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# Automated Greenhouse using IoT sensors with Remote access to Sensors and Sensor Data

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**ABSTRACT:** Recently, there has been a growing concern about the future availability of organically grown nutritious produce due to global food shortages caused by climate change and water scarcity. This has resulted in the increased use of pesticides in cultivating fruits, vegetables, and other crops, leading to health risks and potentially more severe consequences. To address this issue, a solution is proposed in the form of an "Automated Greenhouse using IoT sensors with Remote access." This system utilizes IoT sensors and Microcontrollers to monitor and regulate essential parameters crucial for organic crop growth, such as Temperature, Humidity, Moisture level, Motion Sensor, and control of Water-Pump and electric Fan. The project utilizes Arduino Uno and ESP32 microcontrollers, with ESP32 enabling Wi-Fi connectivity for data upload to the cloud platform and Arduino Uno collecting sensor data and transmitting it to ESP32 for seamless real-time data transfer. The goal of this project is to enable remote control of sensors with real-time monitoring of their fluctuations.

**KEYWORDS:** Organic, Climate change, Artificial, Automated GreenHouse, IOT sensor, Microcontroller, Cloud, Temperature, Humidity, Moisture level, Motion Sensor, Arduino Uno, ESP32, Real-Time data

## I. INTRODUCTION

The Green House is an alternative to the traditional way of farming and cultivation that was introduced in the 1800s specifically to grow medicinal tropical plants, which was later accepted by people to grow other vegetables and other human consumption food. Green House is a closed House which has its own environment inside it that fosters the growth of plants and different crops. Traditional way of GreenHouse usage involves working in a certain environmental condition which restricts its usage to some specific crops or plants and this drawback of greenhouse hold back its integrity to make it as an effective alternative for traditional farming practices to overcome this the environment of greenhouse needs to be monitored continuously and controlled efficiently which involves maintaining the temperature, humidity, soil moisture level and also controlling the water supply to avoid over watering to the crops.

To control all the environmental parameters of the greenhouse in order to make it more functional and alternative to traditional farming techniques integration of Internet Of Things will help achieve Automation of Green House parameters allowing us to control and manage the parameters effectively to make effective use of GreenHouse. This engineering implementation allows Automate the Green House to make Green House useful for several other crop or vegetable cultivation by automating the temperature, humidity, soil moisture and other parameters overcoming the drawback of specific crop or vegetable cultivating traditional GreenHouse. The Automated GreenHouse using IOT sensor and sensor data also facilitate the remote control over the parameters of Green House by which one can manage and control the GreenHouse at distance with ease and real-time monitoring.

The objective of this project is to allow every other person to grow and nurture their daily needs fruits and vegetables at their own premises with just a minimal installation charge and with more efficient control over their cultivation allowing them to consume pesticide free and quality food. This project mainly aims to build a system that allows every individual to have remote access and control over the data and sensors to maintain the environment as per the crop cultivated.

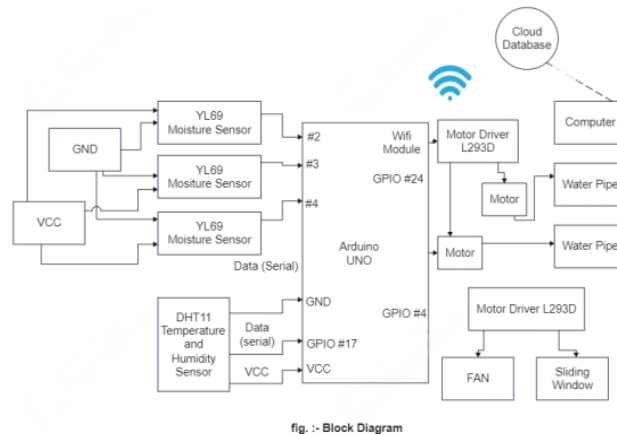


Fig-1: - Block Diagram

## II. LITERATURE SURVEY

The existing research on automated greenhouse systems using IoT sensors provides valuable insights into how technology can enhance greenhouse management. Here's a summary of the key findings from the studies you mentioned:

### 1. Automated Greenhouse Design and Monitoring

- Shukla et al. (2015)** focused on IoT-based intelligent greenhouse systems that automate environmental controls. They used sensors to monitor critical factors like temperature, humidity, and light, which helped improve decision-making through real-time data. However, they noted challenges such as dependency on network connectivity and potential delays in cloud data transmission that could affect the system's performance.
- Ardiansah et al. (2020)** reviewed Arduino-based IoT systems in greenhouses, emphasizing the role of precision farming. Their findings indicated that integrating sensors for monitoring temperature, soil moisture, and light can significantly enhance operational efficiency. Still, they pointed out limitations related to real-time data synchronization with cloud systems, which could hinder scalability and remote control capabilities.

### 2. IoT and Sensor Integration for Greenhouse Automation

- Kulkarni et al. (2020)** designed an IoT-based greenhouse system that allows continuous monitoring of environmental factors. Their research showed that real-time sensor data can lead to better control of greenhouse conditions. However, they also identified challenges such as internet connectivity issues and the power demands of IoT devices that need to be addressed for improved functionality.
- Agnal et al. (2018)** implemented an automated smart greenhouse system that uses IoT technology for precise management of humidity and temperature. They concluded that while IoT significantly enhances agricultural management, concerns regarding real-time data transmission and scalability remain, especially for larger greenhouse operations.

### 3. Cloud and IoT Integration

- Raj and Ananthi (2019)** demonstrated how integrating IoT sensors with cloud technology, specifically using Google Cloud IoT Core, facilitates real-time data gathering and remote monitoring of greenhouse conditions. While this integration improved scalability, it also brought up challenges related to data transmission and system reliability.



- b. **Hoque et al. (2020)** introduced a greenhouse automation system powered by solar energy, showcasing the benefits of using IoT for environmental monitoring, especially in remote areas. Their study highlighted how solar power can make these systems more sustainable and accessible.

Overall, these studies highlight the potential of IoT and cloud technologies in revolutionizing greenhouse management while also addressing the challenges that need to be overcome for widespread adoption.

| Sr. No. | Published Year & Authors  | Research Paper Name  | Inference  |
|---------|---|--|--|
| 1       | December 2017 Muhammad Faizan Siddiqui, Asim ur Rehman Khan, et al. | Automation and Monitoring of Greenhouse                        | This paper focuses on addressing food shortages through automated greenhouse systems that regulate temperature, moisture, and light to enhance plant growth. The system, powered by Arduino, allows for remote management via web or Android apps, improving yields for crops like tomatoes.               |
| 2       | June 2018 M. Danita, Blessy Mathew, et al.                          | IoT Based Automated Greenhouse Monitoring System               | The paper outlines an IoT-enabled greenhouse system using Raspberry Pi and YL69 and DHT11 sensors to control key conditions such as moisture, temperature, and humidity. Data is uploaded to the cloud (ThingSpeak) for remote monitoring through a web interface.   |
| 3       | July 2020 K. Latha, SK. Shaira Bhanu, et al.                        | IoT Based Automated Greenhouse Monitoring & Controlling System | This work describes IoT-based systems for automating greenhouses, managing factors like temperature, humidity, and soil moisture with devices like Arduino and Raspberry Pi. The system supports automatic control of irrigation and ventilation, enhancing productivity with real-time remote monitoring. |
| 4       | May 2022 Fedro S. Zazueta and Jiannong Xin                          | Automation of Greenhouse Using IoT                             | The research presents an IoT system leveraging ESP32 microcontrollers and sensors (temperature, humidity, soil moisture, light, CO2) for automatic greenhouse management, promoting crop growth with remote monitoring capabilities via cloud services.  |
| 5       | May 2020 Pranjali D. Shiyale, Hemangi Thombre, et al.               | IoT-Based Smart Greenhouse Automation                          | The paper details a smart greenhouse system that automates environmental monitoring, such as temperature, soil moisture, and light, with sensors sending data through a GSM module to a mobile app, reducing labor and improving agricultural efficiency.  |

|   |                                     |   |  |
|---|-------------------------------------|---|--|
| 6 | August 2017 Tanu Saha, Ashok Verma  | Automated Smart Irrigation System Using Raspberry Pi                            | This paper discusses a sensor-based greenhouse monitoring system that tracks environmental parameters like temperature, humidity, light, and soil moisture. Data is processed by a microcontroller, connected to the internet via a Wi-Fi module for real-time management. |
| 7 | 2015 P.S. Asolkar, Dr. U.S. Bhadade | An Effective Method of Controlling the Greenhouse and Crop Monitoring Using GSM | The study focuses on measuring soil moisture by analyzing its dielectric constant using capacitance sensors. It highlights the direct relationship between soil moisture and the dielectric constant, particularly useful in sandy soils for effective greenhouse control. |

### III. EASE OF USE

The system you've described appears to be a comprehensive solution for greenhouse management, integrating various features that enhance usability and efficiency. Here's a breakdown of the key components:

1. The user-friendly interface is crucial for ensuring that anyone, regardless of their technical skill, can easily monitor and adjust greenhouse conditions. Clear visualizations of critical data like temperature, humidity, and soil moisture help users make informed decisions effortlessly.
2. Remote monitoring and control stand out as significant advantages, allowing users to manage their greenhouses from anywhere. This is made possible through IoT sensors and cloud technology, which provide real-time data access. Users can adjust irrigation schedules or monitor environmental conditions without being on-site, which is especially beneficial for busy or traveling individuals.
3. Automated alerts and notifications enhance the system's responsiveness. By notifying users of any environmental threshold breaches—like excessive temperature or moisture levels—through SMS, email, or mobile notifications, users can quickly take corrective actions. This proactive approach helps prevent potential crop damage.
4. The plug-and-play installation feature simplifies the setup process. With pre-configured sensors and microcontrollers, even those without technical expertise can install the system quickly. This accessibility encourages more people to adopt such technology in their greenhouse operations.
5. Lastly, the low maintenance requirements ensure that once the system is up and running, it requires minimal ongoing attention. Automated controls for irrigation and ventilation reduce the need for manual checks, while remote access allows for easy monitoring and adjustments, saving users time and effort.

Overall, this system seems to offer a robust solution for efficient greenhouse management, combining user-friendliness with advanced technology.

### IV. MODULE DESCRIPTION

Above Block Diagram (figure 1.1) comprises the Hardware required for installing the "Automated Greenhouse using IoT sensors with Remote access ". The hardware required for this project are :- a) Arduino uno, b) ESP32, c) Soil Moisture Sensor, d) DHT11 Sensor, e) PIR sensor, f) Water Pump, g) DC Fan

**A) Arduino Uno :-**

The primary element of our project is the Arduino Uno, which is a microcontroller board that is open-source and built on the Microchip ATmega328P microcontroller (MCU). This board features a variety of digital and analog input/output (I/O) pins, including 14 digital I/O pins and 6 analog I/O pins. It can be programmed using the Arduino IDE through a type B USB cable. The board can be powered either through a USB cable or a barrel connector that accepts voltages ranging from 7 to 20 volts. In this project, the Arduino Uno is specifically utilized to collect data from all the connected sensors and transmit that information via serial communication to the ESP32. It also oversees the operation of all the sensors and relay modules



Fig-2: - Arduino Uno

**B) ESP32 :-**

The second key component of this project is the ESP32, which is widely recognized as a chip microcontroller. It operates at either 160 or 240 MHz and can achieve performance levels of up to 600 DMIPS. The ESP32 is a versatile system-on-chip (SoC) that includes built-in Wi-Fi and Bluetooth capabilities, making it suitable for various IoT applications. Its ability to connect to Wi-Fi and transmit data to cloud platforms like Blynk or ThinkCloud enhances its usefulness for this project. In this setup, the ESP32 is used to connect to Wi-Fi, receive data from the Arduino Uno, and then relay that information to a cloud platform for real-time data monitoring.



Fig-3: - ESP32

**C) Soil Moisture Sensor :-**

The Soil Moisture Sensor is a low-cost device designed to measure the moisture level in the soil. It primarily relies on capacitance to assess the soil's water content (dielectric permittivity). To operate this sensor, it is inserted into the ground, and it provides information about the soil's water content as a percentage. It requires a voltage of 5V and operates with a current of less than 20mA.

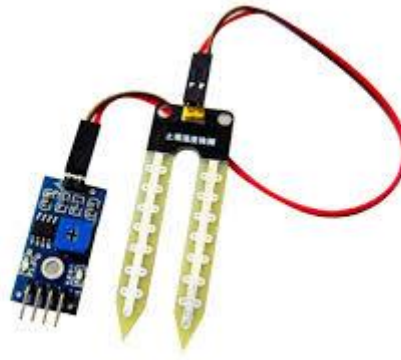


Fig-4: - Soil Moisture Sensor

#### D) DHT11 Sensor :-

The DHT11 sensor is a popular device used for measuring temperature and humidity. It transmits humidity and temperature data serially using a one-wire protocol. The DHT11 provides relative humidity readings in percentage (ranging from 20 to 90% RH) and temperature readings in degrees Celsius (from 0 to 50 °C). It operates with a power supply between 3 and 5.5V and comes in a 4-pin package arranged in a single row. The DHT11 employs its own one-wire protocol, which necessitates the implementation of specific firmware in the microcontroller to facilitate communication with the sensor.



Fig-5:- DHT11 Sensor

#### E) PIR sensor :-

A PIR (Passive Infrared) sensor is a device that detects motion by sensing infrared radiation from objects within its range. It identifies variations in infrared radiation, usually resulting from the movement of people or animals. Typically, a PIR sensor functions on a voltage between 5V and 12V and can detect motion from a distance of 6 to 10 meters, depending on the lens and the environment.

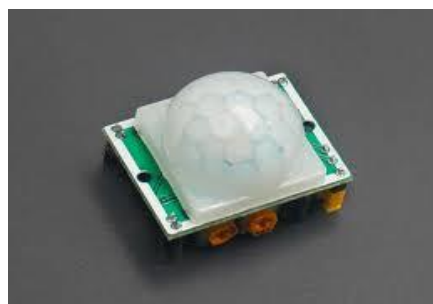


Fig-6: - PIR Sensor

**F) Water Pump :-**

A Water Pump is included in this project to create a Smart Irrigation system that can be managed remotely and is also driven by data from the moisture sensor, ensuring accurate and efficient water usage. The water pump can be powered either through direct electrical connections or solar energy for better energy efficiency. It requires a DC power supply of 12V to 24V. Soil moisture sensors continuously track the moisture content in the soil, and when the levels fall below a set threshold, the IoT system sends a signal to the relay to turn on the pump.



Fig-7 :- Water Pump

**G) DC Fan :-**

A DC fan plays a crucial role in regulating air circulation and maintaining optimal environmental conditions for plant growth. It is typically used for ventilation, cooling, and maintaining the humidity and CO<sub>2</sub> levels in the greenhouse. DC Fan operates on 12V-24V DC power supply. When sensors detect that the greenhouse is getting too warm, the IoT system automatically activates the DC fan to expel hot air and maintain optimal growing conditions. In conjunction with humidity sensors, the fan is triggered when humidity levels exceed the desired threshold, promoting airflow to reduce moisture and prevent disease.



Fig-8: - DC Fan

**V. METHODOLOGY**

The creation of the "Automated Greenhouse using IoT Sensors with Remote Access to Sensor Data" follows this organized method:

1. **System Design and Component Selection:** Define the system architecture and choose essential hardware components, including the Arduino Uno for managing sensors, the ESP32 for connecting to the cloud, and various sensors and actuators like the DHT11, Soil Moisture Sensor, Water Pump, and DC Fan. Position the sensors strategically to ensure precise data gathering.



2. **Hardware and Software Integration:** Connect the sensors to the Arduino Uno for gathering data, and link the actuators (water pump and fan) to relays for automated operation. Program both the Arduino and ESP32 for data transmission and control via a cloud platform, such as Blynk.
3. **Automation Logic and Control:** Establish automation rules, like activating the water pump according to soil moisture levels or turning on the fan for temperature control. Create an easy-to-use interface for real-time monitoring and remote management.
4. **Testing and Calibration:** Test system functionality, sensor accuracy, and actuator responsiveness. Calibrate sensors to ensure precise control.
5. **Remote Monitoring and Data Logging:** Enable cloud-based monitoring and remote control via mobile/web interfaces, and implement an alert system for critical environmental changes. Log data for trend analysis and system optimization.

## VI. REMOTE ACCESS AND MONITORING

Remote monitoring is a crucial feature of the "Automated Greenhouse using IoT Sensors", enabling users to oversee and manage the greenhouse environment from anywhere in real time. Using a microcontroller like ESP32, which connects to the internet via Wi-Fi, sensor data such as temperature, humidity, soil moisture, and other critical parameters are continuously uploaded to a cloud platform(e.g. Blynk). Through mobile or web applications, users can access this data remotely and receive alerts when conditions deviate from the optimal range. Additionally, the system allows for remote control of devices such as water pumps and fans, ensuring timely interventions to maintain ideal growing conditions. This capability not only reduces the need for constant manual labor but also provides flexibility, allowing quick responses to changes in the greenhouse environment, ultimately enhancing productivity and preventing crop failure.

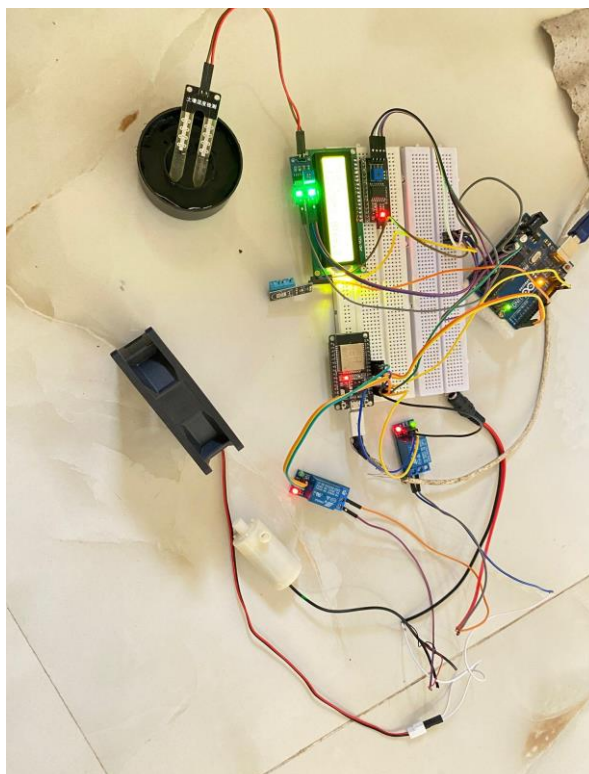


Fig-9:- Connections

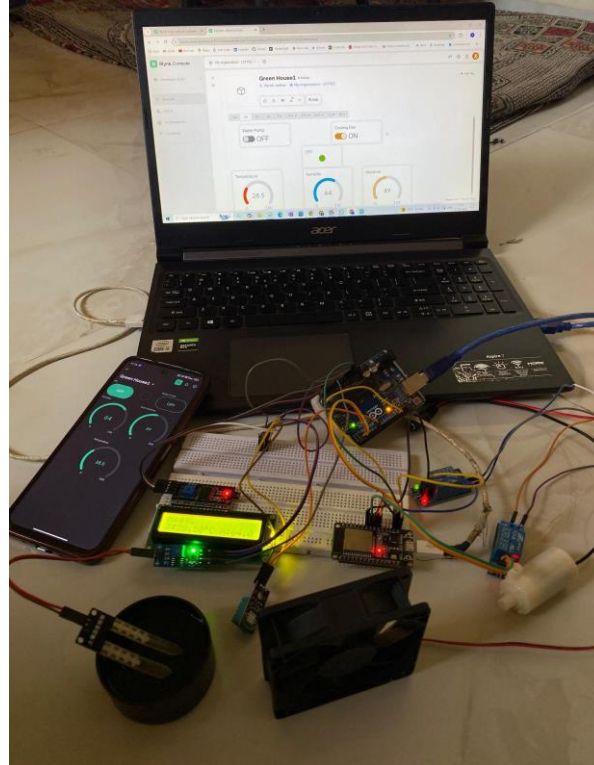


Fig-10: -Real Time update on APP and Website



Fig-11: -APP Interface

## VII. CONCLUSION

The "Automated Greenhouse using IoT Sensors with Remote Access to Sensor Data" presents a groundbreaking solution to issues related to climate change, water shortages, and the reliance on harmful pesticides in farming. By automating essential environmental factors like temperature, humidity, and soil moisture, the system allows for the growth of organic vegetables and crops with minimal human involvement. The use of IoT sensors and microcontrollers, such as the Arduino Uno and ESP32, facilitates real-time data collection and remote monitoring, enabling users to effectively oversee greenhouse operations from anywhere. This not only decreases the need for manual labor but also supports sustainable farming practices by optimizing resource usage and improving crop yields. Ultimately, the system offers a scalable and flexible approach to tackling global food security challenges through advanced agricultural technology.

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