

**An-Najah National
University**



**Faculty of Engineering and
Information Technology**

**Smart Greenhouse Environmental and Monitoring
Control using IoT
Graduation Project 2**



SMART GREENHOUSES

Presented in partial fulfilment of the requirements for
Bachelor degree(Electrical and Telecommunication
Engineering)

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

“يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ”

صدق الله العظيم

{المجادلة:11}

Dedication

For Our Palestine

For Our university....

For Our Teachers...

For Our family

We Present This Research....

Acknowledgment:

First of all, whoever does not thank people does not thank God in the beginning, praise

be to God, who gave us the strength to complete this project, titled “Smart Greenhouse Environmental Monitoring and Control using IOT”.

We extend our sincere thanks and gratitude to Allah, whose guidance and blessings enabled us to successfully complete this research.

We express our deep appreciation to our esteemed institution, An-Najah National University

Our heartfelt gratitude goes to our beloved parents, who have bestowed upon us all that is good in their lives, and we thank them for their continuous support and encouragement, which has significantly motivated us toward success.

We extend our profound thanks to Dr. Saed Tarapiah for his valuable advice and continuous support throughout the various stages of preparing this research.

We also convey our gratitude to our friends, whose efforts and assistance played a pivotal role in the outstanding accomplishment of this research endeavor.

Finally, we extend our thanks to everyone who contributed in any way to support us, appreciating their efforts and contributions to the success of this research.

All praise is due to Allah, by whose grace righteous deeds are accomplished.

DISCLAIMER

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List of Abbreviations

IOT	Internet of Things
IEEE	Institute of Electrical and Electronics Engineers
M2M	Machine To Machine
LTE-M	Long Term Evolution
WCDMA	Wideband Code Division Multiple Access
EDGE	Enhanced Data rates for GSM Evolution
GPRS	general packet radio service

Abstract :

This graduation project introduces an innovative solution to enhance greenhouse agriculture by integrating Internet of Things (IoT) technology. The focus is on environmental monitoring and control in a smart greenhouse, optimizing conditions for plant growth by continuously sensing key parameters such as air temperature, humidity, and soil moisture. The system utilizes strategically placed sensors to regulate the greenhouse climate, activating smart fans for temperature control and automated watering when soil moisture is below a set threshold. Additionally, the system dynamically adjusts artificial lighting based on real-time conditions using a light sensor. The integration of a dust sensor and temperature sensor enhances decision-making for fan control, ensuring optimal conditions for plant health.

Real-time monitoring and data analysis are accessible through an LCD screen, and remote monitoring is facilitated through the ThingSpeak website, allowing users to make informed decisions and interventions from any location. This smart greenhouse system contributes to precision agriculture, promoting environmentally conscious and technologically advanced farming practices for sustainable and efficient resource management.

❖ **Chapter one : Introduction**

Here's a brief introduction to this innovative concept:

What is a Smart Greenhouse?

Think of it as a high-tech greenhouse equipped with sensors, automated systems, and software platforms that work together to create an optimal environment for plant growth. Imagine temperature, humidity, light, irrigation, and even nutrient delivery being precisely controlled and adjusted based on real-time data and pre-programmed settings.

1.1 Overview:

In the current age of technological advancement, the integration of intelligent devices has opened new avenues for monitoring and assisting the elderly and disabled. This project focuses on the application of Internet of Things (IoT) technology to create a smart greenhouse that facilitates continuous environmental monitoring and control. By embedding sensors in the greenhouse, we aim to provide optimal conditions for plant growth while addressing challenges such as temperature regulation, soil moisture management, and light availability.

smart greenhouses offer a non-intrusive approach to cultivation, enhancing agricultural practices and contributing to sustainable farming. The project explores various technologies, including sensors for temperature, humidity, and soil moisture, as well as smart fans and automated watering systems. The objective is to seamlessly integrate these components to create an intelligent greenhouse environment that ensures the well-being of plants.

1.2 Statement of the problem:

Greenhouse, an urban farming approach, provides farmers with an option to provide optimum cultivation condition by offering a controlled environment according to the crop's requirements. However, many farmers fail to get good profits and desired yield from greenhouse crops because they cannot efficiently monitor and control important factors like light, air, temperature etc., that determine plant growth and productivity.

Some of the major challenges faced by traditional greenhouses:

- Temperature going higher or below than a certain degree
- High humidity – resulting in crop transpiration
- Condensation of water vapor
- Water evaporation from the humid soil

The goal of achieving high yield, high quality and high efficiency production is a problem in the study of greenhouse environment control.

With traditional greenhouses, growers can control the environmental parameters through a proportional control mechanism, which involves manual intervention, often resulting in production loss, energy loss and increased labor cost.

To overcome such challenges, automated greenhouse monitoring and control system comes to the rescue. The rising ubiquity of technologies like the Internet of Things (IoT), in the development of a connected greenhouse in the coming years.

There are several limitations of having to manually control all the

factors that can affect the quality of plants and their yields. Hence, an automated monitoring and controlling system is a solution that enhances greenhouse farming which will take guesswork out of the job.

Our Smart Greenhouse solution provides advanced microclimate control and energy optimization. Benefits of our Smart Greenhouse solution

Create the right environment for better yield With Smart Greenhouse, farmers can tailor an environment for their crops that offers a climate-smart and nutrition-sensitive atmosphere to increase the quality of crops.

Use water correctly Water wastage is one of the major challenges that the agriculture sector faces today By quantifying water usage, Smart Greenhouse helps growers to increase crop yields while conserving water. Smart Greenhouse ensures apt conservation of water by setting a schedule based on the type of crops, quality, yield and local weather parameters

Smart greenhouses empowered by IoT technologies represent a significant advancement in agricultural practices. Integrating sensors, automation systems, data analytics, and connectivity offers immense potential for optimizing resource utilization, enhancing productivity, and promoting sustainable farming.

1.3 The main objective of smart green house IoT automation:

The primary objectives of this project are as follows:

- **Designing an Integrated Environmental Control System:** Develop a sophisticated yet user-friendly system that seamlessly integrates IoT devices and sensors for monitoring and controlling temperature, humidity, soil moisture, and light levels within the greenhouse.
- **Enhancing Agricultural Efficiency:** Implement a solution that aims to optimize resource utilization and improve crop yields by providing precise and automated control over environmental factors critical for plant growth.
- **Cost-Effective Automation:** Create a budget-friendly and scalable home automation system that leverages microcontroller technology for efficient hardware management, ensuring accessibility to a broad spectrum of users.
 - **Expandability and Scalability:** Develop a system architecture that is not only scalable to accommodate additional sensors and devices but is also adaptable for integration with future advancements in greenhouse automation technology.
 - **Promoting Sustainable Agriculture:** Emphasize the role of the smart greenhouse in promoting sustainable agricultural practices by optimizing resource usage, reducing energy consumption, and minimizing environmental impact.

- **Safety Integration:** Incorporate safety features that can promptly alert users in case of emergencies, such as fire or gas leaks, ensuring the well-being of both the plants and the greenhouse infrastructure.

- **Electricity Consumption Management:** Implement energy-efficient practices within the smart greenhouse system, contributing to reduced electricity consumption through intelligent control of lighting, heating, and other electrical devices.

- **User Empowerment:** Empower users with a sense of control over their greenhouse operations, allowing them to make informed decisions based on real-time data and insights provided by the smart system.

These revised objectives aim to capture the essence of your smart greenhouse project while providing a distinct perspective on the goals and outcomes.

1.4 Scope of the work:

We hope that the achievement of this project in reality will make the modern sensor and communications technologies, smart greenhouses automatically capture and deliver information on the surroundings and crop. Collected data is fed into an IoT platform where analytical algorithms turn it into actionable intelligence to uncover bottlenecks and abnormalities. Consequently, getting information such as temperature, humidity besides other required climate parameters and also live field information about soil and plant too. This gathered data is collected and stored over the cloud, it can be further processed to monitor and predict everyday plant necessities, send alerts to the users to take requisite action and over time build predictive models that can help realize higher crop

1.5 Importance of the work:

Protection From External Conditions Prevents risks of unpredictable weather conditions, pest damage and diseases
Increases resource efficiency whilst reducing use of pesticides
Optimises growing parameters based on yield quantity and quality, increasing crop production densities
Responsive Greenhouse Environment Increases energy efficiency due to adaptable interior climate in response to crop and exterior conditions
Remote Access & Control Automated monitoring, climate control and fertigation systems minimises human intervention and reduces labour costs.

1.6 Report organization:

This report consists of seven chapters. The first chapter is talking about our project in general, the objective of it and the importance of it in our life. The next chapter is talking about constraints and

cod/standards related to the project. The third chapter contains the literature review which talks about some steps and results of our project. Then , in chapter four we explained each step of the project in details and gave sufficient detail about our materials and methods which be used on this project . All data that have been collected summarized on chapter five. After that we discussed all the results on chapter six. The last chapter contains the conclusions and recommendations.

❖ **Chapter two: Constrain,Standard/Codes and Earlier course work**

This chapter will includes the constrains that we were focused, standards that we used, and the most benefit coursework that we took them within four years study and we could to subject them in our project.

2.1 Identification problem:

Defining the problem of smart greenhouse agriculture projects includes the following issues:

- Optimize resource use: Smart greenhouses need to balance the use of resources such as water, energy and nutrients to ensure sustainable and efficient agriculture

- Adapting to climate change: Smart greenhouses should be able to mitigate the effects of climate change by providing a controlled environment for crops to grow.
- Ensuring food security: Smart greenhouses should help increase crop production and improve food security in areas with limited resources and harsh climates.
- Automate crop monitoring and control: Smart greenhouses should be equipped with advanced sensors and automation systems to monitor and control the growing environment remotely.
- Integrating AI: Applying AI in smart greenhouses can help improve decision-making and optimize the cultivation process.
- Reduced human effort: Smart greenhouses should reduce the need for manual labor and human intervention in crop management.

- Addressing the urban-rural divide: Smart greenhouses can help promote sustainable urban living by providing a solution for urban agriculture and reducing the need for food transportation.
- Balancing Cost and Sustainability: Smart greenhouses must be cost-effective while promoting sustainable agricultural practices.

These issues can be addressed by integrating advanced technologies such as the Internet of Things, artificial intelligence and automated systems into smart greenhouses, leading to more efficient and sustainable agricultural practices.

2.2 Standards/Codes:

The standards we used in our project:

IEEE 802.11a/b/g/n WiFi Standards:

The 802.11 standards are a group of evolving specifications defined by the Institute of Electrical and Electronic Engineers (IEEE). Commonly referred to as Wi-Fi.

802.11 standards define a through the air interface between a wireless client and a base station access point or between two or more wireless clients.

Standard	Maximum Data Rate (Mbps)	Typical Throughput (Mbps)	Operating Frequency Band	Channel wide.
802.11b	11	5Mbps	2.4 GHz	20MHz
802.11g	54	8 (Mixedb/g) 25(Only802.11g)	2.4 GHz	20MHz
802.11n	Upto600	Upto400	2.4GHz& 5GHz	20MHzor 40MHz

Table 1-Wifi standard

	Owner	Frequency (MHz)	Range	Power requirement	Security	Compatibility
Zigbee	Zigbee Alliance	868 - 868.6 (Europe) 902 - 928 (US)	10–100 meters line-of-sight	Low-Power, Potential Batteryless	Low, basic encryption	Compatible across Zigbee devices. DotDot OS.
Lo-RaWan	LoRa Alliance	169, 433, 868 (Europe) 915 (US)	Up to 6.2 miles or 10 km.	Low-Power	Basic 64-128 bit encryption	Depends on OEM
LTE-M	GSMA - Cellular Carriers	LTE Bands: 450-2350 (uplink)	Global	Band dependant	NSA AES-256	Application dependant
IEEE 802.11af (White-Fi)	Open - IEEE Certified	470 - 710 (Digital Dividend)	Short, up to 100m	Low	WPA	Application dependant
IEEE 802.11ah (HaLow)	Open - IEEE Certified	850 (Europe) 900 (US) 700 (China)	Up to 13 miles or 20 km.	Medium	WPA	Application dependant

Table 2-IOT standard Protocol

➤ **ZIGBEE: PROPRIETARY, SHORT-RANGE, INEXPENSIVE AND BASICALLY SECURE:**

Zigbee is a low-power, low-data-rate, close-proximity ad hoc wireless network, supporting mesh network topology. It is especially suited for home and office applications, where devices are located in a small area. It only works in distances from 10 to 100 meters line-of-sight. It uses the IEEE 802.15 WPAN specification, providing data rates of 250 kbps, 40 kbps and 20 kbps.

➤ **LORA: PROPRIETARY, LONG-RANGE, INEXPENSIVE AND SECURE:**

LoRa is the preferred choice for deploying a large number of non-critical sensors and control devices in large areas. Its use of unlicensed radio makes it the perfect choice for city-wide

environmental sensors, streetlamp control and monitoring, basic control units for agricultural farms and monitoring of small objects.

➤ **LTE-M: THE CELLULAR CARRIER'S SOLUTION TO REPLACE M2M:**

LTE-M, which stands for Long-Term Evolution for Machines, serves as the Machine-to-Machine (M2M) industry's solution for Internet of Things (IoT) connectivity through secure cellular networks designed for long-range communications. This wireless system is provided by cellular carriers and is endorsed by industry associations such as GSMA and the 3GPP standards organization.

It's worth noting that LTE is commonly known as 4G cellular networks.

Operating over cellular networks, LTE-M facilitates the monitoring, control, and data reception from IoT devices integrated into various modes of transportation like trucks, trains, boats, and more. In instances where an LTE network is unavailable, the system seamlessly transitions to WCDMA (3G) or GPRS/EDGE (2G) to ensure continuous connectivity.

➤ **IEEE 802.11af (White-Fi) and IEEE 802.11ah (HaLow) :**

are the most sought-after solutions for connectivity. Both use previously licensed spectrum and do not interfere with traditional Wi-Fi signals in the 2.4-GHz and 5-GHz bands nor

with 2G and 3G cellular networks. Some of the spectrum is shared with some LTE channels used in the United States.

White-Fi makes use of the digital dividend of frequencies freed up when broadcast television moved to digital terrestrial and some of the previous UHF channels ceased to operate. The use of the digital dividend spectrum is regulated differently in the U.S. and Europe, and the connected devices need to look for available frequencies at regular intervals.

HaLow extends Wi-Fi into the 900-MHz band, enabling the low power connectivity necessary for applications, including sensors and wearables. Because this frequency is freely available for basic communications, HaLow is the preferred Wi-Fi standard for IoT.

2.3 Earlier course work:

Many courses were taken that are related to this project, such as: c++ language course ,Microcontrollers and Embedded Systems Programming course,electrical circuit 1course ,electrical circuit 2 course ,Digital number design 1 course .

❖ **Chapter Three : Literature Review**

This chapter provides an overview of some topics that are similar to our project, which in turns provided some ideas for this project.

With the rapid development of electronic and agricultural technology research and their applications have been paid more and more attention, especially the greenhouse has become an important role. Greenhouse is a said to be a place that creates the best conditions for plant growth, can change plant growth and avoid influence on plant growth due to outside changing seasons and severe weather.

Monitoring greenhouses all the time is the problem facing most farmers, soMany studies have focused on this problem to solve it. Some of these studies asthe next:

- ✓ Asst.Prof. Khaldun I.Arif, Hind Fadhil Abbas. 8, August 2015, This paper proposes an efficient automatic irrigation system based on computing various changes necessary in green house using wireless sensor network and using server and client web service for control and monitorin [1]

- ✓ Prof. D.O.Shirsath, Punam Kamble, Rohini Mane, Ashwini Kolap, March 2017 In this paper, the Design had been aimed data acquisition in greenhouse for multiple sensors to use data for simulation or processing to achieve the better enhancement of growth in greenhouse, this data has effect on the climate of greenhouse. Graphical User Interfaces (GUI)

had been used through LabVIEW, firmware of arduino as software and arduino board and sensors as hardware. by using arduino mega board provides multiple inputs analogs and I/O digitals to made read data sensor easy to take temperature, humidity, CO2 gas, also measuring the soil moisture that needed for irrigation plants and the intensity of lights that applied for greenhouse .These factors has the major effect on increase in growth of plants. Greenhouse environments monitoring different changes to parameters, the system for this purpose had been provided and given ability to control on climate of greenhouse [2].

- ✓ Mohammad Woli Ullah, Mohammad Golam Mortuza, Md Humayun Kabir, Sovan Kumar Dey Supta, Zia Uddin Ahmed, Partho Das, Syed Mohammad Didar Hossain 2018,, This paper proposes such an automatic system for greenhouses to control its' internal environment, to store each climate properties in a database for future analysis and to ensure remote monitoring to those data. Internet of Things (IoT) is used for remote monitoring and analysis of data. Also, an android application is developed to display those data in a short range through Bluetooth technology. The system controls the temperature, humidity, light and soil moisture level by sensing the values from sensors and controlling heaters/coolers, sprayers, bulbs and water pumps accordingly. [3]

- ✓ Mangesh Ramesh Shinde, Onkar Mahadev Chougale, Sanket Dnyaneshwar Rajgude, Prof. Ayubkhan Mulani April-2023, In this study, we developed a Smart Greenhouse Monitoring and Control System using a Raspberry Pi 3, DHT11 sensor, soil moisture sensor, LDR sensor, fan, motor pump, LED light, and web-camera. The system continuously monitored and controlled the environmental conditions within the greenhouse, including temperature, humidity, soil moisture, and light intensity, while also providing live feed of the greenhouse on a web page. We evaluated the performance of the system in a greenhouse setting and found that it effectively maintained the desired environmental conditions for plant growth. [4]

- ✓ The paper aims to develop an IoT-based smart greenhouse system that enables automatic control of climate conditions (temperature, humidity, light, and soil moisture) and allows for remote monitoring and data analysis through a combination of sensors, actuators, and an Android application. This system seeks to enhance crop yield and quality, reduce the use of protective chemicals, and provide the ability to manage the greenhouse environment from any location global [5]

- ✓ The paper provides an overview of smart agriculture based on IoT technologies, highlighting various research contributions and advancements in the field. It discusses the potential benefits of implementing IoT solutions in agriculture, such as

improved production quality, resource conservation, and economic efficiency. The paper reviews studies proposing innovative approaches, such as the use of poly houses and sensor networks connected to the internet, to address challenges in farming. Additionally, it emphasizes the importance of precision farming techniques and data-driven decision-making in achieving enhanced productivity and sustainability. Overall, the paper suggests avenues for further research, including the development of ideal IoT designs for agribusiness and the exploration of advanced technologies like precision agriculture IoT (PAIoT) for continuous improvement in farming practices. It underscores the significance of leveraging technology to overcome agricultural challenges and promote smart farming practices that are both profitable and environmentally sustainable. [6]

- ✓ This paper introduces a novel optimization scheme tailored for greenhouse production systems, with a primary focus on reducing energy consumption while ensuring optimal crop growth conditions. Greenhouse farming offers a promising solution to meet increasing global food demands, but challenges such as high energy usage and labor costs persist. The proposed optimization scheme aims to strike a balance between energy consumption and key climate control parameters like temperature, light levels, and humidity. To assess its effectiveness, the authors developed an emulator of the greenhouse environment and conducted experiments using 15 days of external environmental data from Jeju,

South Korea. Comparative analysis with a baseline scheme demonstrates the efficacy of the proposed optimization, showcasing significant reductions in both energy consumption and costs. The paper concludes by emphasizing the potential of the proposed scheme to enhance energy efficiency and crop productivity in real-world greenhouse settings, motivating further research in this direction [8].

- ✓ This report aims to provide an overview of a comprehensive greenhouse management system leveraging IoT technology. The system integrates wireless sensor networks (WSN), internet-based service platforms, and decision-making support systems (DMSS) to enable efficient monitoring and control of environmental conditions crucial for crop growth. By utilizing knowledge support technology and cloud services, the system analyzes data collected by WSN, incorporates expert knowledge, and generates optimal decisions to regulate greenhouse operations. The ultimate goal is to achieve high-resolution optimization management in greenhouse farming, leading to improvements in environmental indices such as Integrated Pest Management (IPM) and economic sustainability. [9]

- ✓ This paper aims to address the challenges faced by farmers in managing productivity and plant growth in greenhouses by proposing a smart greenhouse monitoring system. The system is designed to automatically track and manage the environment inside greenhouses using Wireless Sensor

Network (WSN) technology. Powered by Arduino and Atmega328 microcontrollers, the monitoring device includes various sensors such as soil moisture sensor, humidity sensor, temperature sensor, light sensor, Light Dependent Resistors (LDR) sensor, and a pump. The paper describes the design, installation, and operation of these sensors to effectively control the greenhouse environment, thereby assisting farmers in optimizing crop growth and productivity. [10]

Chapter Four: Methodology

The methodology of a smart greenhouse involves the integration of various technologies to monitor and control environmental conditions. Key components include sensors such as temperature sensors that monitor

and adjust temperature levels, humidity sensors that regulate humidity levels by opening or closing windows, soil moisture sensors that automate irrigation, light sensors that monitor light intensity and adjust accordingly, rain sensor that monitors and senses the rain to fill the water tank, and there is a servo motor to control the opening and closing of the cover of this tank. Microcontrollers like Arduino Boards are used to connect and control the sensors and actuators. Automation systems include servo motors that open or close windows to regulate humidity, pumps that irrigate the soil when necessary, fans and vents that control air circulation and ventilation, and heaters and cooling

systems that maintain optimal temperature. Data analytics involves real-time monitoring and data storage for future analysis and improvement. Security measures include surveillance systems, access control mechanisms, and fire detection and prevention systems. Proper protocols for chemical handling, pesticide management, and waste management ensure a safe and clean working environment. This integrated system provides convenience, accessibility, and security while ensuring optimal environmental conditions for crop growth. the used technology :

❖ **Hardware and Software requirements:**

A. Hardware Components:

1. Wi-Fi module ESP8266(Node MCU)
2. 16x2 LCD Display
3. Arduino Mega 2560.
4. Temperature and Humidity sensor(DHT11)
5. Soil moisture sensor
6. LDR sensor.
7. Rain sensor .
8. 2 DC Fan.
9. Peltier 12 volt.
10. 2 heat sink.
11. 4 Relay 2 channel 12 volt .
12. Water pump.
13. Lamp 220 tungsten.
14. Power supply 12volt
15. Servo motor SG90
16. Servo motor MG 996R

B. Software Components:

Arduino softwareC++.

Thingspeak IoT website .

4.1 Working principle:

The proposed project for a smart greenhouse based on the Internet of Things It consists of various sensors and modules. It measures Various parameters such as temperature, light unit, Humidity in the soil, rain sensor and the important outputs of these parameters using a fan to reduce the heat with a piece called a heat sink. LED lights, water pump by integrating with microcontroller called arduino. Arduino is a microcontroller used as the core of this System. Its main importance is its contact information Complete order. The controller in the morning is They are linked to input devices and product modules. the The Arduino timing controller is programmed by Arduino IDE software.

The master is used for his notice Temperature and humidity in the greenhouse. He collects data In an environment friendly and nourished environment Arduino Mega microcontroller. The important readings that the soil needs, such as temperature, humidity, soil moisture, and light intensity, are displayed on the LCD screen after every second. comma. It will give the Arduino Uno cooling to turn on or off fan. This will help you maintain the internal temperature greenhouse.

The LDR monitors the light intensity When the sunlight is less than the important value, so The controller will signal The electric start starts when it lights up As the gland swells, the lamp will turn off. There is a humidity and moisture sensor Moisture in the soil. When the humidity level drops below The required value, the window will be opened using a servo motor to obtain appropriate ventilation. As for the soil moisture, the water pump will be turned on and will work to obtain suitable and moderate soil. It will be turned off automatically when the humidity level is required. Get. There is also a

rain sensor that will sense the presence of rain. It will open the lid of the water barrel to fill it, and when there is no rain, it will close the lid. This is also done using a specific servo motor. Also, when temperatures are higher than expected, there will be a heat sink, which in turn cools the greenhouse. And it gets moderate heat. In addition, the Website will be used to provide a service to Storing data from networked devices The Internet by linking it to the values of the sensors and the Arduino Including temperature, lighting and other sensors.

4.2 Block diagram:

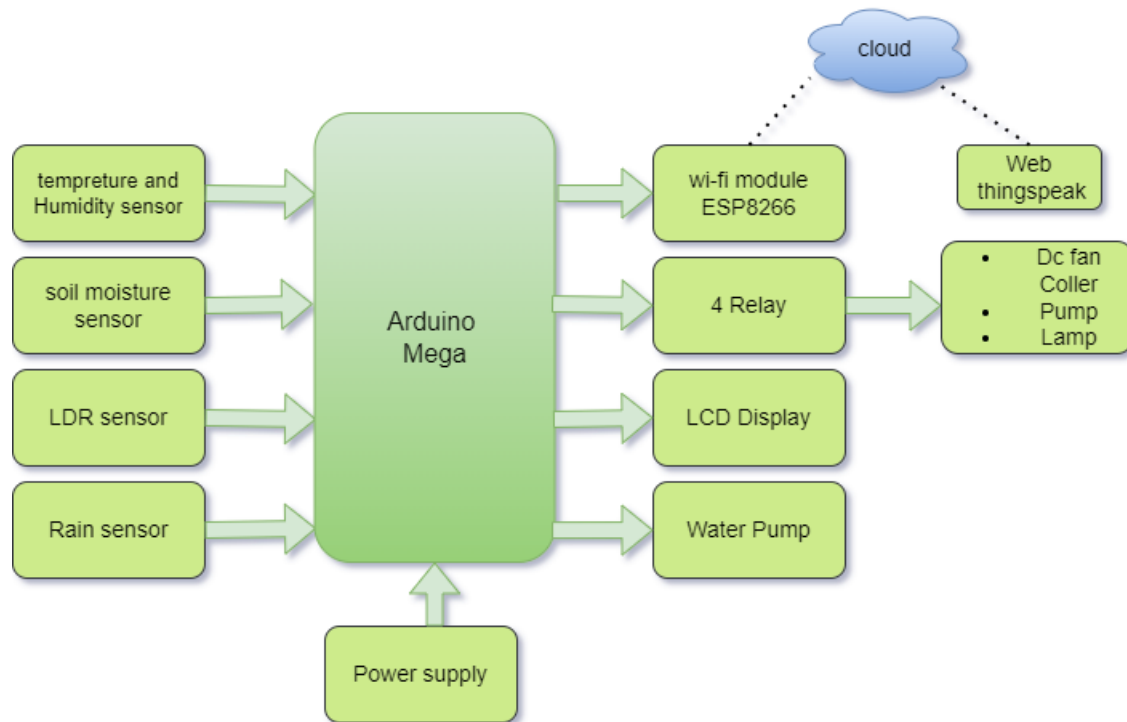


Figure 1-Arduino

4.3 Block diagram description:

The block diagram of the proposed greenhouse control and monitoring system consists of various sensors that collect data on the environmental conditions inside the greenhouse. These sensors include a temperature and humidity sensor to monitor the temperature and humidity levels, a soil moisture sensor to measure the moisture content of the soil, a light dependent resistor (LDR) sensor to detect the light intensity, and a rain sensor to identify rainfall.

The data collected by these sensors is fed into an Arduino Mega microcontroller, which serves as the central processing unit of the system. The Arduino Mega processes the sensor data and sends control signals to various devices to maintain the desired environmental conditions.

To enable remote monitoring and control, the system incorporates a Wi-Fi module, specifically the ESP8266. This module allows the Arduino Mega to connect to the internet and transmit the collected data to a cloud platform, such as Thingspeak. Users can then access and monitor the greenhouse conditions remotely through the cloud interface.

Additionally, the system includes an LCD display that shows the real-time readings from the various sensors. This provides a convenient way for on-site monitoring of the greenhouse conditions.

The control devices in the system include a DC fan and cooler to regulate the temperature, a pump to water the plants based on soil moisture levels, and a lamp to supplement sunlight when necessary. The Arduino Mega controls these devices based on pre-programmed parameters to maintain optimal conditions for plant growth.

By integrating sensors, microcontrollers, control devices, and cloud connectivity, this greenhouse control and monitoring system automates the process of creating and maintaining an ideal environment for crop production. The remote monitoring capabilities allow for efficient management and optimization of greenhouse operations

4.4 Flow Chart and Project Description:

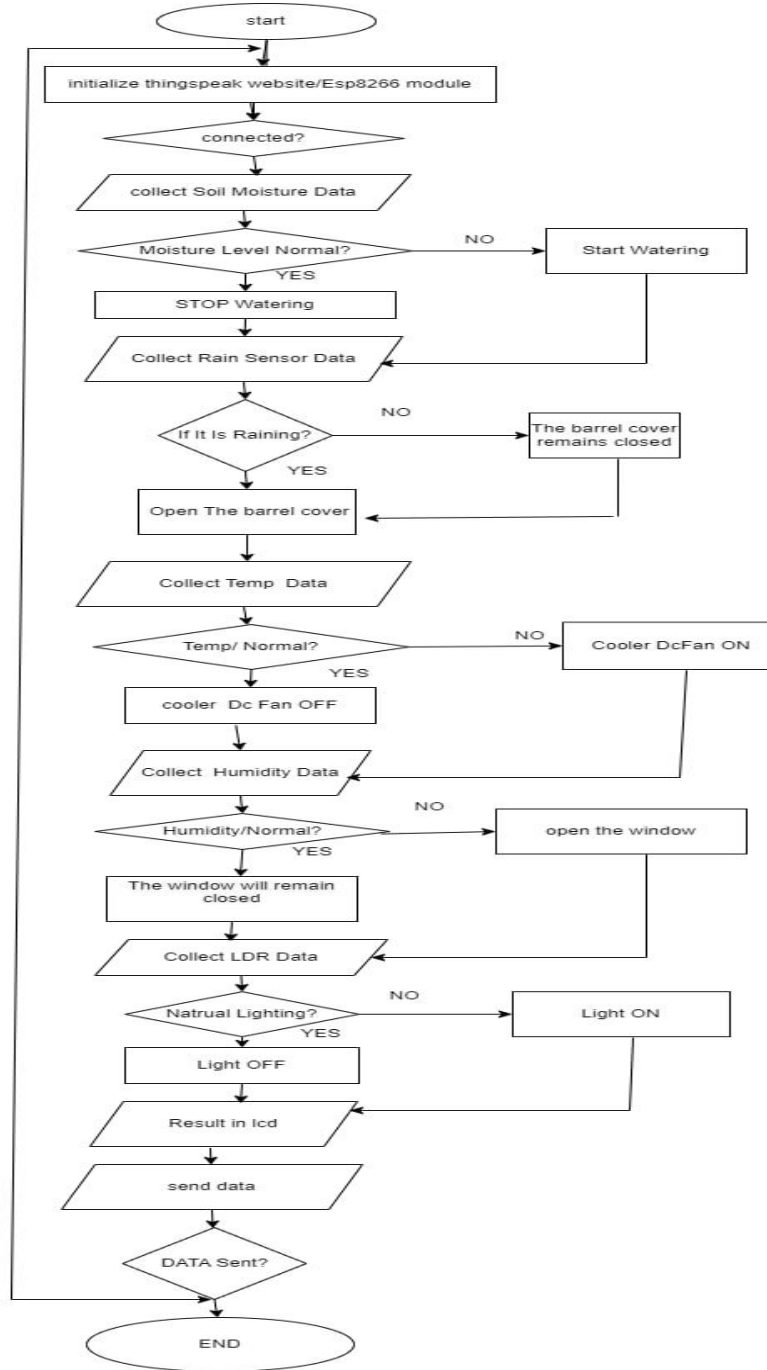


Figure 2-Flowchart

4.5 Flow Chart description:

the flowchart appears to show the control logic for a smart greenhouse system. Here's a breakdown of the steps involved:

- ✓ **Initialize ThingSpeak, website/ESP8266 module:** The system first connects to the ThingSpeak cloud platform or the local ESP8266 Wi-Fi module.
- ✓ **Collect Soil Moisture Data:** The system then reads the moisture level of the soil using a sensor.
- ✓ **Moisture Level Normal?:** If the moisture level is within the normal range, the system does not water the plants and proceeds to collect temperature and humidity data.
- ✓ **Collect Temp /Hum Data:** If the moisture level is too low, the system starts watering the plants. Once watering is complete, the system collects temperature and humidity data from sensors.
- ✓ **Temp Normal?:** If the temperature are within the normal range, the system turns the cooler Dc fan off. If not, the climate Cooler Dc fan is turned on to regulate the greenhouse.
- ✓ **Humidity Normal?:** If the Humidity are with in the normal range, the window of the green house remind at the same but if the Humidity level is higher than average the window open .
- ✓ **Collect Rain Data:** The system reads data from a rain sensor to determine if it is raining, The system reads data from a rain sensor to determine if it is raining.
- ✓ **Rain detected? :** If there is rain, the cover of the barrel will open to fill it, but if there is no rain, it will remain closed.
- ✓ **Collect LDR Data:** Next, the system reads the light level using an LDR sensor.

- ✓ **Natural lighting?:** If the natural light level is insufficient, the system turns on artificial lights. If the natural light is enough, the artificial lights are turned off.
- ✓ **Results in LCD:** Finally, the system displays the sensor data on an LCD screen.
- ✓ **Send data?:** The system then attempts to send the collected data to the ThingSpeak cloud platform.
- ✓ **Data sent?:** If the data is sent successfully, the system continues to the next iteration of the loop. If not, the system tries to send the data again.

This flowchart provides a basic overview of how the smart greenhouse system would operate.

The specific details of the system, such as the sensor thresholds and watering durations, would likely be configured by the user.

Overall, this flowchart appears to be a well-designed and logical approach to controlling a smart greenhouse system. It uses sensors to monitor the key environmental factors and takes appropriate actions to maintain optimal conditions for plant growth.

4.6 Project component properties:

1. Arduino mega 2560:

Arduino is an open-source platform (prototype platform) which is based on an easy-to-use hardware as well as software. It comprises a circuit board, which shall be programmed (usually known as a microcontroller) and a software called Arduino IDE (Integrated Development Environment), with which one can write and upload the computer code on to the physical board. The Arduino microcontroller board is very easy to use one yet a powerful single board computer. It has gained considerably a good adhesion in the hobby as well as the professional market.

Arduino is referred to as open-source, which means that the hardware is reasonably priced as per the usage and the development software is free of cost.

Specification	Arduino mega 2560
Processor	ATmega256
Program memory	256KB
Data memory	8KB
EEPROM	4KB
Device pins	100
Digital I/O pins	54
Analog inputs	16
PWM outputs	14
Serial ports	4

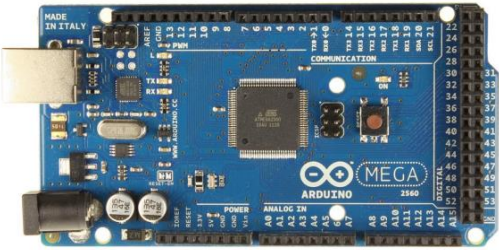


Figure 3-Arduino Mega 2560

Table 3Arduino Specification

2. Temperature and Humidity sensor:

Moving on the temperature sensor which is installed in the greenhouse to show the temperature high, we can see the temperature is increasing as presented on the LCD display and on the Wi-Fi controller app, after a certain temperature with exceeding about the threshold value the fan get automatically switched ON to maintain desired temperature condition. After the temperature condition is normal which is called below the threshold value then fan gets switch OFF automatically.

Specifications:

- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings $\pm 2^\circ\text{C}$ accuracy
- Dimensions: 15.5mm x 12mm x 5.5mm
- 3 pins

Arduino Connection

DHT11 Module	Arduino UNO
GND	GND
DATA	A0
VCC	3.3V

Table 4-Arduino Connection

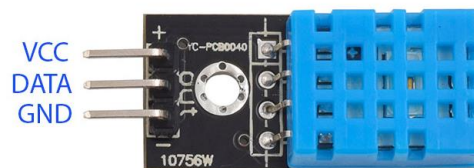


Figure 4--temperture sensor

3. Soil Moisture Sensor:

The soil moisture sensor which will be placed in the ground/soil inside the greenhouse to sense the moisture present in the soil, as the moisture in the soil is dropped and it will be sensed by the soil moisture sensor and the pump will get

switched ON automatically to restore the moisture condition, that is projected on the LCD screen as well in the Wi-Fi controller app on our smart mobile, as soon as the sensor senses the enough moisture in the soil which makes this condition normal and the pump will get switched OFF automatically.

Soil Moisture Sensor Module Features & Specifications

- Operating Voltage: 3.3V to 5V DC
- Operating Current: 15mA
- Output Digital - 0V to 5V, Adjustable trigger level from preset
- Output Analog - 0V to 5V based on infrared radiation from fire flame falling on the sensor
- LEDs indicating output and power
- PCB Size: 3.2cm x 1.4cm
- LM393 based design
- Easy to use with Microcontrollers or even with normal Digital/Analog IC
- Small, cheap and easily available

Pin name	Description
Vc	the Vcc pin powers the module, typically with +5V
GND	Power Supply Ground
Do	Digital Out Pin for Digital Output.
Ao	Analog Out Pin for Analog Output

Table 5-pin name and description

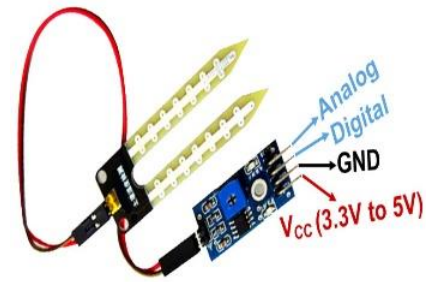


Figure 5-soil moisturs sensor

4. Wifi module Node MCU :

This module is also known as wireless local area network module. This electronic elements secret in many products to accomplish wireless cellular coupling to internet. This Wi-Fi module is used for the growth of finish point IOT.

NodeMCU ESP8266 Specifications & Features

- Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106
- Operating Voltage: 3.3V
- Input Voltage: 7-12V
- Digital I/O Pins (DIO): 16
- Analog Input Pins (ADC): 1
- UARTs: 1
- SPIs: 1
- I2Cs: 1
- Flash Memory: 4 MB
- SRAM: 64 KB

- Clock Speed: 80 MHz
- USB-TTL based on CP2102 is included onboard, Enabling Plug n Play
- PCB Antenna
- Small Sized module to fit smartly inside your IoT projects

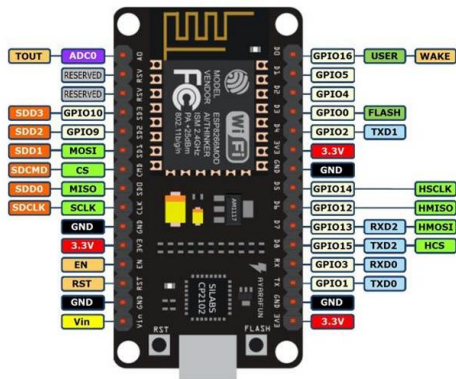


Figure 6-Data sheet of Node MCU



Figure 7-MCU

5. LDR Module (Photo-Resistor sensor):

intensity of light can be determined using LDR sensor module. it is digital sensor as well as analog sensor module that can also be refer to as Photoresistor sensor. This sensor has an onboard Light Dependent Resistor, that helps it to detect light. The yield of the module goes high in the absence of light and it gets to be low in the presence of light. The affectability of the sensor can be balanced utilizing the onboard potentiometer.

Features

- Light resistance : ~1k Ohm.
- Dark resistance : ~10k Ohm.
- Max voltage : 150V.
- Max power: 200mW.



Figure 8-Photo Resistor sensor

6. 16X2 LCD Display:

The LCD is familiar as liquid crystal display, it is a mixture of two states, the liquid and solid it fabricates a visible aspect with the help of liquid crystal. The facts and control are two registers for LCD. It carries 16 pins that are accessible at one side as show in figure below.

Features:

- 16 Characters x 2 Lines
- 5x7 Dot Matrix Character Cursor
- HD44780 Equivalent LCD Controller/driver Built-In
- 4-bit or 8-bit MPU Interface.



Figure 9-LCD

7. Relay 12 v :

A relay is like a remote-controlled switch for electronic devices. we are use in this project (smart greenhouse), a 12-volt relay connected to an Arduino.

By using the relay, your Arduino can control the fan and bulb without being directly connected to the high-voltage power needed to run them. It's like having a smart assistant that tells a powerful device (the relay) when to turn things on or off, ensuring a safe and controlled environment for your plants in the smart greenhouse.

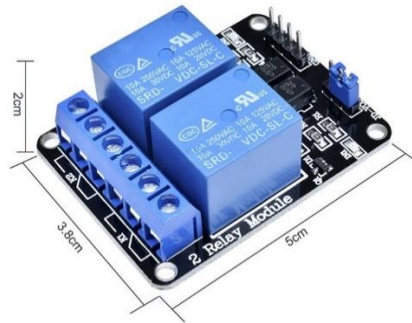


Figure 10-Relay 12v

8. Power supply 12 volt :

The 12-volt power supply As shown figure (11) in your smart greenhouse IoT project is the source of electrical energy that powers the various components of the system. It provides a stable and consistent 12 volts of direct current (DC) to ensure proper functioning of devices like the Arduino, sensors, and the relay.

AC Input 12 Volt Power Supply Specifications:

Dimensions: 7.96" x 3.92" x 1.96"

Complies with RoHS Directive

AC Input Voltage Range: 85-132/ 170-264VAC Selected by Switch

Input Frequency: 47-63Hz

Inrush Current: Cold Start, 20A/115V, 40A/230V

Input Leakage Current: <0.7mA/230V

Line Regulation (Full Load): $\pm 0.5\%$

Output Voltage Adj. Range: $\pm 10\%$

Output Overload Protection: 110-130% Constant Current, Auto Recovery

Output Over Voltage Protection: 115-150%

Withstand Voltage: I/P-O/P: 3.0KVAC/1min; I/P-F/G:

1.5KVAC/1min; O/P-F/G: 0.5KVAC/1min

Rise Time: 50ms@full load (typical)

Hold Up Time: 20ms@full load (typical)

Operating temp.& humidity: -10°C to 50°C (14°F - 122°F), 20%-93%RH (non-condensing)

Storage temp.& humidity: -20°C to 85°C (-4°F - 185°F), 20%-93%RH (non-condensing).



Figure 11-Power supply

9-Rain Sensor

Rain sensors are used in the detection of water beyond what a humidity sensor can detect. Rain Sensor uses humidity way to detect that there is no rain. The sensor is placed in the outdoor, when rain dripping petal-shaped detection surface, the humidity will increase, with the attendant voltage rise, controller will know rain, and the rain sensor detects water that completes the circuits on its sensor boards' printed leads . The sensor board acts as a variable resistor that will change from 100k ohms when wet to 2M

ohms when dry. In short, the board wetter the more current that will be conducted.

- Product Description:

Water is essential for life on Earth. Using water efficiently is very important. With the easy-to-use simple rain sensor, farmers can save water while irrigating their crops. The sensor will alert them to shut down the water supply when it senses rain. It can even act as an automatic on and off switch, like turning on wipers on a car when it senses rain.

This sensor has two pieces – the rain sensor and the simple sensor. The rain sensor has nickel-coated lines on both sides. It measures moisture and outputs the data to the simple sensor that reads it. The simple sensor uses the LM393 differential comparator. The main benefit of this board is ability to give analog and digital output. By setting the potentiometer on the board, you are able to get digital signal at the DO pin when signal crosses certain value, while analog values will be present on the AO pin at all times.

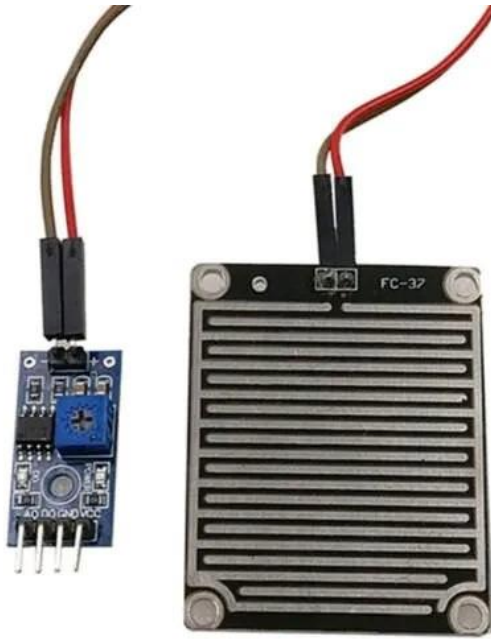


figure 12:Rain detection sensor

10- Lamp 220 tungsten

The lamp 220 tungsten is a type of tungsten halogen lamp that operates at a voltage of 220-240 volts and has a power rating of 120 watts. Here are some key features and benefits:

➤ Key Features:

- **Voltage and Power:** The lamp operates at a voltage of 220-240 volts and has a power rating of 120 watts.
- **Type:** It is a tungsten halogen lamp, which means it uses a tungsten filament that is heated to produce light.
- **Spectrum:** The lamp produces a spectrum that is close to the natural daylight spectrum, making it suitable for various applications.

- Color Temperature: The color temperature of the lamp is around 2800-3000K, which is relatively warm and similar to traditional incandescent bulbs.
- Luminous Efficacy: The lamp has a luminous efficacy of around 16-20 lumens per watt, which is relatively high compared to traditional incandescent bulbs.
- Life Expectancy: The lamp has a relatively long life expectancy of around 2,000 hours, which is longer than traditional incandescent bulbs.

✚ The benefit of a lamp 220 tungsten in a smart greenhouse is that it provides a high-quality, energy-efficient lighting solution for optimal plant growth. Here are some key benefits:

- Energy Efficiency: LED grow lights like the 220 tungsten lamp are designed to be energy-efficient, using significantly less power than traditional lighting options. This reduces energy consumption and saves costs.
- Customizable Spectrum: The lamp's adjustable spectrum allows for precise control over the light spectrum, mimicking natural light conditions and providing the optimal spectrum for different plant species.
- Increased Yield: By providing the right light spectrum and intensity, the lamp helps promote healthy plant growth, leading to increased yields and better crop quality.
- Improved Plant Health: The lamp's precise control over light conditions helps prevent overwatering and under watering, reducing the risk of root rot and other diseases.

- Space Optimization: The lamp's compact design and adjustable mounting options make it easy to integrate into vertical farming systems, maximizing space and increasing overall yield.



figure 13: Lamp 220 tungsten

11-12v dc Small Water Pump motor Supplier

Liquid fills the pump casing when the mini centrifugal pump working, the impeller rotates quickly, and the blades prompt the water to rotate quickly. Rotating water flies away from the impeller under the action of centrifugal force. While the central part of the impeller form a vacuum area, after the water in the pump is thrown out. Water in the water source is pressed into the inlet pipe through the pipe network under the action of atmospheric pressure (or water pressure). In such continuous cycles, realize the continuous water pumping.


An automatic water pumping system for a smart greenhouse, optimizing plant irrigation using renewable energy. It features sensors monitoring soil moisture, and a control unit adjusting pump operation based on sensor readings. The system, linked to the Internet, enables remote monitoring and control. Expected benefits include reduced manual watering, decreased reliance on non-renewable energy, and enhanced greenhouse efficiency. Smart greenhouses aim to enhance plant cultivation sustainability, with a crucial role played by the automated irrigation system, comprising a control unit, pump, and moisture sensors. Internet connectivity facilitates remote monitoring and adjustment for informed greenhouse operation.



figure 14: 12v dc Small Water Pump motor Supplier

12- Peltier

the heart of this project is a Peltier TEC module. A Peltier Thermoelectric cooling module consists of two ceramic plates separated by semiconductor pellets. One of the plates absorbs heat (cools down) and the other plate dissipates heat (heats up) when a current is passed through the pellets. It is composed of an array of 'doped' Bismuth Telluride semiconductor pellets so that a single kind of charge carrier, either +ve or -ve, carries the majority of the current. The pairs of P & N pellets are adjusted in such a manner that they are connected electrically in series, but thermally in parallel. The cooling/heating capability of a Peltier module always *depends on the applied temperature difference between its two ceramic plates* .

 **The job of a Pelletier in a smart greenhouse:** is to provide a cooling system that helps maintain optimal temperature and humidity levels for plant growth. How?

a Pelletier (also known as a Peltier) in a smart greenhouse is to provide an efficient cooling system that helps maintain optimal temperature and humidity levels for plant growth. Here's how it works:

The Pelletier is a solid-state heat pump that uses the Pelletier effect to create a temperature difference between its two sides. When an electric current is applied, one side of the Pelletier becomes cold while the other side becomes hot. In a smart greenhouse, the cold side of the Pelletier is used for cooling, while the hot side is dissipated using a heat sink or a fan.

The Pelletier is typically integrated with the greenhouse's automation system, which monitors and controls the temperature and humidity levels. When the temperature inside the greenhouse rises above the desired set point, the automation system activates the Pelletier to provide cooling. The cold side of the Pelletier absorbs heat from the greenhouse air, effectively lowering the temperature.

To maintain optimal humidity levels, the Pelletier can be used in conjunction with a water pump and a DC fan. The water pump supplies water to the greenhouse, while the DC fan circulates the air and helps remove excess moisture. The automation system coordinates the operation of the Pelletier, water pump, and DC fan to maintain the desired temperature and humidity levels.

By using a Pelletier-based cooling system, smart greenhouses can achieve precise temperature and humidity control, which is crucial for promoting healthy plant growth and maximizing crop yields. The Pelletier's solid-state design makes it a reliable and energy-efficient option compared to traditional cooling systems



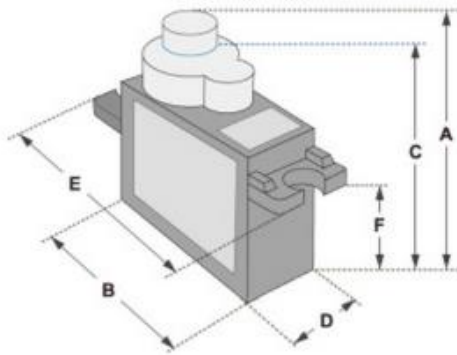
figure 15: Peltier12 volt.

13- Servo motor SG90

Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos. , especially since it will fit in small places. It comes with a three horns (arms) and hardware, The SG90 servo motor is used in smart green house to open and close the window when the humidity level is higher than the required value. The servo opens the window to give the green house fresh and appropriate air, and when it is satisfied, it closes it

Details

- Power: 4.8V – 6V DC max (5V works well)
- Operating Voltage : 3.0-7.2 Volts
- Average Speed: (4.8V no load): 0.12sec/60 degrees
- Torque: At 4.8V 1.2kg-cm / 42.3oz-in ; 6.0V 1.6kg-cm / 56.4oz-in
- Wire length : 20cm
- Size mm: (L x W x H) 22 x 11.5 x 27mm
- Interface : 3 pins



Dimensions & Specifications	
A (mm) :	32
B (mm) :	23
C (mm) :	28.5
D (mm) :	12
E (mm) :	32
F (mm) :	19.5
Speed (sec) :	0.1
Torque (kg-cm) :	2.5
Weight (g) :	14.7
Voltage :	4.8 - 6

Position "0" (1.5 ms pulse) is middle, "90" (~2ms pulse) is middle, "180" (~1ms pulse) is all the way to the left.

PWM=Orange (⏏)
 Vcc = Red (+)
 Ground=Brown (-)

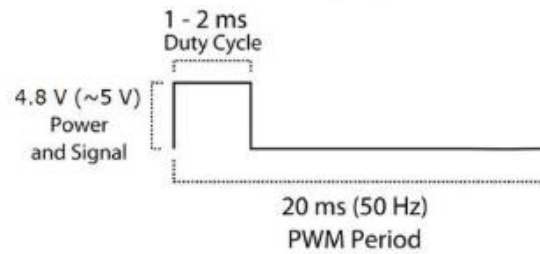


figure 16:Data Sheet of Servomotor SG90



figure 17:SG90 Servomotor

14-MG996 servo motor

The MG996R servo motor is a high-performance motor known for its exceptional torque and precise control. Designed for robotics, automation, and other projects requiring reliable motor movement, the MG996R delivers impressive performance and versatility.

With its robust construction and metal gear design, the MG996R servo motor offers excellent durability and longevity. It can generate a torque of up to 11 kg/cm, allowing it to handle demanding tasks with ease. Whether you're building a robotic arm, a hexapod robot, or any other project that requires strong and precise motion control, the MG996R is up to the challenge.

Featuring 180-degree rotation and a response time of under 0.2 seconds, this servo motor ensures smooth and accurate positioning. It operates on a 4.8V-7.2V power supply, making it compatible with common power sources used in robotics and electronics projects.

The MG996R servo motor also supports continuous rotation modification, providing flexibility for specific applications. The motor comes with a standard 3-pin connector for easy wiring and is designed for straightforward plug-and-play functionality.

This servo is used in smart green house to lift the cover off the water tank when it senses the presence of rain so that it can fill the tank with water and refill it when there is no rain to fill the tank.



figure 18:MG996 servomotor

✚ *Wire Configuration of MG996R Digital Metal Gear High Torque Servo Motor (180 Degree Rotation):*

- RED – Positive
- Brown – Negative
- Orange – Signal (PWM)

✚ Specifications of MG996R Digital Metal Gear High Torque Servo Motor (180 Degree Rotation)

- Operating voltage: 4.8 V - 7.2 V
- Running Current 500 mA – 900 mA (6V)
- Stall Current 2.5 A (6V)
- Temperature range: 0 °C – 55 °C
- Control System: Analog

- Operating Angle: 180degree
- Required Pulse: 900us-2100us
- Direction: CCW
- Operating speed: 0.17 s/60° (4.8 V), 0.14 s/60° (6 V)
- Dead band width: 5 μ s
- Wire length: 30cm
- Connector: 3 pin 'S' type female header
- Weight: 55 g
- Dimension: 40.7 x 19.7 x 42.9 mm approx.
- Stall torque: 9.8 kgf·cm (4.8 V), 11 kgf·cm (6 V)
- Stable and shock proof double ball bearing design

15-Heat Sink

A heat sink is a passive heat exchanger that transfers the heat generated by an electronic or a mechanical device to fluid medium, often air or a liquid coolant, where it is dissipated away from the device, thereby allowing regulation of the device's temperature. In computers, heat sinks are used to cool CPUs, GPUs, and some chipsets and RAM modules. Heat sinks are used with high-power semiconductor devices such as power transistors and optoelectronics such as lasers and light-emitting diodes (LEDs), where the heat dissipation ability of the component itself is insufficient to moderate its temperature.



figure 19:Heat Sink

HOW A HEAT SINK WORKS

Ambient air flows into the heat sink and expels hot air

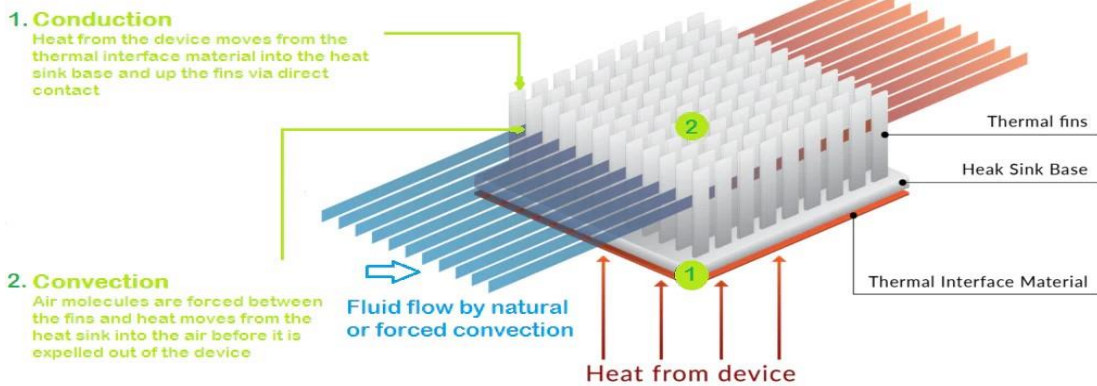


figure 20:How Heat Sink Work

How heat is Transferred ?

The Heat is transferred from higher temperature to lower temperature by the following 3 Ways-

Conduction: It happens due to movement of molecules. Molecules at higher temperatures vibrate at a higher amplitude and pass the energy to the lower temperature molecules.

Convection: Heat is transferred from a hot surface to a cool surface by the bulk movement of fluids (air or liquid).

Radiation: Heat transfer happens in the form of Electromagnetic radiation.

Most of the electronic device cooling systems use conduction and convection type heat transfer for thermal management.

❖ Chapter five :Result and Analysis

This chapter will include the results and discussion of our project.

5.1 Current Achievements:

We gathered the necessary information, read many research papers on smart greenhouse , made a plan to work on it, spotted the tools that we will deal with to control the system, then examined each one separately, and searched for the best sources for electronic parts. at the best price. We also noticed the difference between the controllers and chose the appropriate one, and designed a webpage to send data from the ESP8622 to the controller, because it saves money than buying other parts to design an app. Then we began to study the programming of electronic parts to provide the best performance for the smart greenhouse, and we also obtained satisfactory results

5.2 Feasibility Study:

In this section we analyze the economical part of our project. We compare between the local market prices and the online prices:

Component	localmarketprices
Wi-fi module Esp8266	9.57\$
16 x 2LCD Display	4.1\$
Temperature and humidity sensor DHT11	5.47\$
Soil moisture sensor	5.47\$
LDR Sensor	4.1\$
2DC fan 12volt and heatsink	15\$
2Relay 12 volt	11.00\$

Water pump	16.4\$
Lamp 12volt	5.47\$
Power supply 12volt	54.7\$
Arduino mega 2560	27.35\$
Pelteir 15.4 volt	5\$
Servo motor MG996	14\$
Servo motor SG90	8\$
TotalCost	185\$

Table 6-Feasibility Study

These prices include individual electronic parts and not wholesale, which are much cheaper

5.3 Swot analysis :

SWOT analysis is a powerful framework used to assess the Strengths, Weaknesses, Opportunities, and Threats associated with a specific project or product. This strategic approach serves as a vital tool in understanding the project's position in its market and identifying future strategic directions. In the context of the smart greenhouse project using Internet of Things (IoT) technology , the SWOT analysis provides a comprehensive overview by highlighting the internal strengths and weaknesses of the project, along with external opportunities and threats that may impact it.

Through this framework, the project can leverage its strengths, mitigate weaknesses, capitalize on available opportunities, and take corrective measures to address potential threats, thereby enhancing the project's success and sustainability in the future.

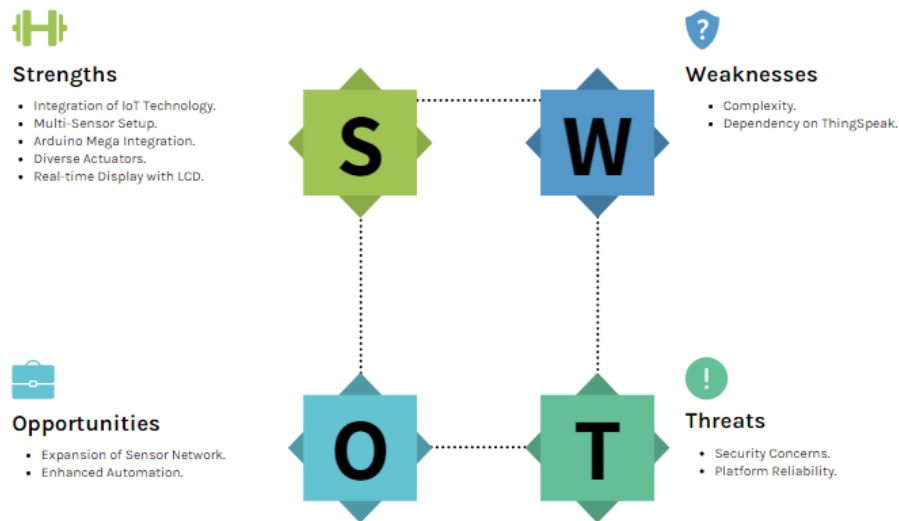


Figure 21-SWOT Analysis

➤ Strengths:

- **Integration of IoT Technology:** The use of IoT technology, including the connectivity to the ThingSpeak platform through the ESP8266, enhances the project's capabilities for remote monitoring and data analysis.
- **Multi-Sensor Setup:** The incorporation of various sensors, such as humidity, temperature, soil moisture, and light sensors, provides comprehensive environmental data, enabling precise control over greenhouse conditions.
- **Arduino Mega Integration:** The use of Arduino Mega allows for efficient and effective control of multiple sensors and actuators, ensuring a robust and scalable system.
- **Diverse Actuators:** The inclusion of a DC fan, water pump, and light bulb as actuators allows for automated control of

temperature, irrigation, and lighting, contributing to a holistic smart greenhouse system.

- **Real-time Display with LCD:** The presence of an LCD screen facilitates real-time monitoring and analysis, providing users with immediate access to relevant data.

➤ Weaknesses:

- **Complexity:** The integration of multiple components, sensors, and actuators may introduce complexity in terms of system setup, calibration, and maintenance.
- **Dependency on ThingSpeak:** The reliance on the ThingSpeak platform for data transmission and analysis may pose a vulnerability, especially if there are disruptions in the platform's services.

➤ Opportunities:

- **Expansion of Sensor Network:** There's an opportunity to expand the sensor network to include additional parameters or specialized sensors, further enhancing the precision of environmental monitoring.
- **Enhanced Automation:** Continuously improving the automation capabilities by incorporating machine learning algorithms or advanced control strategies can optimize resource utilization and increase efficiency.

➤ **Threats:**

- **Security Concerns:** As the project involves IoT connectivity, there is a potential threat related to cybersecurity. Ensuring robust security measures will be crucial to protect the system from unauthorized access or data breaches.
- **Platform Reliability:** The project's dependence on the ThingSpeak platform introduces a vulnerability. If the platform experiences downtime or discontinuation, it may affect the project's functionality.

By considering these factors, you can develop strategies to capitalize on strengths, address weaknesses, explore opportunities, and mitigate potential threats in the implementation and future development of your smart greenhouse project.

Chapter Six: Conclusion and Result :

In the first part of this project, we designed the infrastructure network and several sensors, linking them to a website to display the results in the smart greenhouse. We then enhanced this system by designing a dedicated controller to manage the temperature, soil moisture, and lighting intensity within the greenhouse. This control unit, known as the Arduino mega , serves as the core of our system.

Additionally, we incorporated a rain sensor to open the water barrel and fill it with rainwater. A servo motor was also added to open when humidity levels increase. Furthermore, we built a transparent structural design for the project. Originally, the system operated with three other sensors: the DHT11 sensor to activate the cooler fan when the temperature rises, a soil moisture sensor to trigger the pump when the soil dries out, and a light sensor to turn on the lamp when the light level drops.

Moreover, the project sends data to the ThinkSpeak website, enabling remote monitoring and data analysis.

We hope that this project will help users monitor the smart greenhouse at all times. With these additions, the previously mentioned issues will be effectively addressed.

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Appendix:

The code of Arduino mega :

```
#include <DHT.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <Servo.h>
LiquidCrystal_I2C lcd(0x27, 16, 2);
DHT dht(2, DHT11);
#define RELAY_1_PIN 4 // تعريف دبوس ريليه 1
#define RELAY_2_PIN 5 // تعريف دبوس ريليه 2
#define RELAY_3_PIN 6 // تعريف دبوس ريليه 3
#define LDR_PIN A1 // دبوس مستشعر الإضاءة LDR
#define SERVO_PIN 3 // دبوس محرك السيرفو
#define SERVO_RAIN_PIN 8 // دبوس محرك السيرفو الخاص بالمطر
#define RAIN_SENSOR_PIN A2 // دبوس مستشعر المطر
Servo servo; // Declare the Servo object
Servo servo2; // إنشاء كائن لمحرك السيرفو الخاص بالمطر

void setup() {
  Serial.begin(9600);
  dht.begin();
  Wire.begin();
  lcd.init();
  lcd.backlight();
  pinMode(RELAY_1_PIN, OUTPUT); // تعيين دبوس الريليه 1 كمخرج
  pinMode(RELAY_2_PIN, OUTPUT); // تعيين دبوس الريليه 2 كمخرج

  // بدء محرك السيرفو
  servo.attach(SERVO_PIN);
  servo.write(0); // ضبط زاوية البداية للسيرفو

  // بدء محرك السيرفو الخاص بالمطر
  servo2.attach(SERVO_RAIN_PIN);
  servo2.write(90); // ضبط زاوية البداية للسيرفو الخاص بالمطر
```

```

}

void loop() {
  int soil = analogRead(A0);
  float humadity = dht.readHumidity();
  float temperature= dht.readTemperature();
  int lightLevel = analogRead(LDR_PIN); // قراءة مستوى الضوء من سنسور LDR
  int rainRaw = analogRead(RAIN_SENSOR_PIN); // قراءة قيمة مستشعر المطر

  Serial.println(String(soil)+", "+String(humadity)+", "+String(temperature)
);
  Serial.flush();
  // التحقق من قيمة الرطوبة
  if (soil >= قيمة) {
    // تشغيل ريليه 1
    digitalWrite(RELAY_2_PIN, LOW);
  } else {
    // إيقاف ريليه 1
    digitalWrite(RELAY_2_PIN, HIGH);
  } //التحقق من قيمة درجة الحرارة
  if ( temperature>= قيمة) {
    // تشغيل ريليه 1
    digitalWrite(RELAY_3_PIN, LOW);
  } else {
    // إيقاف ريليه 1
    digitalWrite(RELAY_3_PIN, HIGH);
  }
  // التحقق من شدة الإضاءة
  if (lightLevel>= قيمة) {
    // تشغيل ريليه 2
    digitalWrite(RELAY_1_PIN, LOW);
  } else {
    // إيقاف ريليه 2
    digitalWrite(RELAY_1_PIN, HIGH);
  }
  // التحقق من رطوبة الهواء لتشغيل السيرفو
  if (humadity <= قيمة) {
    // تشغيل السيرفو إلى 90 درجة
    servo.write(90);
  } else {
    // إعادة السيرفو إلى 0 درجة

```

```

    servo.write(0);
}
// التحقق من المطر لتشغيل السيرفو الآخر
if (rainRaw <= 500) { // يمكنك ضبط هذه القيمة بناءً على حساسية مستشعر المطر
    تشغيل السيرفو الآخر إلى 90 درجة
    servo2.write(90);
} else {
    // إعادة السيرفو الآخر إلى 0 درجة
    servo2.write(0);
}

// LCD عرض القيم على شاشة
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("RH:");
lcd.print(humadity);
lcd.print("T:");
lcd.print(temperature);
lcd.print("C");

lcd.setCursor(0, 1);
lcd.print("S:");
lcd.print(soil);
lcd.print(" L:");
lcd.print(lightLevel); // بالنسب المنوية LDR عرض قيمة مستشعر الإضاءة

delay(3000);
}

```

The code of ESP8266:

```

#include <Wire.h>
#include <ESP8266WiFi.h>
#include <ThingSpeak.h>

char* ssid = "wifi_network";
char* password = "123456789";

WiFiClient client;

unsigned long channel = 2544435;
const char * apiKey = "XI05AL5YOKWNMVRV";

void setup() {
    Serial.begin(9600);
}

```

```

    WiFi.begin(ssid, password);
    ThingSpeak.begin(client);
    Wire.begin();
}

void loop() {
    if (Serial.available() > 0) {
        String data = Serial.readStringUntil('\n');

        while(Serial.available() > 0) {
            Serial.read();
        }

        int comma1 = data.indexOf(',');
        String soil = data.substring(0, comma1);

        int comma2 = data.indexOf(',', comma1 + 1);
        String humidity = data.substring(comma1 + 1, comma2);

        String temperature = data.substring(comma2 + 1);

        ThingSpeak.setField(1, temperature.toFloat());
        ThingSpeak.setField(2, humidity.toFloat());
        ThingSpeak.setField(3, soil.toInt());
        ThingSpeak.writeFields(channel, apiKey);
    }
}

```