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Smart Poly House Monitoring Systems

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***Abstract* - Modern agriculture makes use of a variety of poly house systems. Poly house systems can be used to grow healthier crops in larger quantities. Temperature, humidity, and wetness are examples of environmental variables that influence plant growth. This strategy protects crops from insects, uncertain weather, and sickness. The poly house will address all deficits for hazardous seasonable crops as well as electricity consumption by harnessing solar energy. The factors that influence the development of crops are monitored using appropriate sensors. The ESP 32 microprocessor will control the optimal conditions in the poly house system.**

Keywords: ESP32, Internet of Things (IoT), Renewable Energy Sources, Poly house Automation, Sensors.

I. INTRODUCTION

Agriculture is the broadest economic sector that contributes significantly to India's development. India is also focusing on technology factors. When technology and agriculture are combined, good things can happen. The traditional method of growing necessitates a huge amount of time and human work, as well as constant monitoring. in the traditional way of cultivation, there are various issues such as unpredictable weather conditions and plants that are readily damaged by pests and diseases. A poly house is a closed environment in which plants grow on a controlled platform regardless of climate or location. Poly house refers to the development and healthy production of plants under controlled favorable conditions in closed or partially closed environments. [7] The Poly house concept arose in response to harsh weather conditions such as excessive rain, hot temperatures, extremely cold temperatures, wind, and so on. Wind, rain, radiation, precipitation, and other environmental variables are all protected by poly houses. It generates a microclimate around the crops, allowing for maximum growth in terms of yield and quality. The Poly house concept arose in response to harsh weather conditions such as excessive rain, hot temperatures, extremely cold temperatures, wind, and so on. Wind, rain, radiation, precipitation, and other environmental variables are all protected by poly houses. It generates a microclimate around the crops, allowing for maximum growth in terms of yield and quality. Agriculture is the largest economic sector in India, contributing significantly to its growth. India is focusing on technology factors. [1]

Integrating technology with agriculture can lead to beneficial outcomes. Conventional cultivation is time-consuming, labor-intensive, and requires constant monitoring. Conventional agricultural methods provide challenges such as unpredictable weather and vulnerability to pests and diseases. Poly houses provide a controlled environment for plant growth, regardless of temperature or location. A poly house is a building made of bamboo or iron pipes and coated with a certain thickness of ultraviolet material. The thickness of ultraviolet sheets varies per crop species. [2] Poly house is a solid and vital approach to increase revenues. This automated system optimizes physical conditions for plant development. Poly houses can have any shape, including tunnels (known as polytunnels). It may be square, semi-circular, or extended in form. The poly house is coated with polyethylene sheets. These sheets moderate UV radiation and promote optimal photosynthesis in crops. The manual method for a poly house involves preheating the air inside using the sun's rays. Temperature, humidity, and light intensity are key characteristics to consider while designing a poly house. Many poly houses fail to exhibit results owing to human errors or improper maintenance. The plant specification sets only three parameters. Scientists have demonstrated that poly house farming techniques may yield 4 to 10 times more than traditional methods. Poly houses are often built in an east-west orientation to maximize sunlight and protect crops from severe weather conditions like excessive humidity and warmth. Poly houses provide temperature and humidity control capabilities. [3]

1.1 Present Theories and Practices

A smart poly house monitoring system involves the integration of various technologies to monitor and control environmental conditions within a poly house or greenhouse. The goal is to optimize crop growth, increase yield, and reduce resource consumption. Here, I'll present the theory and practices involved in smart poly house monitoring systems.

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Theory:

1. Sensors and Data Acquisition:

Temperature Sensors: Monitor air and soil temperature

Humidity Sensors: Measure the moisture content in the air.

Light Sensors: Measure natural and artificial light levels.

Soil Moisture Sensors: Monitor the moisture content in the soil.CO_2 Sensors: Measure carbon dioxide levels for photosynthesis optimization.

2. Actuators and Control Systems:

Heating and Cooling Systems: Maintain optimal temperature. Irrigation Systems: Control watering based on soil moisture levels. Shading Systems: Adjust shading to regulate light levels. Ventilation Systems: Ensure proper air circulation. Fertigation Systems: Control the application of fertilizers through irrigation.

3. Data Analytics and Decision Support:

Big Data Analytics: Process large volumes of sensor data to identify patterns. Machine Learning Algorithms: Predict environmental conditions and crop behavior. Decision Support Systems: Assist farmers in making informed decisions based on data analysis.

Practices:

1. Environmental Monitoring: Deploy sensors strategically throughout the poly house to capture real-time data. Continuously monitor temperature, humidity, light intensity, soil moisture, and CO_2 levels.
2. Automation and Control: Integrate actuators with sensors to automate environmental control. Implement algorithms that adjust conditions based on predefined thresholds.
3. Remote Monitoring and Control: Enable farmers to monitor and control the poly house environment remotely using web or mobile applications Receive alerts for critical conditions that require immediate attention.
4. Energy Efficiency: Implement energy-efficient systems for heating, cooling, and lighting.
5. Data-Driven Decision Making: Use data analytics to gain insights into crop behavior and environmental trends. Implement feedback loops to improve system performance continuously.
6. Integration with Crop Management: Integrate the monitoring system with crop management practices to optimize overall farm operations.

1.2 Need of the Project

Smart poly house monitoring systems are a type of precision agriculture technology that uses sensors and data analytics to monitor and control environmental conditions inside a poly house. This allows farmers to optimize crop growth and yield by providing the plants with the ideal environment.

1.3 Objectives

- The primary goal of this project is to monitor the crops by controlling the temperature, humidity, and moisture.
- Using the Internet of Things, you may also monitor receive, and send signals.
- The temperature sensor detects temperature and generates an analog signal.
- The humidity and moisture sensor values are also obtained.
- The state of the entire operation can be determined using the Internet of Things.
- DHT11 sensors for humidity and temperature measurement, soil sensors for moisture measurement.

1.4 Motivation

The need to address issues like climate fluctuation and resource optimization, this initiative aims to provide farmers with real-time data on environmental conditions within poly homes. The system uses sensors, automation, and data analytics to precisely control temperature, humidity, and irrigation, assuring optimal crop development. This novel strategy not only maximizes yields but also encourages sustainable farming practices, thereby helping to food security in a rapidly changing agricultural landscape.

II. LITERATURE SURVEY

1) Yogesh R. Sonawane, Sameer Khandekar et.al., "Environment monitoring, and control of a poly house farm through internet". Control and monitoring of environmental parameters inside a Poly house farm, to ensure continuous maintenance of a favorable crop atmosphere is the objective of the work presented in this paper. The objective is achieved through the use of internet-based technology. The system is also expandable to be integrated with mobile telephony. The concept encompasses data acquisition of thermal process parameters through a sensor network, data storage, post processing, and online transmission of data to multiple users logged on to their respective web browsers. Further, control of process parameters of a Poly house (for example, toggle on/off control of pumps and accessories, louvers and ventilators, air flow rate, sunlight management, etc.) from one or more remote monitoring stations over the

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web server in real time is also integrated. A graphical user interface (GUI) is unified for the ease of operations by the farming community. The system also allows transmission of process parameters, including emergency alarm signals via e-mail client server or sending a SMS on a mobile phone. A conventional chat has also been integrated with the GUI to add vibrancy to inter-user communication. This feature can be embedded in upcoming 3G mobile technology. Simulations and video tutorials can also be integrated in the web server for teaching the farming community. Such an integrated approach greatly widens the socio-economic possibilities for farmers through interaction with modern technological resources.

2) V. Chaithra, C. Harshitha et.al., "IoT based Automated Poly house Monitoring and Control System". The system proposed in this paper is based on Internet of things (IOT), is a cloud of interconnected physical devices, which can communicate with each other over the internet. Physical devices such as microcontrollers, microprocessors, actuators and sensors will not directly communicate with the Internet, they do so by using an IOT gateway. This entire infrastructure is known as IOT infrastructure. In which crop monitoring and controlling parameters like temperature, soil moisture, humidity, light intensity, etc., is automated inside the poly house. The actuated data from these sensors is pushed in to the cloud and displayed on the server database using windows application. The system is implemented using low power wireless components and easy to install.

3) Vishal Parkhe, Roshan Sable, Gaurav Kajale et.al., "Automation in Poly house using IOT based Technique". The poly-house can be in any shape it may be in tunnel and it is termed as poly tunnel. It may be also square, semi-circular, or elongated in shape. The poly house is covered with polyethylene sheets. These sheets are used to stabilize the ultra violet rays and helps in proper photosynthesis in crops. The manual process for poly house is that the sunrays falls on it will pre-heat the air inside it. The major parameters to be considered for the poly house are temperature, humidity, and the intensity of the light. The many poly houses will be failed to show the result due to the manual error such as not maintaining it properly. Three parameters are set only by the specification of the plant. Scientist proves that poly house techniques can held 4 to 10 times more yielding than normal method of farming techniques. Mostly the poly house is constructed in east to west direction to allow proper entry of sun light in poly house farming; we can protect our crops from any adverse environment such as high humidity or high temperature. There is a facility in poly house to control temperature or humidity.

4) Ramandeep Sandhu, Pichakuntla Sai Charn et.al., "Working model of IOT embedded smart poly house agriculture system". In the technological embedded world, IoT has taken a long gait towards making the society a smart society whether it is in terms of education, life style, health care or agriculture. Keeping into consideration various benefits of IoT, this research paper presents a working model of an IoT embedded smart poly house agriculture system. The system utilizes various sensors to collect environmental data, which is processed by a microcontroller and sent to the cloud for analysis. The proposed system is capable of controlling various actuators to maintain optimal growing conditions for crops, and alerts the farmer in case of critical environmental changes. Apart from this, it is a mobile connected agriculture system which connects mobile app with the farmer to remotely monitor and control the poly house environment, while data analytics provide insightsthat can help improve crop management. The proposed system has the potential to significantly increase crop yield and reduce water usage in agriculture, while also providing real-time monitoring and control for farmers.

5) Prof. Subhash G. Rathod, Krishna S. Gaikwad, GajananV.Vairagkar et.al., "Smart poly-house system". In India maximum population occupation is farming. They are doing farming by using traditional methods. They are using permutation combinations for crop growth. Feeding Water, Biopesticides, and fertilizer based on logical decisions. Sometimes that decision goes wrong and results in a loss in crop production. This is a major problem in India. In developed countries, farming is done by using so many advanced technologies. On the other side in our country lack of resources, unplanned management, less budget, and traditional methods are very crucial problems. Farmers are taking care of crops by surveying in farm and analyzing those problems, regarding that problem which is time-consuming and sometimes the disease is not correctly identified and providing suitable solutions as per their knowledge. We are going to cut this methodology which has been followed by farmer for so many years. We proposed a system based on a technical platform. This system will provide automatic soil moisture/ water level, and disease/ infection detected based on type of crop. Send notification to farmer i.e. Soil water level, temperature, Humidity, light. Also Control the water level, temperature, humidity, and light. We also provide a database that contains a better schedule for each type of crop. The farmer will not need to go for a survey on the farm to analyze the problem. The farmer will get an automatic alert if any changes are occurred. It will provide location-wise requirements so that it will provide accuracy. It helps with the proper use of water, fertilizer, and Biopesticides. It will provide a schedule for different crop which helps for improving crop production.

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6) Prof. Piyush Kulkarni, Prof. Pravin Pachorkar, Prof. Vipin Wani et.al., "Smart Poly house Controlling Using AI". The Internet of Things (IOT's) can be termed as connecting ordinary objects like a smart phones, Internet TVs, sensors and actuators to the internet in which the gadgets are intelligently connected enabling new types of communications among things. This is a low cost and flexible tracking controlling system which uses ATMEGA 328 microcontroller. Greenhouse Automation System is the practical method where the farmers from the rural regions might be benefitted through a means of automatic tracking and control of greenhouse/poly house environment. It alternates the direct supervision of the human. In this paper the exceptional papers had been reviewed and the proposed gadget based on the problem in the gift monitoring system. All the system operation will be monitored and controlled using Android Mobile App. Sensors such as soil moisture sensor, humidity sensor, mild sensor and temperature sensor might be used to display the performance of the field. Depending upon the output of sensors, controller will control the load on the output side.

7) Prof. R.S. Lavhe , Purabh R Ovhal et.al., "Review on Smart IoT Based Poly house Management System Controlled and Visualized via Android Application". The review paper titled "Smart IoT based Poly house Management System Controlled and Visualized via Android Application explores the utilization of Realtime Firebase Database. In the context of intelligent iot-based poly house management systems poly houses 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 poly house 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 can 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 poly house management. This review serves as a valuable resource for researchers and practitioners seeking to enhance efficiency and productivity in agricultural practices.

8) Ajitha, Shivani Sarika et.al., "Smart Poly house using Internet of Things". Currently, Internet of Things technology (IoT) is playing a crucial role in system automation and reducing human effort and intervention in maintaining them. IoT finds applications numerously in different fields like health, smart cities, agriculture, etc, In this paper, IoT-based smart poly house is proposed and a prototype is designed as a proof of concept (PoC). The system monitors the inside poly house conditions for effective plant growth using various sensors and controls the operations of watering, lighting, and temperature maintaining systems. Also, farmer is informed about the operating conditions in the poly house through a message.

9) Li Fu-Juan, Li Shi-hua et.al., "Design and Research of Intelligent Greenhouse Monitoring System Based on Internet of Things". Since the greenhouse has characteristics of temperature humidity uneven distribution, strong coupling, and traditional control strategy can't achieve the ideal control effect, the greenhouse monitoring system based on the internet of Things (IoT) is designed. The system uses a fuzzy neural network which has good control effectiveness in complex and changeable greenhouse systems. Perception layer using ZigBee protocol for wireless communications, and greenhouse environment can be controlled by site control software/master node, which makes the system more effective and stronger. The master node uses a mobile communication network to send sensing layer data to the application layer and can send alarm SMS. This system has the characteristics of low cost, simple structure, flexible networking, and easy extension, which adapts to the requirements of complex greenhouse control.

10) Manying H., "Design of Intelligent Greenhouse Control System based on MCGS and PLC". In modern agriculture, intelligent greenhouse systems have become a critical component for optimizing crop growth and maximizing yield. By integrating information technology with the isolation and climate control capabilities of greenhouses, these systems not only enable the automation and intelligence of agricultural production, but also play a crucial role in regulating seasons, protecting crops from extreme weather events, and ensuring optimal growing conditions. In this paper, a comprehensive control system for an intelligent greenhouse was designed, with Mitsubishi PLC and MCGS as the core components, based on the specific growth requirements of plants. The system consists of two main parts: hardware and software. The researchers constructed an advanced control system using a range of sensors and control devices, utilizing a typical PID control algorithm to maintain ideal growing conditions for plants. This research highlights the importance of intelligent greenhouse systems in modern agriculture and presents a promising solution for optimizing

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crop growth and yield through advanced automation and control.

III. SYSTEM DESCRIPTION

3.1 Methodology

1. Define Objectives and Requirements: Clearly define the goals of your smart poly house system. Consider factors such as temperature control, humidity, soil moisture, light levels, and ventilation. Identify the types of plants you are cultivating, as different plants may have different environmental requirements.
2. Sensor Integration: Deploy a network of sensors to monitor environmental parameters. Common sensors include temperature sensors, humidity sensors, soil moisture sensors, light sensors, and CO_2 sensors. Choose sensors based on the specific needs of your plants and the conditions in your poly house.
3. Data Processing and Analysis: Develop algorithms to process and analyze the collected data. This may include setting thresholds for environmental parameters and generating alerts if conditions deviate from the desired range. Consider incorporating machine learning techniques for predictive analysis and to adapt the system to changing conditions.
4. Control Systems: Implement actuators to control environmental factors based on the analysed data. For example, use automated systems to adjust temperature, humidity, and irrigation. Integrate feedback loops to continuously optimize conditions for plant growth.
5. User Interface: Develop a user-friendly interface for monitoring and controlling the poly house environment. This could be a web-based dashboard or a mobile application. Include real-time data visualization, historical data analysis, and the ability to adjust settings remotely.
6. Power Management: Consider energy-efficient solutions for power management.
7. Testing and Optimization: Conduct thorough testing of the entire system under various conditions. Continuously optimize the system based on feedback and performance data.

3.2 Block Diagram

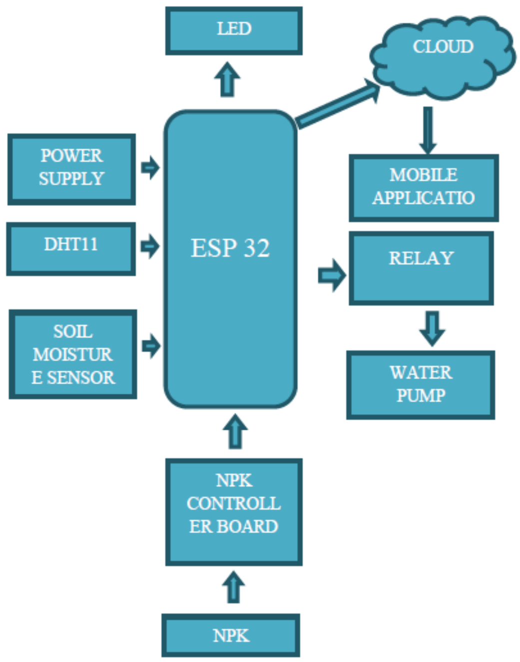

Figure 1: Block diagram

IV. PROJECT WORKING

4.1 Project Working

Smart Poly house Monitoring System Using ESP32, NPK Sensor, Temperature & Humidity Sensor, Blynk App, and Pump Control

4.1.1 Key Components

1. Microcontroller: ESP32, a powerful Wi-Fi and Bluetooth-enabled microcontroller with sufficient processing power and GPIO pins for sensor interfacing and actuator control.
2. NPK Sensor: Measures the levels of Nitrogen, Phosphorus, and Potassium in the soil, providing crucial information for optimal fertilizer application. Consider using high-quality sensors like the SENSOIL Aqua Check or EC25, or consider DIY options if suitable for your requirements.
3. Temperature & Humidity Sensor: Monitors the ambient environment within the poly house, essential for maintaining optimum plant growth conditions. Sensors like DHT22 or BME280 are cost-effective and reliable options.
4. Blynk App: Provides a user-friendly interface for real-time data visualization, control actions, and historical data analysis. Blynk has pre-built widgets for displaying sensor readings and controlling actuators, simplifying development.

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5. Pump: Delivers water or nutrient solution to the plants based on sensor readings and user-defined parameters. Choose a pump that aligns with your poly house size, irrigation method, and power source. Consider using solenoid valves or peristaltic pumps for precise control.

4.1.2 Hardware Connections

1. Sensor Connections: Connect the NPK sensor's I2C or SPI pins to the corresponding ESP32 pins as per the sensor's datasheet. Connect the temperature & humidity sensor's digital or analog pins to the ESP32 as per its datasheet.
2. Pump Connection: Connect the pump's control signal pin to an ESP32 digital output pin (PWM for variable flow or GPIO for on/off control). Use MOSFETs or driver circuitry if the pump's current/voltage requirements exceed the ESP32's capabilities.

4.1.3 Software Implementation

1. ESP32 Code: Write Arduino IDE-compatible code (C/C++) to: Initialize the ESP32, sensors, and Blynk library. Regularly read sensor values and send them to the Blynk app via Wi-Fi. Implement control logic based on sensor readings and user-defined thresholds. Send control signals to the pump as needed.
2. Blynk App: Create a Blynk project and add widgets: Gauges or graphs to display sensor data (NPK, temperature, humidity). Sliders or buttons to adjust control parameters (set points, watering duration). Virtual pins to link app controls to ESP32 inputs/outputs.

4.1.4 Calibration and Testing

1. Sensor Calibration: Follow the sensor datasheets for calibration procedures to ensure accurate measurements. Calibrate the NPK sensor with known nutrient solutions or soil samples. Calibrate the temperature and humidity sensor using reference instruments.
2. System Testing: Thoroughly test individual components (sensors, pump, code) before integration. Test the complete system in a controlled environment to verify data accuracy, control functionality, and safety.

4.1.5 Additional Considerations

1. Power Supply: Use a reliable power source (battery, solar, mains) that can adequately supply the ESP32, sensors, and pump.
2. Data Storage: Consider implementing Blynk's offline functionality or integrating logging features in the ESP32 code to store sensor data for later analysis.
3. Security: Implement proper authentication and encryption for the Blynk app connection to protect your data.
4. User Interface: Design the Blynk app interface to be intuitive and user-friendly for farmers or growers.
5. Scalability: If you have a large poly house or want to monitor multiple parameters, consider using multiple ESP32s for distributed sensing and control, or explore using industrial-grade controllers.

Remember: This is a general guideline. Adapt the project to your specific requirements, sensor choices, and environmental conditions. Be mindful of legal restrictions or regulations that may apply to sensor use, data collection, and agricultural practices in your region.

4.2 Flow Chart

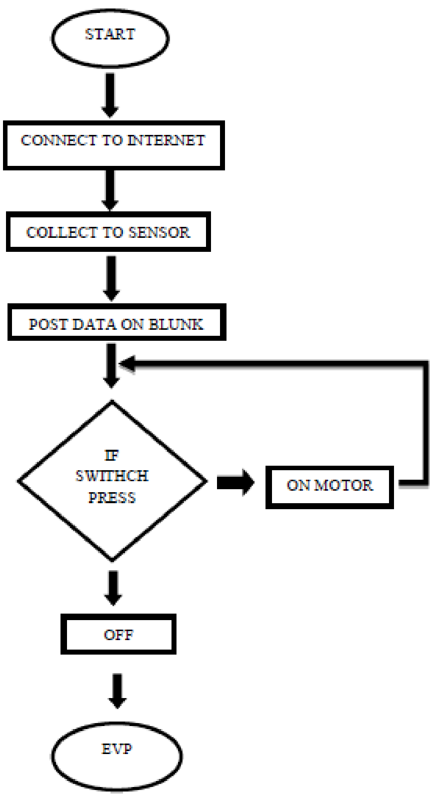

Figure 2: Flow chart

V. CONCLUSION

The employment of various poly house frameworks in modern agriculture represents an entirely novel approach to crop cultivation. These systems help to produce happier, more abundant crops by effectively managing environmental variables including heat, humidity, and moisture. Protection from insects, weather, and diseases results in more secure and predictable agricultural produce. The integration of current sensors with the ESP32 microcontroller enables precise

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monitoring and adjusting of crop development parameters. This level of automation provides for optimal circumstances within the poly house, resulting in increased crop yields and agricultural production overall. Poly house systems, in essence, provide a comprehensive and technologically advanced answer to conventional farming problems, paving the way to a more efficient and flexible agricultural future.

5.1 Future Scope

1. Integration of Artificial Intelligence (AI): Implementing AI algorithms can enhance the decision-making process within the poly house system. AI can analyze data from various sensors, predict optimal conditions for plant growth, and automate control systems to create an environment that maximizes productivity.
2. Advanced Sensors and IoT Integration: Future systems may incorporate more advanced sensors to monitor a wider range of environmental factors such as soil moisture, nutrient levels, and plant health. Integration with the Internet of Things (IoT) can enable real-time data collection and remote monitoring, allowing farmers to access information and control the poly house from anywhere.
3. Energy Efficiency and Sustainability: Continued focus on energy-efficient solutions will likely lead to the development of poly house monitoring systems that utilize renewable energy sources, such as solar power. Additionally, there may be advancements in sustainable practices, such as closed-loop nutrient systems and water recycling, reducing environmental impact.
4. Data Analytics for Predictive Insights: The accumulation of data over time can be leveraged for predictive analytics. By analyzing historical data, smart poly house systems could provide insights into trends, enabling farmers to anticipate issues and optimize cultivation practices for better yield and resource utilization.
5. Autonomous Systems: Automation may extend beyond simple control systems to more autonomous functionalities. This could include automated harvesting, robotic maintenance, and even autonomous decision-making based on real-time sensor data and AI analysis.
6. Crop-Specific Customization: Tailoring the poly house environment to the specific needs of different crops could become more sophisticated. Systems may be designed to adjust parameters such as temperature, humidity, and light intensity according to the requirements of specific plant varieties.
7. Blockchain for Traceability: Implementing blockchain technology can enhance traceability in the agricultural supply chain. Each stage of production and distribution can be recorded on a secure and transparent blockchain, providing consumers with information about the origin and quality of the produce.
8. User-Friendly Interfaces: The development of intuitive and user-friendly interfaces will be crucial for widespread adoption. Farmers should be able to easily interact with and understand the data provided by the monitoring system, facilitating better decision-making.

5.2 Application

1) Climate Control

Temperature Monitoring: Smart sensors can continuously monitor and regulate the temperature inside the poly house. This ensures optimal conditions for plant growth and prevents damage due to extreme temperatures. Humidity Control: Monitoring and controlling humidity levels are crucial for preventing diseases and ensuring optimal plant growth. Smart systems can automate the adjustment of humidity levels as needed.

2) Irrigation Management

Soil Moisture Monitoring: Sensors in the soil can provide real-time data on moisture levels. Automated irrigation systems can be triggered based on this data, ensuring that plants receive the right amount of water. Nutrient Management: Smart systems can monitor nutrient levels in the soil and automatically adjust fertilization schedules to meet the specific needs of the plants.

3) Lighting Optimization

Natural Light Integration: Sensors can measure natural light levels, and smart systems can adjust artificial lighting accordingly to supplement or replace natural light during cloudy days or nighttime. Energy-Efficient Lighting: Smart poly house systems can optimize the use of energy-efficient LED lights, adjusting intensity and duration to maximize plant growth while minimizing energy consumption.

4) Ventilation and Air Quality

CO_2 Monitoring: Monitoring carbon dioxide levels helps optimize photosynthesis. Smart systems can control ventilation to maintain optimal CO_2 levels for plant growth. Air Circulation: Automated fans and vents can be controlled to ensure proper air circulation, preventing the buildup of heat and humidity in specific areas of the poly house.

5) Security and Surveillance

Intrusion Detection: Smart cameras and sensors can detect unauthorized access or unusual activities within the poly house, enhancing security. Remote Monitoring: Farmers

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or greenhouse managers can remotely monitor the poly house conditions, and receive alerts on their smartphones or computers, enabling quick responses to any issues.

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