

# Greenhouse Monitoring and Controlling Using Iot and Machine Learning

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**Abstract-** This study presents an ESP8266-based greenhouse monitoring and controlling system that effectively regulates environmental parameters essential for plant growth. The system utilizes sensors such as the DHT11 for temperature and humidity, YL69 for soil moisture, and an LDR for light intensity. These sensors provide real-time data to the ESP8266 microcontroller, which not only processes the inputs but also enables wireless connectivity for remote monitoring and control. Through relay modules, the system controls devices such as water pumps, artificial lighting, and ventilation fans to maintain optimal growing conditions. A display panel can be included for on-site visualization, while data transmission via Wi-Fi facilitates integration with cloud platforms for data logging and analytics. This IoT-enabled approach supports automation, enhances sustainability, and minimizes manual intervention, making it a robust solution for modern greenhouse management.

**Index Terms-** IoT, Machine learning, Wireless communication, Prediction.

## I. INTRODUCTION

This project is an IoT-based greenhouse monitoring and controlling system using ESP8266. It uses four sensors to track light, temperature, humidity and soil moisture. A temperature sensor controls a fan to keep the temperature within the desired range. A light sensor adjusts a shade (using a DC motor) if the sunlight is too strong. The humidity sensor and soil moisture sensor control a blower and a water outlet to maintain the right levels of moisture and humidity. These actions are managed by a microcontroller, which sends signals to relays that control the devices, making the greenhouse more automated.



Fig. No. : 1 Block Diagram of The System

### ESP8266

Main microcontroller and Wi-Fi module. Reads data from sensors, processes it, controls the relays, and sends/receives data over Wi-Fi.

**Connectivity:** Interfaces with sensors (inputs), relays (outputs), and LCD display.

### DHT11

This sensor monitors environmental temperature and humidity levels. Help control the fan or take actions based on climate conditions.

### LDR Module

Light dependent resistor. Detect ambient light intensity. Usage: Automatically turns the lamp on or off based on light conditions.

### Soil Moisture Sensor

Measures soil moisture level. Usage: Controls the water pump for irrigation based on soil dryness.

### Relay 1 (Fan)

Controlled By: ESP8266. Turns the fan on/off depending on temperature and humidity readings.

### Relay 2 (Lamp)

Controlled By: ESP8266. Turns the lamp on/off based on light intensity from LDR.

### Relay 3 (Pump)

Controlled By: ESP8266. Turns the water pump on/off depending on the soil moisture sensor data.

**LCD 16x2**

Displays real-time sensor data and system status. Can show temperature, humidity, light level, soil moisture, and device states.

**Algorithm**

- Step 1: Start
- Step 2: Establish Connection
- Step 3: Check Connection Success If Yes, proceed to step 4 If No, establish a TCP connection. If successful, implement Layer attack measure and prevention.
- Step 4: Read Sensor Values.
- Step 5: Apply Fuzzy Logic Control System.
- Step 6: Upload Data to Server.
- Step 7: Environmental Control Logic: Temperature Control (T):If  $T > 30^{\circ}\text{C}$ , turn Fan ON and Heater OFF. If  $T < 20^{\circ}\text{C}$ , turn Fan OFF and Heater ON. Else, maintain current state. Humidity Control (H):If  $H < 65\%$ , turn Pump ON. If  $H > 70\%$ , turn Pump OFF. Soil Moisture Control (S):If  $S < 70\%$ , turn Pump ON. If  $S > 80\%$ , turn Pump OFF. Light Intensity (L):If  $L < 400$ , turn Lamp ON. If  $L > 700$ , turn Lamp OFF.
- Step 8: End.

**Flow chart**

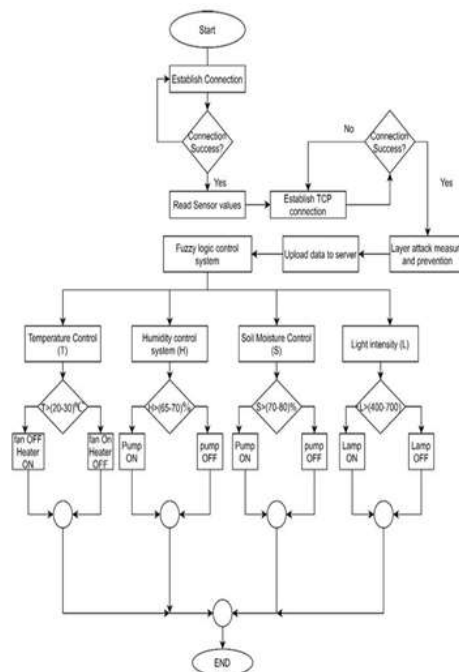


Fig. No. : 2 Flowchart of System

**Components**

**Wi-Fi (ESP8266) :**

The system uses the ESP8266 Wi-Fi SoC from Expressive Systems and the Node MCU, an open-source IoT framework, to generate firmware for ESP-12-compatible devices.

**Temperature and Humidity Sensors (DHT11):**

To measure temperature and the humidity, the project uses DHT11 sensors. These sensors, which offer digital output, are renowned for their affordability, stability, and dependability.

**Soil Moisture Sensor:**

Measures moisture level in the soil.

Controls the water pump for irrigation based on soil dryness.

**Coolers:**

To help maintain the ideal temperature and control circulation within the space, coolers are positioned along the greenhouse's side walls.

**Gas sensor:**

This sensor detects the presence of flammable gases such as LNG, LPG, propane, and iso-butane in gas leak detection systems. To ensure precise detection, it is made to ignore interference from cigarette smoke, cooking odors, and alcohol.

**Light Dependent Resistor (LDR):**

Light or dark sensor circuits benefit greatly from LDRs. Their resistance is quite high under normal circumstances, occasionally reaching 1,000,000 ohms. They work well for light sensitive applications, though, because their resistance drastically drops when exposed to light. IoT-Based

**Monitoring: Sensors:**

An explanation of the various sensors used to track variables like light intensity, temperature and the humidity, soil moisture sensors.

**Data Collection and Communication:**

The methods by which the sensors exchange data with a central controller (for example, via LoRa for long-range communication, Zigbee, or Wi-Fi).

**Data Storage:**

Sensor data can be stored for analysis in local databases or on cloud platforms. Control Based on Machine Learning.

**Data preprocessing:**

Methods for sanitizing and standardizing unprocessed sensor data. Modelling. An explanation of machine learning models used for parameter prediction and control, such as neural networks, decision trees, and regression.

**Control System:**

How the control system (such as actuators to modify the irrigation, humidity, temperature, etc.) is combined with machine learning models.

## II. RESULTS



Fig.No 3: Beginning of project



Fig.No 4: Output of LDR



Fig.No 5: Real time data



Fig.No 6: Output of soil moisture

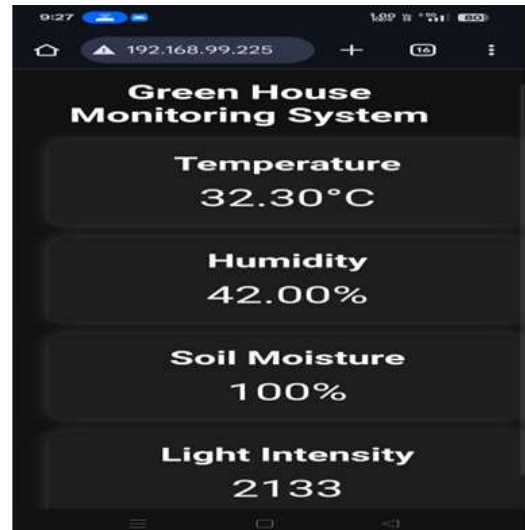


Fig.No 7: Webserver

### Pros :

#### Pros and Cons

### Cons :

#### Monitoring and Control in Real Time:

The Internet of Things makes it possible to gather data from environmental sensors in real time, such as CO<sub>2</sub> levels, light intensity, soil moisture, temperature and the humidity sensors. This makes it possible to monitor the greenhouse conditions continuously and make quick modifications, guaranteeing the best possible conditions for plant growth.

#### Efficiency & Automation:

The efficiency of greenhouse operations is increased by automating processes like lighting, ventilation, and irrigation based on real-time sensor data. This guarantees steady growing conditions and lessens the need for physical intervention.

#### Increased Crop Yields:

Predictive machine learning models combined with the capacity to modify environmental factors for ideal plant growth can greatly increase crop yields. ML algorithms can forecast and modify the environment by using growth trends, historical data, and meteorological conditions.

#### Predictive Analytics:

Machine learning algorithms can analyse recent data to predict optimal conditions and potential problems, enabling proactive interventions.

#### Improved Crop Yield and Quality:

Precise control over environmental factors leads to healthier plants and higher yields.

#### High Initial Investment:

Implementing an IoT and ML-based system can be expensive, requiring sensors, hardware, software, and expertise.

#### Data Security and Privacy:

The IoT network can be vulnerable to cyberattacks, posing a risk to data security and privacy.

#### Interoperability Issues:

Different IoT devices and platforms may not be good compatible, making it difficult to combine systems.

#### Data Overload:

The large amount of data generated by IoT sensors can be overwhelming, requiring efficient data processing and analysis techniques.

### III. CONCLUSION

The mixture of IoT and system studying within the greenhouse tracking and control represents a prime advancement in modern agriculture. those technologies permit non-stop monitoring of vital factors such light depth, soil moisture, temperature and the humidity, and CO<sub>2</sub> stages by means of accumulating real-time statistics from various environmental sensors. via leveraging machine getting to know algorithms to process this statistics, greenhouse structures could make more knowledgeable selections to optimize plant boom and improve useful resource performance.

#### Future Scope

##### Solar Power Integration:

To promote sustainability, the system can be powered using solar energy. This would reduce dependency on conventional electricity and make the setup eco-friendly and more suitable for remote locations.

##### Cloud-Based Analytics:

Data from multiple greenhouses can be stored in the cloud for large-scale analysis. This can assist in identifying trends and improving farming techniques through big data insights.

##### Support for Multiple Crop Types:

Future versions of the system can allow users to select different crop profiles, automatically adjusting parameters like light, temperature, and humidity based on each plant's specific needs.

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