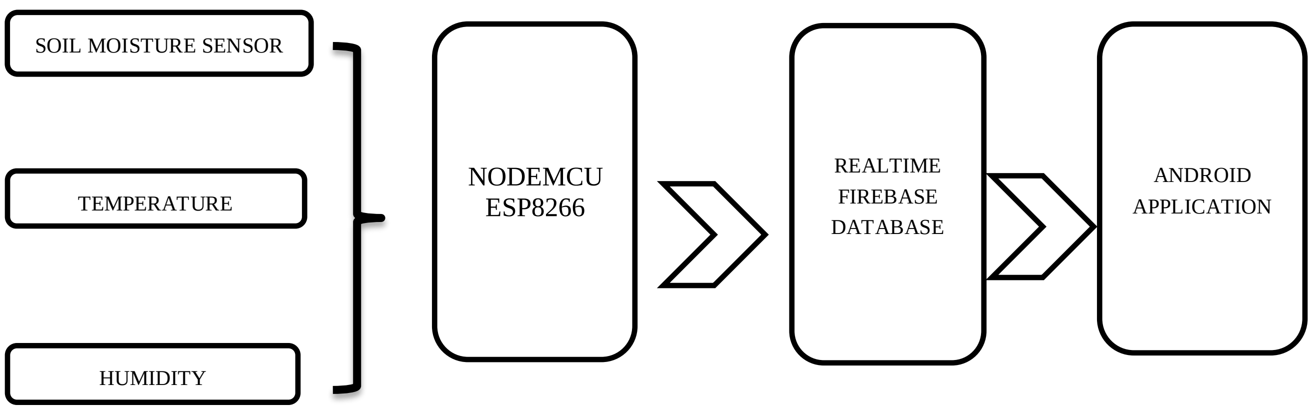

Fig. 2: System Architecture

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