**SMART GREENHOUSE CONTROL SYSTEM**

**USING IoT**

*Report submitted to SASTRA Deemed to be University as the requirement for the course*

# IIOT PROJECT

*Submitted by*

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# SYNOPSIS

A Smart Greenhouse Control System using IoT with humidity, temperature, soil moisture is a sophisticated solution for managing the various aspects of Greenhouse Systems. The system is built with the capability to monitor the environmental conditions of the Greenhouse and store the data collected in the cloud for analysis. The temperature and humidity sensors track the overall Environment conditions of the Greenhouse, while the soil moisture sensor senses the moisture content in soil. The data collected from the sensors is transmitted wirelessly to the cloud, where it can be accessed from anywhere using the internet. The cloud storage also eliminates the need for manual data entry and reduces the risk of errors. With access to real-time data, greenhouse managers can identify potential hazards quickly and take the necessary corrective action. The implementation of this system offers several benefits, including improved safety, less human interference, higher yielding rate and reduced operational costs. The real-time monitoring of the environmental conditions ensures that the vegetation stored in the greenhouse are kept in optimal conditions. The system also helps in identifying and preventing wastage of plants, which can reduce operational costs. In conclusion, the smart greenhouse control System using IoT is a promising technology for greenhouse management. This project demonstrates the feasibility and potential of this technology and paves the way for further research in this field.

**Specific contribution**

1. Testing the working of the model
2. Coding for the circuit to work
3. Documentation

**Specific learning**

From the project, some specific learning can be inferred. Firstly, the project highlights the importance of leveraging IoT technology in greenhouse management systems for improved efficiency, accuracy, and safety. The project demonstrates how sensors can be used to monitor environmental conditions and how the data collected can be stored in the cloud for easy access and analysis. Secondly, the project emphasizes the importance of real-time data in decision- making processes, highlighting the benefits of being able to identify potential hazards quickly

And take corrective action promptly. This real-time monitoring of the greenhouse environment can help in optimizing storage conditions, preventing plantation decay, and reducing operational costs. Thirdly, the project showcases the potential of cloud storage for data management, emphasizing the benefits of eliminating manual data entry and reducing the risk of errors. The cloud storage system used in the project provides a secure and accessible platform for data analysis, making it easier for greenhouse managers to identify trends and patterns and make informed decisions.

**Technical limitations and ethical challenges faced**

One of the technical limitations of the system is the reliability of the sensors used. The accuracy and precision of the sensors can be affected by several factors such as the type of sensor used, the calibration process, and the environmental conditions of the greenhouse. Therefore, it is essential to ensure that the sensors used in the system are reliable and that they are calibrated regularly to ensure accurate readings.

# ABBREVIATIONS AND NOTATIONS

|  |  |
| --- | --- |
| GSM | Global System for Mobile Communication |
| IOT | Internet of Things |
| HPS | High Pressure Sodium |
| PIC | Peripheral Interface Controller |
| LCD | Liquid Crystal Display |
|  |  |
|  |  |

# ABSTRACT

While India anticipates record food grain production, reaching a forecasted 3,235.54 Lakh tons in the 2022-2023 crop period, inefficiencies in greenhouse cultivation threaten this progress. To address these challenges, this project harnesses the power of IoT technology to transform greenhouse management in India, fostering a more sustainable and productive agricultural future.

A sensor network will continuously monitor key environmental parameters, feeding real-time data into a cloud-based analytics platform, empowering farmers to: Optimize resource allocation: Precision irrigation and climate control, guided by data-driven insights, will reduce water usage by 30% and energy consumption by 20%, optimizing fertilizer utilization. This aligns with India's efforts to conserve resources, as exemplified by the 30% increase in agricultural water productivity achieved between 2000 and 2017. Maximize crop yield and quality: Tailored growing conditions, informed by real-time data and predictive analytics, aim to boost yield by 15-20% and enhance product quality. This potential for increased productivity mirrors the growth of India's horticultural output, which rose from 157.5 million tons in 2004-05 to 331.05 million tons in 2020-21. Minimize environmental impact: Closed-loop irrigation and nutrient delivery systems will reduce fertilizer run-off and soil erosion, contributing to India's commitment to sustainable agriculture, as demonstrated by the 20% increase in organic farming area between 2015 and 2020.

Enhance resilience and food security: Predictive models based on historical data and weather patterns will anticipate and mitigate potential risks, ensuring consistent food production. This proactive approach echoes India's efforts to strengthen food security, as reflected in the establishment of a national food security act and a focus on increasing grain storage capacity. Automation will free up farmers' time for crucial tasks, promoting greater efficiency and resilience. By optimizing production, minimizing environmental impact, and empowering farmers, this IoT-driven revolution can contribute to India's agricultural transformation and a secure, sustainable food supply for generations to come.

# CHAPTER 1 SUMMARY OF THE BASE PAPER

SMART CONTROL SYSTEM FOR GREENHOUSE USING IOT

The article provides an overview of the development of an Internet of Things (IoT) enabled Smart Green House System for monitoring and controlling conditions in a greenhouse. It highlights the importance of greenhouse system to maintain flowers, vegetables, fruits and transplants out-of-season, prevent losses caused by factors such as excessive cold or heat, humidity, soil moisture.

The traditional(existing) system relies on outdated methods that are time-consuming and inefficient, leading to plant health issues, reduced yield and quality etc. The proposed system aims to address these issues by utilizing sensors and IoT technology to gather real-time data on soil moisture, temperature, humidity and other parameters in remote locations. The collected data is then transmitted to a cloud platform for analysis and monitoring.

The article cites various studies and literature that explore similar IoT-based systems for grain storage monitoring. These studies emphasize the significance of maintaining optimal temperature and humidity conditions to prevent grain spoilage and quality degradation. They also discuss the use of sensors, data analysis, and decision-making techniques to address abnormal situations and improve grain storage practices.

The proposed system incorporates multiple sensors to monitor parameters such as temperature, humidity, Soil Moisture. It offers real-time monitoring and control capabilities through a dashboard and Email, enabling automation such as activating fans, sending alerts to designated personnel.

The system aims to provide effective monitoring, control, and decision-making to optimize grain storage conditions and minimize losses.

Overall, the article highlights the importance of IoT-enabled systems in improving greenhouse practices, reducing waste, and enhancing yield. It emphasizes the need for advanced monitoring and control technologies to ensure the preservation of vegetation quality and prevent financial losses too.

# CHAPTER 2

**MERITS AND DEMERITS OF THE BASE PAPER**

**Merits:**

1. Increased Crop Yields and Quality: Real-time monitoring of factors like temperature, humidity, light, and soil moisture allows for precise control over the growing environment, optimizing conditions for specific crops and maximizing yields.
2. Improved Resource Efficiency: Smart irrigation systems based on soil moisture sensor data significantly reduce water waste. Precision fertilization based on nutrient level sensors minimizes fertilizer use, benefiting both the environment and the farmer's budget.
3. Reduced Labor Costs: Automation of tasks like irrigation, ventilation, and temperature control reduces the need for manual labor, saving time and money. Real-time data also helps farmers make informed decisions about pest control and disease prevention, further reducing the need for manual intervention.
4. Enhanced Data-Driven Decision Making: Historical data collected from sensors can be analyzed to identify patterns and optimize growing practices. This data can also be used to predict potential problems and take preventive measures.
5. Remote Monitoring and Control: Farmers can monitor and control their greenhouses remotely through mobile apps or web interfaces, eliminating the need to be physically present. This is particularly beneficial for large operations or for farmers located in remote areas.
6. Improved Sustainability: By reducing resource waste and energy consumption, smart greenhouses can contribute to a more sustainable agricultural industry.

Demerits:

1. High Initial Investment: Setting up a smart greenhouse with sensors, actuators, and data management systems requires a significant upfront investment. This can be a barrier for small-scale farmers or those with limited financial resources.
2. Technical Complexity: Operating and maintaining a smart greenhouse system requires some technical knowledge and skills. Farmers may need training in using the technology and troubleshooting potential issues.
3. Reliance on Technology: Smart greenhouses are vulnerable to power outages and technical glitches. System failures can disrupt operations and potentially harm crops if not addressed promptly.
4. Cybersecurity Concerns: As with any connected system, smart greenhouses are susceptible to cyberattacks. Data breaches could compromise valuable information or even disrupt operations.
5. Limited Accessibility: The technology and expertise required for smart greenhouses may not be readily available in all regions, particularly in developing countries. This can exacerbate existing inequalities in the agricultural sector.

# CHAPTER 3

**SOURCE CODE**

#include <DHT.h>

#include <WiFi.h>

#include <ESP\_Mail\_Client.h>

#include <ThingSpeak.h>

#define relayPin 5  //  Define Pin of the Relay

// Replace with your network credentials

const char \*ssid = "Subdid";

const char \*password = "qwertyuiop";

WiFiClient client;

// The smtp host name e.g. smtp.gmail.com for GMail or smtp.office365.com for Outlook or smtp.mail.yahoo.com

#define SMTP\_HOST "smtp.gmail.com"

#define SMTP\_PORT 465

/\* The sign in credentials \*/

#define AUTHOR\_EMAIL "ssanjay3184@gmail.com"

#define AUTHOR\_PASSWORD "gdmn tsne hywi zvul"

/\* Recipient's email\*/

#define RECIPIENT\_EMAIL "1nonly.user@gmail.com"

/\* Declare the global used SMTPSession object for SMTP transport \*/

SMTPSession smtp;

// Replace with your ThingSpeak Channel ID and API Key

const unsigned long channelId = 2413057;

const char \*apiKey = "GGIGV7QAS39Z7GSY";

// DHT sensor setup

#define DHTPIN 15   // Digital pin connected to the DHT sensor

#define DHTTYPE DHT11   // DHT 11

DHT dht(DHTPIN, DHTTYPE);

int soilMoisturePercentage,sensor\_analog;

const int soilmoisture\_pin = 34;  /\* Soil moisture sensor O/P pin \*/

void setup(){

  pinMode(relayPin,OUTPUT);         // Setting the Pin to output signal

  // Start serial communication

  Serial.begin(115200);

  // Connect to Wi-Fi

  WiFi.begin(ssid, password);

  while (WiFi.status() != WL\_CONNECTED) {

    delay(1000);

    Serial.println("Connecting to WiFi...");

  }

  Serial.println("Connected to WiFi");

  // Initialize DHT sensor

  dht.begin();

  /\*  Set the network reconnection option \*/

  MailClient.networkReconnect(true);

  /\*\* Enable the debug via Serial port

   \* 0 for no debugging

   \* 1 for basic level debugging

   \*

   \* Debug port can be changed via ESP\_MAIL\_DEFAULT\_DEBUG\_PORT in ESP\_Mail\_FS.h

   \*/

  smtp.debug(1);

  // Initialize ThingSpeak

  ThingSpeak.begin(client);

}

/\* Callback function to get the Email sending status \*/

void smtpCallback(SMTP\_Status status){

  /\* Print the current status \*/

  Serial.println(status.info());

  /\* Print the sending result \*/

  if (status.success()){

    for (size\_t i = 0; i < smtp.sendingResult.size(); i++)

    {

      /\* Get the result item \*/

      SMTP\_Result result = smtp.sendingResult.getItem(i);

      ESP\_MAIL\_PRINTF("Status: %s\n", result.completed ? "success" : "failed");

      ESP\_MAIL\_PRINTF("Date/Time: %s\n", MailClient.Time.getDateTimeString(result.timestamp, "%B %d, %Y %H:%M:%S").c\_str());

      ESP\_MAIL\_PRINTF("Recipient: %s\n", result.recipients.c\_str());

      ESP\_MAIL\_PRINTF("Subject: %s\n", result.subject.c\_str());

    }

    Serial.println("----------------\n");

    // To clear sending result as the memory usage will grow up.

    smtp.sendingResult.clear();

  }

}

void loop(){

  // Read temperature and humidity from DHT sensor

  float temperature = dht.readTemperature();

  float humidity = dht.readHumidity();

  sensor\_analog = analogRead(soilmoisture\_pin);

  soilMoisturePercentage = ( 100 - ( (sensor\_analog/4095.00) \* 100 ) );

  // Check if DHT had any reads failed and exit early

  if (isnan(temperature) || isnan(humidity)) {

    Serial.println("Failed to read from DHT sensor!");

    return;

  }

  if (temperature>=27) {

    // Writing value "HIGH" to the pin

    digitalWrite(relayPin,LOW);

  }

  else{

    digitalWrite(relayPin,HIGH);

  }

  // Print sensor values to Serial Monitor

  Serial.print("Temperature: ");

  Serial.print(temperature);

  Serial.print("°C, Humidity: ");

  Serial.print(humidity);

  Serial.print("%, soil Moisture: ");

  Serial.print(soilMoisturePercentage);

  Serial.println("%");

  Serial.println("");

  if (soilMoisturePercentage<55){

    Serial.println("low soilmoisture");

    /\* Declare the message class \*/

    SMTP\_Message message;

    /\* Set the message headers \*/

    message.sender.name = F("ESP");

    message.sender.email = AUTHOR\_EMAIL;

    message.subject = F("Smart greenhouse management");

    message.addRecipient(F("Customer"), RECIPIENT\_EMAIL);

    //Send raw text message

    String textMsg = "Time to water the plants !!!";

    message.text.content = textMsg.c\_str();

    message.text.charSet = "us-ascii";

    message.text.transfer\_encoding = Content\_Transfer\_Encoding::enc\_7bit;

    message.priority = esp\_mail\_smtp\_priority::esp\_mail\_smtp\_priority\_low;

    message.response.notify = esp\_mail\_smtp\_notify\_success | esp\_mail\_smtp\_notify\_failure | esp\_mail\_smtp\_notify\_delay;

    /\* Declare the Session\_Config for user defined session credentials \*/

    Session\_Config config;

    /\* Set the session config \*/

    config.server.host\_name = SMTP\_HOST;

    config.server.port = SMTP\_PORT;

    config.login.email = AUTHOR\_EMAIL;

    config.login.password = AUTHOR\_PASSWORD;

    config.login.user\_domain = "";

    config.time.ntp\_server = F("pool.ntp.org,time.nist.gov");

    config.time.gmt\_offset = 3;

    config.time.day\_light\_offset = 0;

    /\* Connect to the server \*/

    if (!smtp.connect(&config)){

      ESP\_MAIL\_PRINTF("Connection error, Status Code: %d, Error Code: %d, Reason: %s", smtp.statusCode(), smtp.errorCode(), smtp.errorReason().c\_str());

      return;

    }

    if (!smtp.isLoggedIn()){

      Serial.println("\nNot yet logged in.");

    }

    else{

      if (smtp.isAuthenticated())

        Serial.println("\nSuccessfully logged in.");

      else

        Serial.println("\nConnected with no Auth.");

    }

    /\* Start sending Email and close the session \*/

    if (!MailClient.sendMail(&smtp, &message)){

      ESP\_MAIL\_PRINTF("Error, Status Code: %d, Error Code: %d, Reason: %s", smtp.statusCode(), smtp.errorCode(), smtp.errorReason().c\_str());

    }

  }

  // set the fields with the values

  ThingSpeak.setField(1, temperature);

  ThingSpeak.setField(2, humidity);

  ThingSpeak.setField(3, soilMoisturePercentage);

  // Update ThingSpeak channel with sensors data

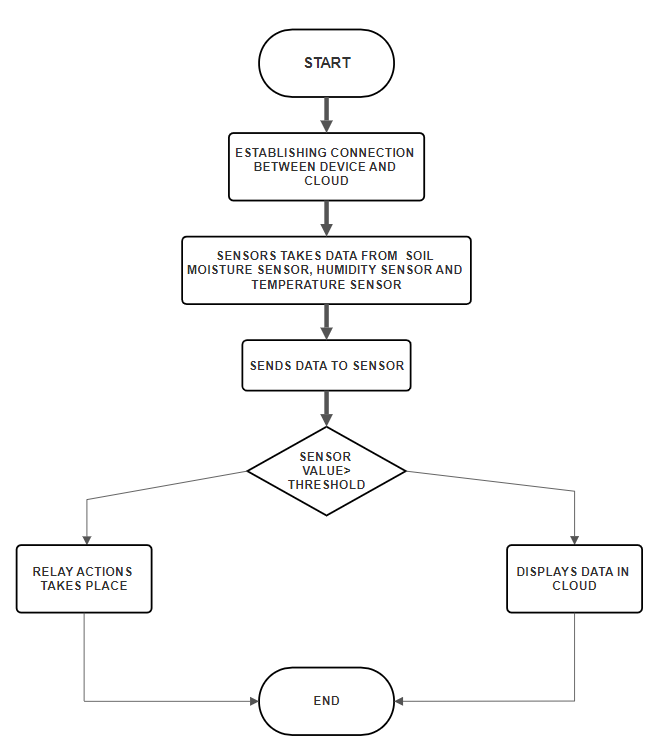
  ThingSpeak.writeFields(channelId, apiKey);

  // Wait for 10 seconds before updating again

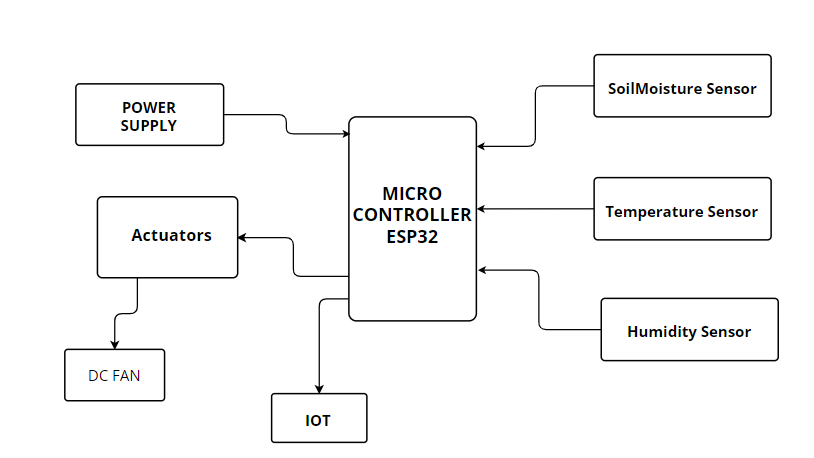
  delay(10000);

}

# CHAPTER 4 METHODOLOGY

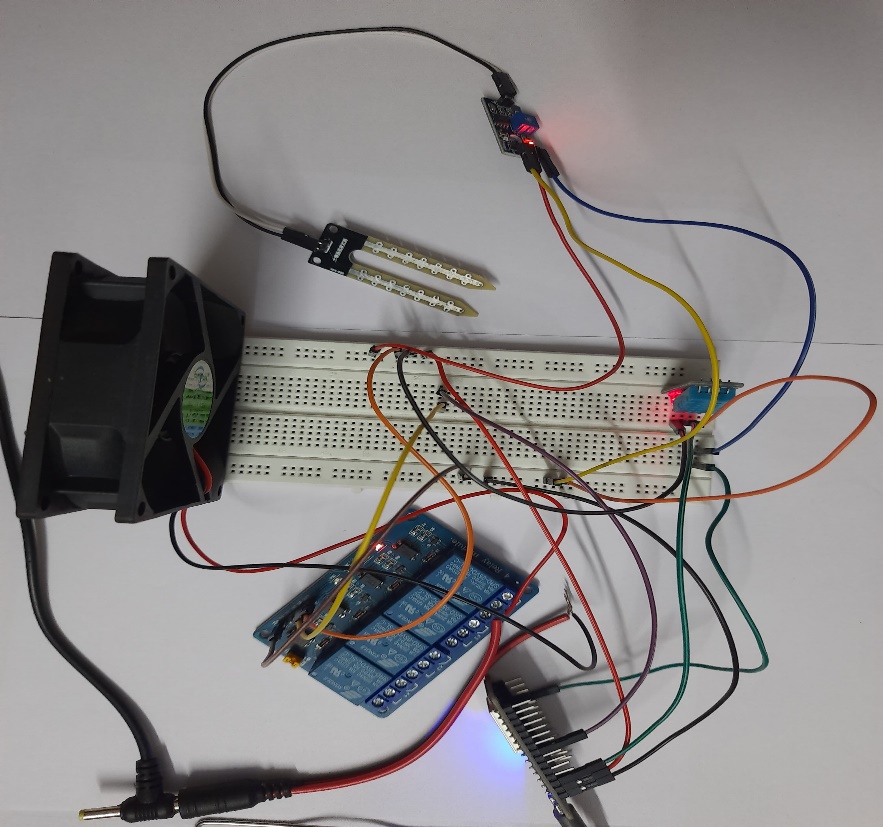
****

**Fig.1 Flow Chart Of The System**

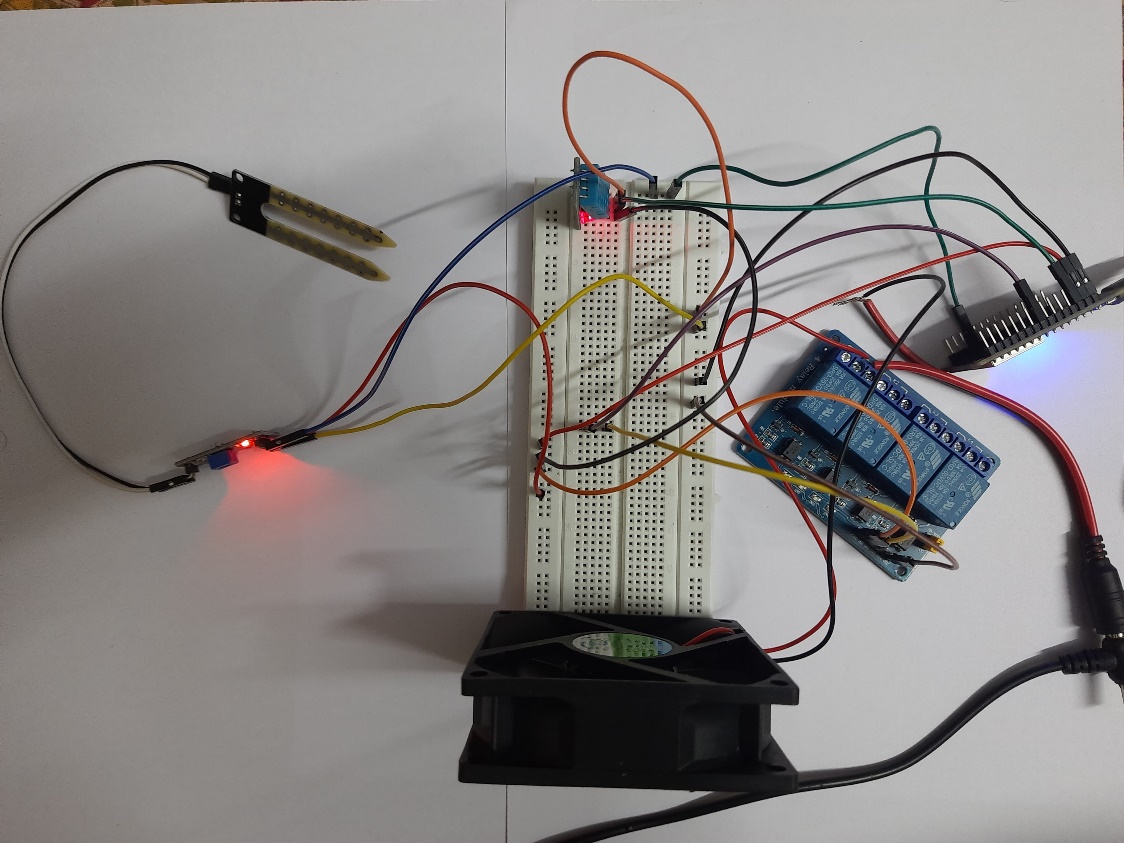


**Fig.2 Block Diagram of the System**

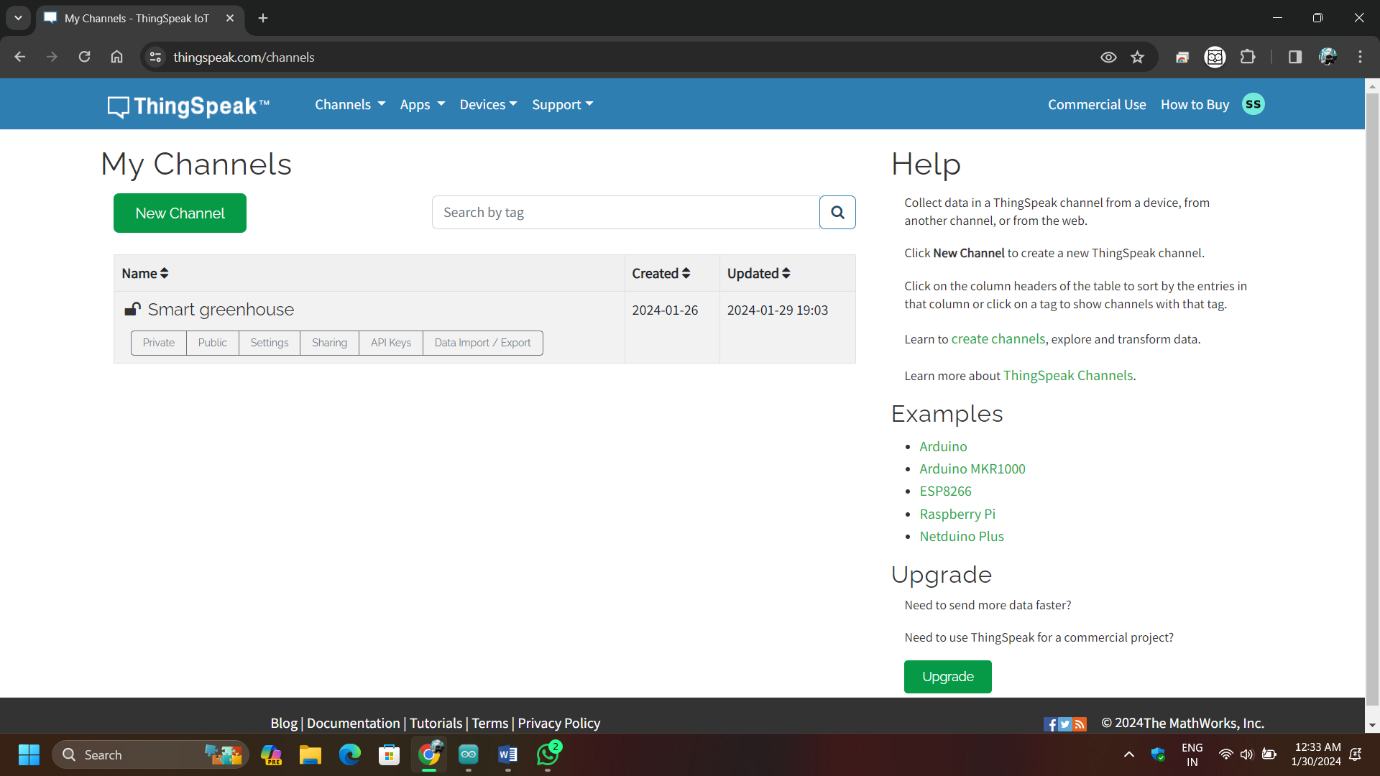
# CHAPTER 5 SNAPSHOTS



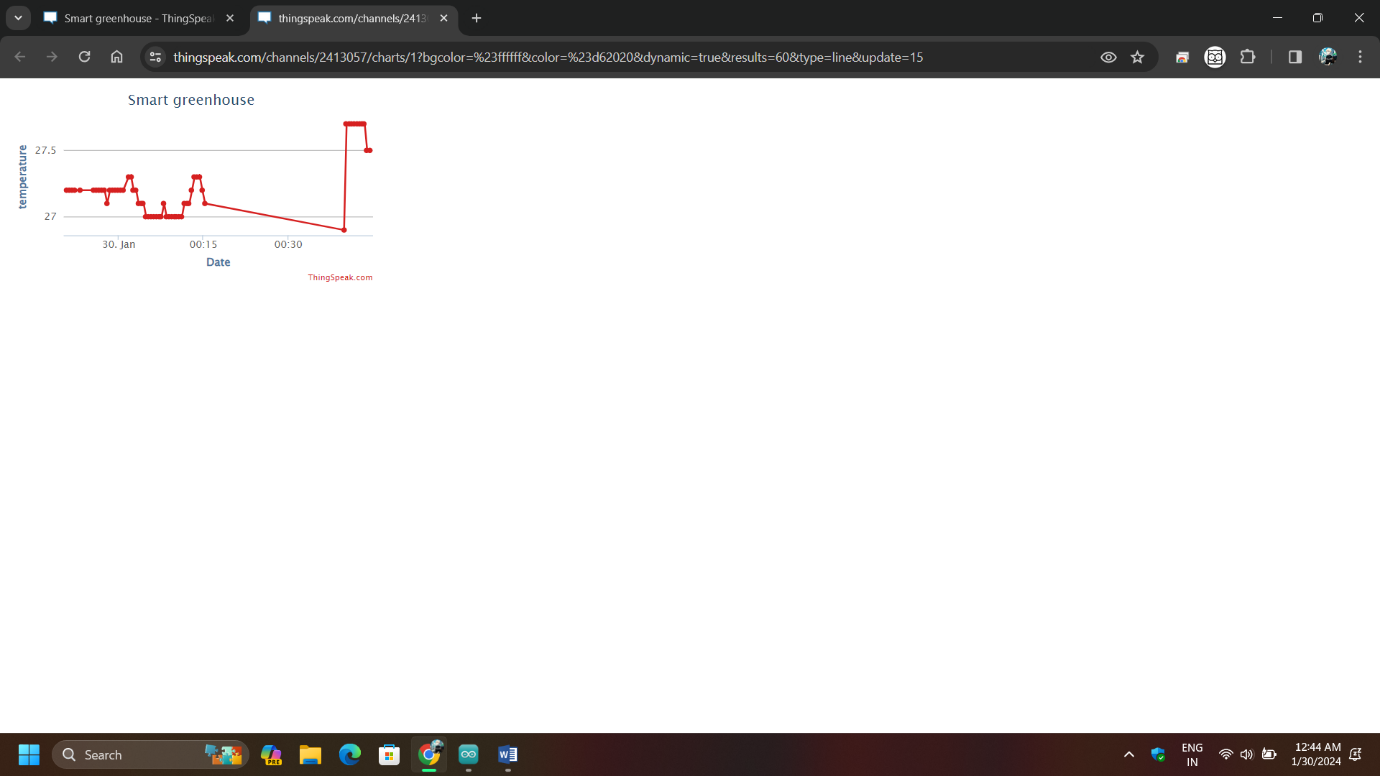
**Fig.1 Model In OFF Condition**



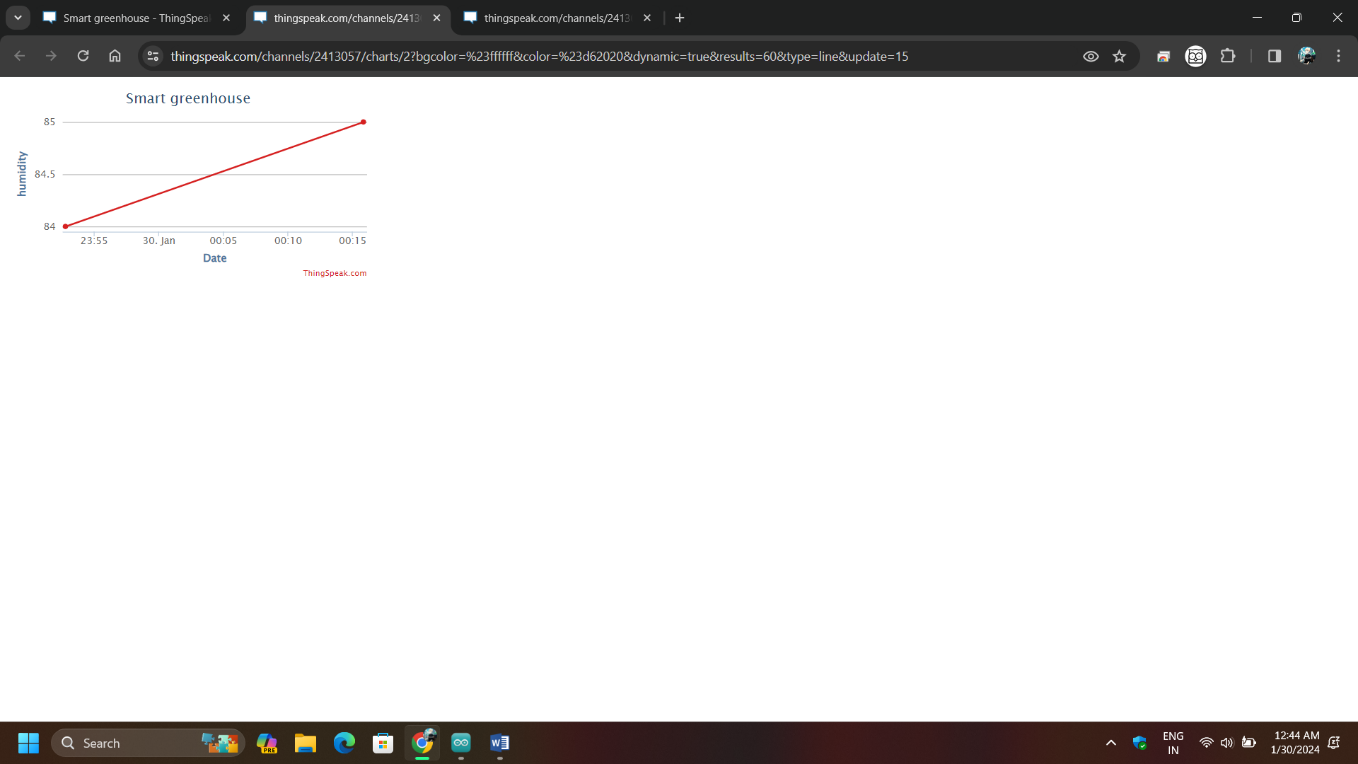
**Fig.2 Model In ON Condition**



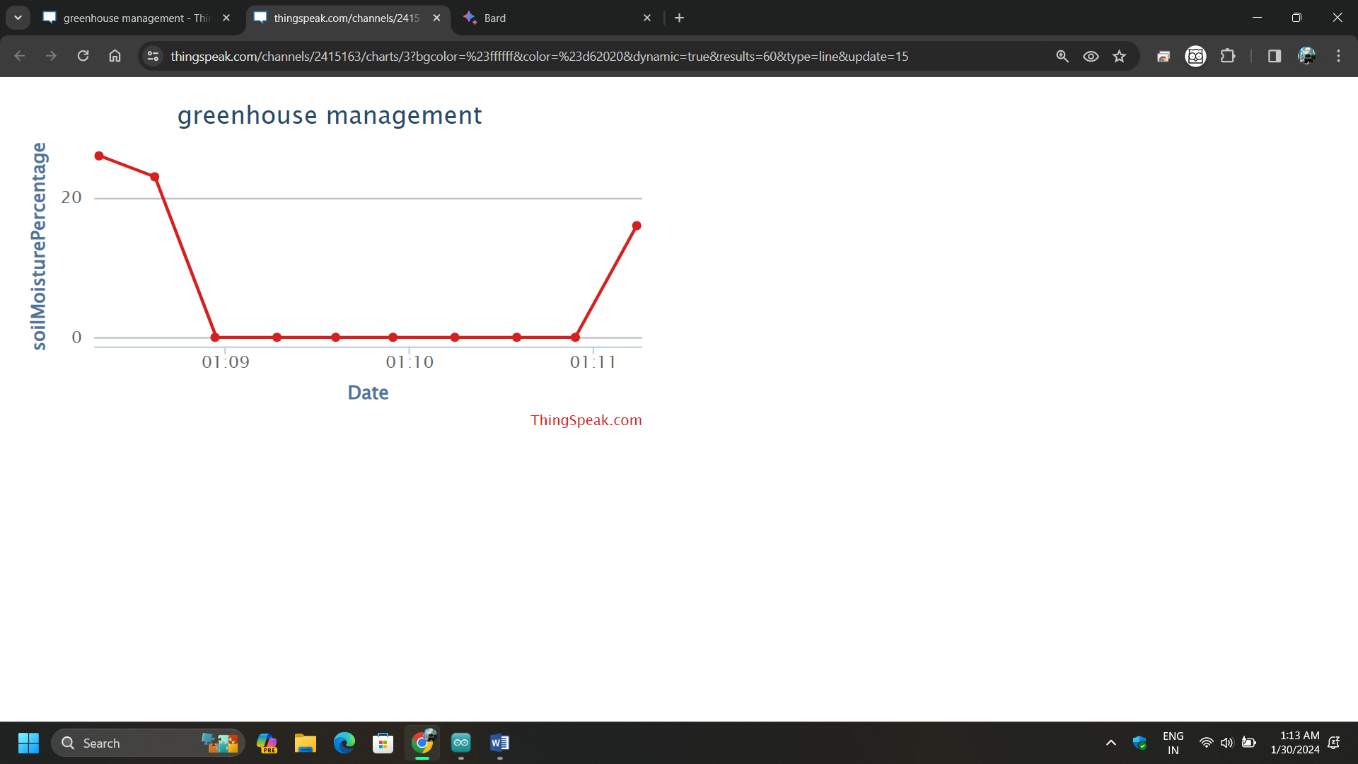
**Fig.3 Cloud**



**Fig.4 Graph - Soil Moisture**



**Fig.5 Graph - Humidity**



**Fig .6 Graph – Temperature**

# CHAPTER 6 CONCLUSIONS AND FUTURE PLANS

This article outlines the development and creation of a monitoring platform for a greenhouse system. It introduces an affordable solution based on the Internet of Things (IoT) technology, along with the implementation of a greenhouse system. The temperature sensor is utilized to detect changes in temperature and ventilation via fan is provided, while the humidity sensor checks for humidity level in environment. Additionally the moisture sensor is employed to assess the moisture levels in the greenhouse soil. Whenever the soil moisture is below 55%, the user receives a notification via the email. The data collected from these sensors is presented on a dashboard, allowing users to access real-time information from anywhere and at any time. This approach promotes the modernization of greenhouse management systems, leading to a reduction in need for human intervention and mitigating avoidable financial losses.

The proposed study only focuses on monitoring temperature, humidity, and moisture levels exclusively within the storage system environment. However, there is potential to enhance the monitoring system and apply it to other areas such as assessing soil quality, artificial lighting system (HPS), watering, aeration, air humidification can be automated via programmable controllers. These expanded applications can be used to make informed decisions about greenhouse plantations and contribute to the advancement in this system. Additionally, managing diverse plant types poses challenges in maintaining specific parameters and specifications. To address this, it is possible to implement a remote server-based system that allows inputting and monitoring of these parameters.

# CHAPTER 7

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THANK YOU