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# IoT Based Greenhouse Monitoring System

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***ABSTRACT***

Greenhouses are controlled area environment to grow plants. As the limitation of existing greenhouse plants is that it is not operated automatically and has to be operated manually with different records. In order to achieve the optimum growth of plants, the continuous monitoring and controlling of environmental parameters such as temperature, humidity, soil moisture, light intensity etc. are necessary for our greenhouse system.

This paper demonstrates a checking and control system for nursery through Internet of Things (IOT). The system will screen the undeniable common conditions, for instance, moistness, soil immersion, temperature, closeness of fire, etc. All the environment parameters data are sent to cloud using WiFi module NodeMCU esp8266. If any condition crosses certain limits related actuator will be turned ON.

The microcontroller will as such turn on the motor if the earth stickiness isn't generally a particular worth. The user can screen and control parameters through mobile and computer. The model was attempted under various blends of obligations to our examination office and the test outcomes were found as expected.

**Keywords:**

1.Arduino IDE program software. 2.Development board Arduino uno 3.Communication devices.

4. Sensors.
5. Watering devices.

## I. INTRODUCTION

An IoT-based greenhouse monitoring system is an advanced technological solution designed to automate and optimize the greenhouse environment by utilizing the Internet of Things (IoT). This system integrates microcontrollers, sensors, actuators, wireless communication, and cloud platforms to monitor and control essential environmental parameters such as temperature, humidity, soil moisture, pH

levels, and light intensity. Sensors like DHT11 measure temperature and humidity, soil moisture sensors track water levels in the soil, soil pH sensors ensure proper soil conditions, and LDR modules detect light intensity to regulate artificial lighting. These sensors send real-time data to microcontrollers such as ESP8266 NodeMCU, which process the information and trigger actuators like water pumps, exhaust fans, heaters, and artificial lights based on predefined thresholds. The system uses Wi-Fi connectivity through ESP8266 or a 4G GSM module to transmit data to cloud-based platforms like Thing Speak, allowing farmers to remotely monitor and control greenhouse conditions through a smartphone or computer. Additionally, a 4-channel relay module automates various electrical devices, a DC submersible water pump provides irrigation, and a DC exhaust fan maintains air circulation. A piezoelectric buzzer alerts users about critical environmental conditions, while a 16x2 LCD display provides on-site real- time data visualization. The system operates on a stable power supply from adapters or batteries, ensuring continuous monitoring and automation. By implementing IoT technology, greenhouse farming becomes more efficient, cost- effective, and sustainable, reducing manual intervention, optimizing resource usage, and significantly improving crop yield and quality.

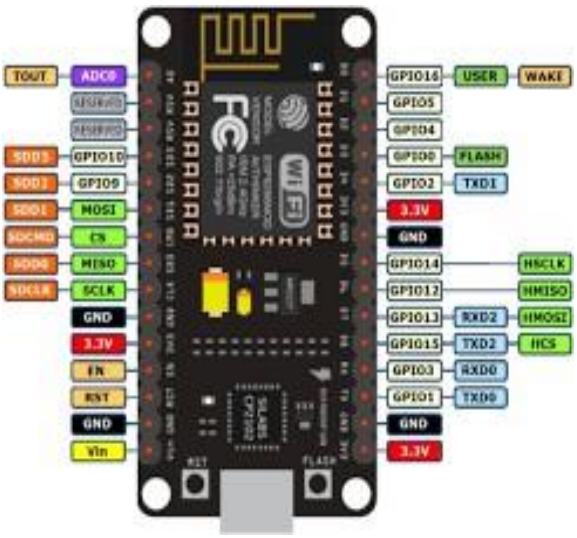
## COMPONENTS OF IOT BASED GREENHOUSE MONITORING SYSTEM

**1. Arduino IDE program software:** Arduino IDE is an open-source software platform used for programming Arduino microcontroller boards.

Arduino IDE is a user-friendly integrated development environment.

1. It simplifies programming for Arduino boards using C/C++.
2. It offers a code editor with syntax highlighting and auto completion.
3. Libraries and examples are included to facilitate code development.
4. A simple interface uploads code to the connected Arduino hardware.
5. It supports various Arduino board models and compatible hardware.
6. Serial monitoring tools assist in debugging and data exchange.
7. Arduino IDE is free and available for Windows, macOS, and Linux.

## 2. DEVELOPMENT BOARD ESP8266




**Connectivity:** The ESP8266 can connect to Wi-Fi networks and GSM, enabling the irrigation system to access the internet. This connectivity can be used for remote monitoring, control, and data exchange.

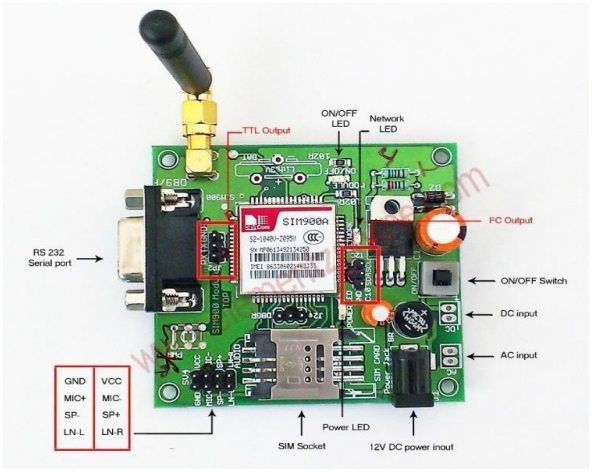
**Sensor Integration:** You can connect various sensors to the ESP8266, such as soil moisture sensors, DHT11, Soil pH sensor, or rain sensor. The ESP8266 can collect data from these sensors, providing real-time information about soil conditions and weather forecasts.

**Automation:** Using the data collected from sensors, the ESP8266 can implement automation rules to optimize irrigation. For example, it can trigger irrigation only when soil moisture levels drop below a certain threshold or when rain is not expected.

**Power efficiency:** Implement power- saving features to ensure the ESP8266 operates efficiently and conserves energy, especially if the system relies on battery power.

**Scalability:** The ESP8266 can be used in both small-scale and large-scale smart irrigation systems, making it versatile for various applications.

## 3. COMMUNICATION DEVICE




**Data Communication:** The Arduino uno connects to a GSM module, typically via UART communication. The GSM module has a SIM card for cellular data access.

**Internet Connectivity:** Once connected, the Arduino uno can access the internet through the GSM module. It can send and receive data from a central server or cloud platform for real-time monitoring and control.

**Remote Control:** Smart irrigation systems can be controlled remotely via SMS or through a web interface hosted by the Arduino uno. Users can change irrigation schedules, turn the system on or off, or receive system status updates.

**Data Logging:** The Arduino uno can log sensor data and upload it to a central server for historical analysis and decision- making. This data may include soil moisture levels, weather forecasts, and irrigation schedules.

**Notifications:** The system can send SMS or push notifications to users for alerts, such as low soil moisture systemmalfunctions.

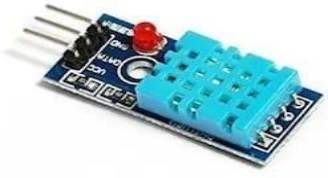
**Energy Efficiency:** To conserve power in remote areas, the Arduino uno and GSM module can be configured to enter sleep mode when not in use, reducing energy consumption.

**Scalability:** GSM connectivity makes water quality monitoring systems more versatile and suitable for remote locations where Wi-Fi or wired internet access is not available. We can control and monitor the water quality monitoring system using GSM from all over the India.

## 4. SENSORS

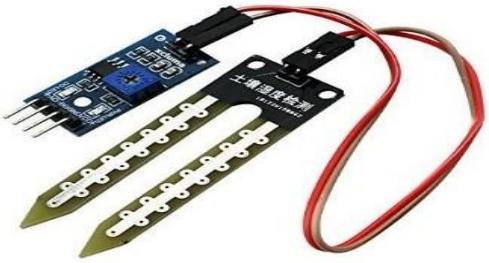
- **DHT11Sensor**

In an IoT-based greenhouse monitoring system, the DHT11 sensor is used to measure temperature and humidity inside the greenhouse. It provides digital output data, which the NodeMCU ESP8266 reads and processes. The sensor helps monitor climate conditions in real-time, ensuring optimal plant growth. The collected data can be sent to platforms like ThingSpeak and Blynk for remote monitoring and automation. Based on the readings, the system can trigger actions like turning on fans or water pumps to maintain ideal greenhouse conditions.



- **Soil moisture sensor**

In an IoT-based greenhouse monitoring system using ThingSpeak, a soil moisture sensor detects soil water levels and sends data to the ESP8266 NodeMCU. The NodeMCU uploads this data to ThingSpeak for remote monitoring. If moisture levels are low, the system can activate a water pump via a relay to maintain optimal soil conditions.



- **LDR Module**

In an IoT-based greenhouse monitoring system using ThingSpeak, the LDR sensor detects light intensity and sends data to the ESP8266 NodeMCU. The NodeMCU uploads this data to ThingSpeak for remote monitoring. Based on the light levels, the system can automate actions like controlling artificial lights or adjusting shading to optimize plant growth.

- **DC Water Pump**

A submersible DC water pump, controlled by an IoT-based greenhouse monitoring system, automates irrigation. When soil moisture sensors detect low levels, the system activates the pump, delivering water directly to plants. This ensures efficient watering based on real-time data, minimizing water waste and promotinghealthy growth.

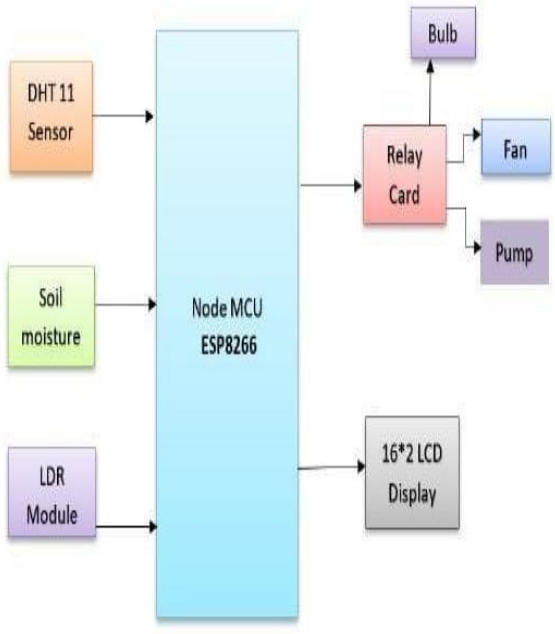
- **DC Exhaust Fan**

A DC exhaust fan, integrated with an IoT-based greenhouse monitoring system, automates ventilation. When sensors detect excess heat or humidity, the system activates the fan to regulate the environment, ensuring optimal conditions for plant growth.

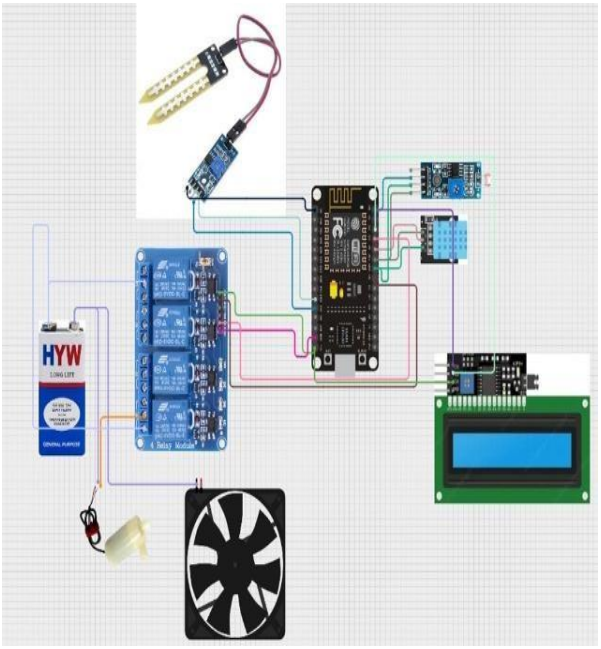
- **5V 4Channel Relay card**

In an IoT-based greenhouse monitoring system using ThingSpeak, the 5V 4- channel relay module controls devices like water pumps, fans, and lights based on sensor data. The ESP8266 NodeMCU receives real-time data from sensors and uploads it to ThingSpeak. When certain conditions are met, the system triggers the relays to automate greenhouse operations, ensuring optimal environmental conditions.

**BLOCK DIAGRAM:**



**Circuit diagram**




**Advantages**

1. **Real-Time Monitoring:** Provides continuous data on temperature, humidity, soil moisture, and light levels using sensors.

2. **Automated Control:** Enables automatic adjustments of ventilation, irrigation, and lighting systems based on sensor data.

3. **Remote Access:** Allows farmers to monitor and control the greenhouse environment using smartphones or computers via IoT platforms like Blynk or Thing Speak.

4. **Resource Optimization:** Reduces water and energy consumption by precisely controlling irrigation and lighting systems.

5. **Increased Crop Yield:** Maintains optimal environmental conditions for plant growth, improving productivity and quality.

6. **Predictive Maintenance:** Identifies equipment failures or sensor malfunctions early using predictive analytics.

**Conclusion**

The IoT-based greenhouse monitoring system enhances modern agriculture through automation, real-time monitoring, and efficient resource management. By integrating sensors, wireless communication, and cloud analytics, it optimizes environmental conditions, improving crop yield and sustainability while reducing manual labor and resource wastage.

Future advancements in AI, machine learning, 5G, and edge computing will further enhance automation, scalability, and cost-effectiveness. Despite challenges like high initial costs and rural connectivity issues, IoT-powered greenhouses will be vital for global food security and sustainable farming.

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