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Greenhouse Automation System using IoT

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Abstract: *Greenhouse automation is an innovative approach that integrates modern technology with agriculture to improve crop production and reduce manual effort. The primary aim of this project is to design and develop an automated greenhouse system capable of monitoring and controlling essential environmental parameters such as temperature, humidity, soil moisture, and light intensity. Maintaining these parameters within optimal ranges is crucial for healthy plant growth and higher yield.*

In this project, various sensors are used to continuously collect real-time data from the greenhouse environment. These sensors are connected to a microcontroller, which acts as the brain of the system. The microcontroller processes the data and automatically controls different devices such as fans, water pumps, heaters, and artificial lighting systems based on predefined conditions. For instance, if the temperature rises above a certain level, the system activates cooling mechanisms like fans, while low soil moisture levels trigger irrigation through water pumps.

The automation system reduces the dependency on manual monitoring and ensures precise control over environmental conditions. This leads to efficient utilization of resources such as water and electricity, minimizing wastage and operational costs. Additionally, the system helps in maintaining consistency in plant growth conditions, which ultimately enhances crop quality and productivity.

The proposed greenhouse automation system is cost-effective, reliable, and user-friendly, making it suitable for farmers as well as research applications. It can also be further enhanced by integrating Internet of Things (IoT) technology, allowing remote monitoring and control through smartphones or computers.

In conclusion, this project highlights the importance of automation in modern agriculture. By combining sensor technology, control systems, and smart decision-making, greenhouse automation offers a sustainable solution to meet the growing demand for food while conserving natural resources and improving overall efficiency..

Keywords: Greenhouse Automation, Environmental Monitoring, Microcontroller System,Sensors, IoT

I. INTRODUCTION

Greenhouse automation is an advanced approach in modern agriculture that uses technology to monitor and control environmental conditions such as temperature, humidity, soil moisture, and light. It helps overcome challenges like climate change, water scarcity, and increasing food demand. By using sensors, microcontrollers, and automated systems, greenhouses can maintain optimal conditions for plant growth with minimal human effort. This improves crop quality, increases productivity, and saves resources like water and energy. Although there are some challenges like initial cost and technical requirements, greenhouse automation provides a sustainable and efficient solution for the future of farming.

II. RELATED WORK

- IoT based greenhouse systems use sensors to monitor temperature, humidity, soil moisture, and light.
- Microcontrollers (Arduino/Raspberry Pi) process data and control devices like fans, pumps, and lights.
- Smart irrigation systems use soil moisture sensors to reduce water wastage.
- Wireless Sensor Networks (WSN) are used for monitoring large greenhouse areas.

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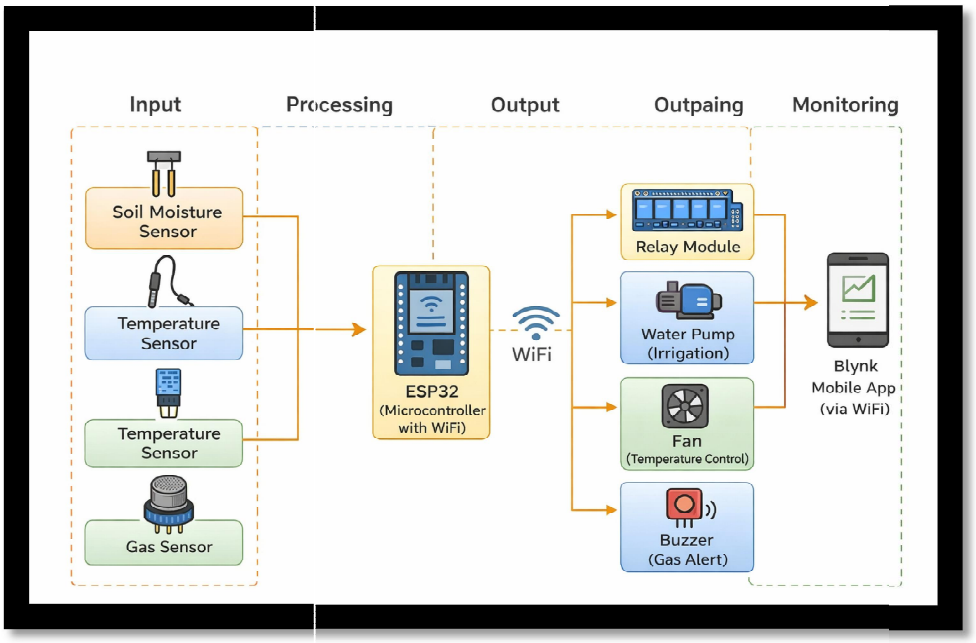
- Cloud platforms and mobile apps enable remote monitoring and control.
- AI and machine learning help in predicting environmental changes and improving crop yield.
- These systems reduce manual labor and improve efficiency, but challenges like cost and connectivity still exist.

III. METHODOLOGY

The methodology of the IoT-based greenhouse automation system involves collecting real-time environmental data using sensors such as temperature, humidity, soil moisture, and light sensors. These sensors are connected to a microcontroller, which processes the data and compares it with predefined threshold values. Based on this analysis, the system automatically controls actuators like fans, water pumps, and lights to maintain optimal conditions for plant growth. The data can also be sent to a cloud platform for remote monitoring and control through a mobile app or computer. This approach ensures efficient resource usage, reduced manual effort, and improved crop productivity.

IV. BLOCK DIAGRAM



V. HARDWARE COMPONENTS

Buzzer
Esp 32
DHT11
Smoke sensor
Soil moisture

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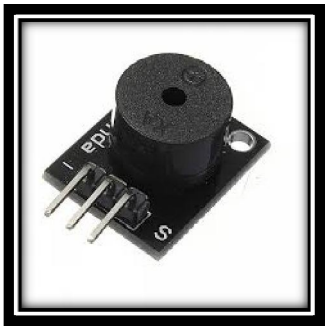
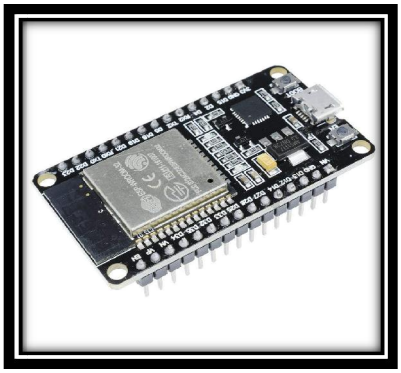


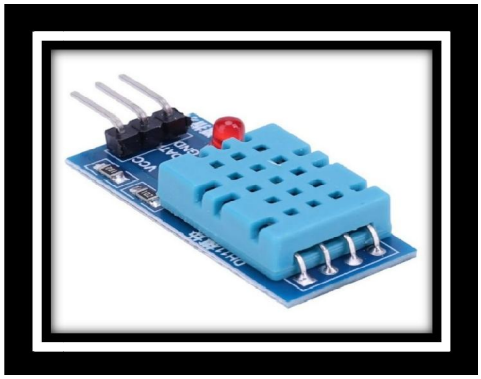
Fig.1 (Buzzer)

A buzzer is a simple electronic device that produces sound when an electrical signal is applied. It is mainly used as an alert or warning system in greenhouse automation. The buzzer gets activated when certain abnormal conditions occur, such as excessive temperature, smoke detection, or system faults. This immediate audio alert helps the user to quickly identify issues and take necessary actions. It plays an important role in enhancing the safety and reliability of the system by providing real-time notifications



Fig(ESP32)

The ESP32 is a powerful and widely used microcontroller in IoT applications, equipped with built-in Wi-Fi and Bluetooth connectivity. In a greenhouse automation system, it acts as the central control unit or "brain" of the project. It receives real-time data from various sensors such as temperature, humidity, and soil moisture sensors, processes this data, and makes decisions based on predefined conditions. It then sends signals to actuators like relays to control devices such as fans, pumps, and lights. Additionally, the ESP32 allows remote monitoring and control of the greenhouse through mobile apps or web platforms, making the system smart



Fig(DHT11)

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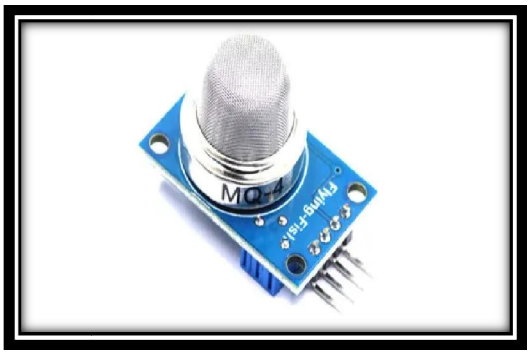
DHT11 sensor consists of a capacitive humidity sensing element and a thermistor for sensing temperature. The humidity sensing capacitor has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC measure, process this changed resistance values and change them into digital form.

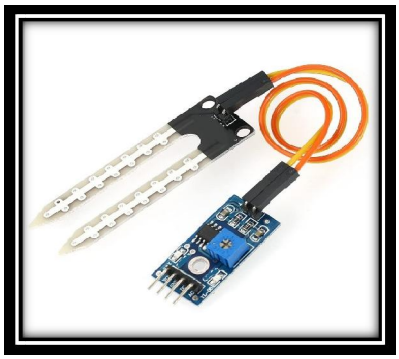
For measuring temperature this sensor uses a Negative Temperature coefficient thermistor, which causes a decrease in its resistance value with increase in temperature. To get larger resistance value even for the smallest change in temperature, this sensor is usually made up of semiconductor ceramics or polymers.

The temperature range of DHT11 is from 0 to 50 degree Celsius with a 2-degree accuracy. Humidity range of this sensor is from 20 to 80% with 5% accuracy. The sampling rate of this sensor is 1Hz .i.e. it gives one reading for every second. DHT11 is small in size with operating voltage from 3 to 5 volts. The maximum current used while measuring is 2.5mA.



Fig(smoke sensor)

Smoke detector is an important safety component used to detect the presence of smoke or harmful gases in the greenhouse environment. It helps in early detection of fire hazards, which can otherwise cause serious damage to crops and equipment. When smoke is detected, the sensor sends a signal to the microcontroller, which can activate a buzzer or trigger other safety mechanisms. This ensures quick response and prevents accidents, making the greenhouse system safer and more secure.



The soil moisture sensor is used to measure the water content present in the soil. It plays a key role in automated irrigation systems by providing real-time information about soil conditions. When the soil becomes dry and moisture levels fall below a certain threshold, the sensor sends a signal to the ESP32, which then activates the water pump through a relay module. This ensures that plants receive the right amount of water at the right time, preventing both overwatering and underwatering, and promoting healthy plant growth.

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VI. CONCLUSION

The IoT-based greenhouse automation system provides an efficient and modern solution to the challenges faced in traditional agriculture. By using sensors, microcontrollers like ESP32, and automated control systems, it ensures continuous monitoring and regulation of important environmental parameters such as temperature, humidity, soil moisture, and light. This automation reduces human effort, minimizes errors, and optimizes the use of resources like water and electricity. As a result, it improves crop quality, increases productivity, and supports sustainable farming practices. Although there are some challenges such as initial cost and technical complexity, the long-term benefits make this system highly valuable. Overall, greenhouse automation using IoT plays a significant role in advancing smart agriculture and meeting the growing food demands efficiently.

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