International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 10 | Oct - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

IOT Based Greenhouse Environment Monitoring and Controlling System

V.Shajin [1], T.Dharma Raj [2]

[1,2]*Department of Electrical and Electronics Engineering,*

[1]*Loyola Institute of Technology and Science, Thovalai, Kanyakumari, Tamilnadu, India.*

[2]*Muthayammal Engineering College, Rasipuram, Nammakal, Tamilnadu, India.*

[1]*shajinengg@gmail.com*

[2]*vinseeedharma@gmail.com*

Abstract: ***Automation in greenhouse is a method where farmer is able to monitor and control the greenhouse environment automatically from anywhere in the world at any time. Also, the system provides the ability for specific people to monitor and manage the systems remotely. It monitors and controls the temperature, water level in soil and light intensity inside the greenhouse and an IoT app is used to store data.***

1.INTRODUCTION

[1] Focusing on making a smart greenhouse-controlled environment area to grow plants. By using a low cost more efficient programmable module to detect the climatic behavior inside the greenhouse and controlling the parameters according to their crop production need, through various techniques with the use of board ESP8266 Node MCU module. The parameters that need optimization are the water content of the soil, the light intensity coming from the natural or artificial sources, the temperature and humidity of the field area. The design proposes monitoring by soil moisture sensor, LDR sensor, and DHT22(temperature and humidity) sensor; all these sensors collected the data and given to the NodeMCU module, and then after processing the data all the parameters are controlled via water pump, motors, exhaust system, and light system as per the data calculations. With the help of HTTP protocol, the NodeMCU module is connected to the wireless internet connection or through IoT platforms like telegram bot. The collected environmental parameters data sent to smartphones via online mode to the farmers to make the proper overlook on their fields, no matter how far they are just by using the IoT platform. In the field of agriculture and food production, the technology has paced up very quickly and is still furnishing its way, to optimize and achieve maximum plant growth in the field of agriculture. An accurate system would surely bring the change in this world of Android/IDS smartphone applications. [2] Climate change has already proven its terrible effect on agriculture. Although greenhouse is already an established system for crop production, with technological advancement it is possible to apply automation in many parts of this greenhouse. Therefore, an automated smart greenhouse based on an adaptive neuro fuzzy inference system (ANFIS) and Internet of Things (IoT) could be the best solution to boost the crop production inside the house. Where, four kind of weather data such as temperature, humidity, sunlight and soil-moisture are being collected by using sensors in real time. These collected data are then feed as input variables to the fuzzy control system. The fuzzy control system manipulate the data and ANFIS then make prediction for optimum values of the weather parameters. Thus, farmers can monitor all the data and can decide the best value for temperature and humidity. The end users (farmers) can visualize all the data by a simple mobile app installed on their cell phone. GSM or TCP/IP is being used for all kind of data transferring. The FIS node also utilizes same networks to transfer IoT perception layer data to application layer. To ensure the data security, four types of potential IoT perceptron layer attacks are considered and shown their probability to occur through the confusion matrix. Later, necessary steps are taken to prohibit the attacks. Here winter crops are considered in the final simulation, when the optimum temperature in winter is 24° Celsius and humidity is 76.00%. The system is 93.62% capable to detect any attack or security breach at perception layer with a Precision value of 0.83, recall of 0.78 and FI score is 0.81. In comparison to other recently proposed and available systems, this work also combines IoT technology for identifying data threat on a network transfer with fuzzy set. This approach improves learning efficiency, improves prediction accuracy, and proved to be a feasible and effective automated greenhouse maintenance system. Simultaneously, the data collecting module and presentation schema of data from various sensors, as well as the security subsystem module, achieve cloud data storage and format conversion that is compliant with protocol format data. As a result, it may provide data traceability and durability for customized indoor agriculture quality and safety. Thus this modern greenhouse maintenance system is efficient, cost effective, secure and easy to use. [3] The Internet of Things, also known as the IoT, refers to the billions of devices around the world that are now connected to the Internet, collecting and sharing data. The amount of data collected through IoT sensors must be completely securely controlled. To protect the information collected by IoT sensors, a lightweight method called discover the flooding attack-RPL (DFA-RPL) has been proposed. The proposed DFA-RPL method identifies intrusive nodes in several steps to exclude them from continuing routing operations. Thus, in the DFA-RPL method, it first builds a cluster and selects the most appropriate node as a cluster head in DODAG, then, due to the vulnerability of the RPL protocol to Flooding attacks, it uses an ant colony algorithm using five steps to detect attacks. Use Flooding to prevent malicious activity on the IoT network. In other words, if it detects a node as malicious, it puts that node on the detention list and quarantines it for a certain period of time. The results obtained from the simulation show the superiority of the proposed method in terms of Packet Delivery Rate, Detection Rate, False Positive Rate, and False Negative Rate compared to IRAD and REATO methods. [4] IoT-based smart farming techniques have come up as one of the solutions to tackle the effect of climate change, water scarcity, etc. which are the prime reason for the decline of agricultural products and increase in their price. In recent year, many works have presented innovative ideas and prototypes which can be used for IoT-based smart farming. This article presents a comprehensive review of the cutting-edge technologies and advancements in the field of IoT-based smart farming. This article also presents a discussion on the IoT-based commercial products developed for smart farming. Based on the review of these exiting works and commercial products, some key challenges and future scope of research in this domain are found and presented in the article. [6] Internet of Things (IoT)-based smart

agriculture monitoring system designed to monitor the environmental temperature, soil moisture, and humidity of the crop soil. The system uses sensors, including the temperature and humidity sensor for temperature and humidity monitoring, and a soil moisture sensor to detect the level of soil moisture. These sensors connect to an ESP32 microcontroller, the central element for data processing and communication. These sensors transmit data to a smartphone application, which gives users immediate access to essential information about their plant. When the temperature and humidity levels surpass predetermined limits, the water pump will function to ensure that crops receive sufficient water at the right time. With the support of the Blynk App, users may remotely monitor and control the system using the mobile application, which provides real-time alerts. By utilizing IoT technology, an intelligent agricultural field monitoring system that tracks temperature and humidity in the soil can be achieved. The implementation of this system tends to eliminate water waste, save labor costs, and develop more sustainable as well as effective farming techniques. By using this technology, farming operations will become more intelligent, and agricultural output will increase significantly. [7] An IoT-based greenhouse environment monitoring and controlling system is an automated system that uses internet-connected sensors to collect data on temperature, humidity, soil moisture, and light levels, and then uses this data to control actuators like fans, pumps, and lights to maintain optimal growing conditions. This technology automates processes, reduces manual labour, and allows for remote monitoring and management through a user-friendly application or dashboard. By continuously adjusting environmental factors, the system ensures plants receive the right conditions for healthy growth, leading to increased crop yield and quality. A green house is where plants such as flowers and vegetables are grown. Greenhouses warmup during the day when sun-rays penetrates through it, which heats the plant, soil and structure. Green houses help to protect crops from many diseases, particularly those that are soil borne and splash onto plants in the rain. Greenhouse effect is a natural phenomenon and beneficial to human being. [8] Numerous farmers fail to get good profits from the greenhouse crops for the reason that they can't manage two essential factors, which determines plant growth as well as productivity. Green house temperature should not go below a certain degree, High humidity can result to crop transpiration, condensation of water vapour on various greenhouse surfaces, and water evaporation from the humid soil. To overcome such challenges, this greenhouse monitoring and control system comes to rescue. This project demonstrates the design and implementation of a various sensors for greenhouse environment monitoring and controlling. This greenhouse control system is powered by Atmega328 microcontroller it consists of temperature sensor, light sensor, soil moisture sensor, LDR sensor, LCD display module, 12v DC fan, Bulb and pump. Temperature sensor, senses the level of temperature., if it goes high DC fans gets on and when the temperature goes low the fan gets off. Soil moisture sensor, senses the water level as the level decreases the pumps gets on. In the absence of light, the LDR sensor senses and the bulb starts glowing. By this way it will become easy to monitor and control the system. [9] *Agriculture is a really important field for the economic development of any country. Most of the researchers are focusing on this field, by providing smart solutions for the day to day problem in field of agriculture. IoT (Internet of Things) has played a very essential role for the development of this sector, in fact IoT Technology has played a vital role in each and every field. IoT enables a working area in which everything works smartly and intelligently. IoT can be defined as a network of things which can make a self-configuring network. By developing new smart devices for the field of agriculture, it is converting the face of traditional farming to a new and intelligent level of agriculture production. IoT is not only enhancing the traditional agriculture to a smart agriculture but it enabling the new techniques for smart agriculture which are cost-effective as compared to the traditional agricultural tools. By the continuous monitoring of the processes and production it is also reducing the wastage of the crops. This paper aims to explore the various available techniques, methods, devices in the sector of the smart agriculture.*

2. PROPOSED SYSTEM:

The proposed system uses transducers to sense the light, temperature, humidity, soil moisture and control the conditions inside the greenhouse using IoT technique.

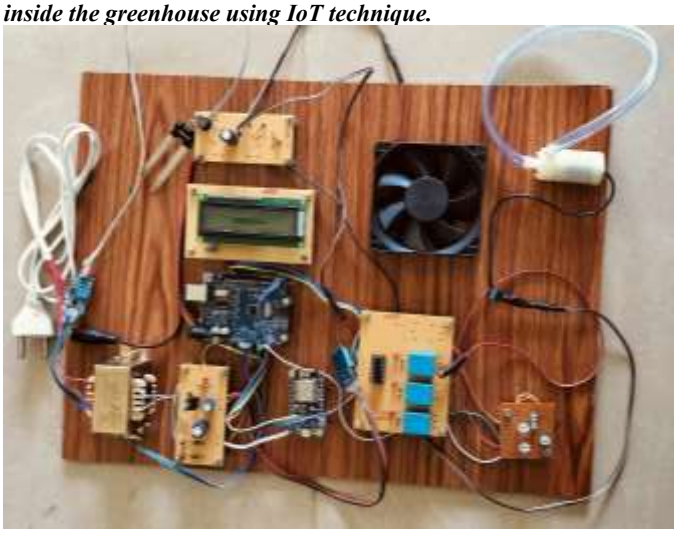

Figure 1. Proposed system

The Figure. 1 represent the output of the project.

[6] An IoT-based greenhouse environment monitoring and controlling system integrates various sensors to provide real-time data on crucial environment parameters such as temperature, soil moisture, humidity and light intensity. These sensors continuously collect data within the greenhouse. The temperature sensor monitors the ambient temperature, ensuring it remains within the ideal range for the specific plants being cultivated. Soil moisture sensors gauge the moisture content, ensuring plants receive adequate hydration without overwatering. Humidity sensors track the moisture levels in the air. Light intensity sensors measure the amount of light available, essential for photosynthesis and regulating plant growth cycles. This system automatically gathers data from these sensors and transmits it to a mobile device, providing real-time updates to greenhouse managers or owners. Thus the IoT-based greenhouse monitoring and controlling system empowers growers with actionable insights, enhancing efficiency and ensuring the successful cultivation of crops.

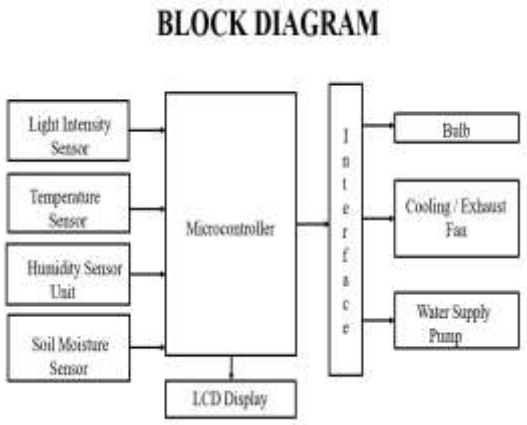

Figure 2. Proposed Block Diagram

2.1 *SOIL MOISTURE SENSOR*:

This sensor is used to test the moisture of the soil. When the moisture level of the soil is low, the sensor output will be high otherwise the output will be low. The module has three outputs. Digital output, Analog output and Serial output.

2.2 TEMPERATURE SENSOR & HUMIDITY SENSOR:

It is used to monitor the temperature & humidity of the atmosphere. The sensor uses capacitive humidity sensor and a thermistor.

2.3 WATER SUPPLY PUMP:

The DC 3V-6V Mini Micro Submersible Water Pump is used. It is a low cost, small size submersible pump motor. It operates with a 2.5V to 6V power supply. It can pump up to 120 litres per hour with a very low current consumption of 220mA.

2.4 POWER SUPPLY:

Power supply is used to supply electric power to the circuit. In the circuit +12V & +5V power supply is used in the circuit.

2.5 MICROCONTROLLER:

The Arduino Integrated Development Environment (IDE) is a cross-platform application in which the functions are written in C and C++ languages. It is used to write and dump the written programs to Arduino compatible boards with the help of third-party cores and other vendor development boards.

2.6 LIGHT INTENSITY SENSOR:

It refers to the intensity of light inside the green house. It is measured using photo diode.

2.7 LIQUID CRYSTAL DISPLAY(LCD):

The LCD is used to display the values of humidity and temperature within the greenhouse as well as pump and fan status.

2.8 COOLING / EXHAUST FAN:

The cooling fan is used to circulate fresh air inside the green house. Exhaust fans are essential for maintaining the air quality and temperature of homes and commercial spaces. They work by pulling out hot, humid, and stale air and making it relatively cool. In this blog, we will explore the benefits of exhaust fans, how they work and how you can choose a suitable option for your needs.

2.9 INTERFACE:

The interface displayed real-time data from the sensors including temperature, humidity, soil moisture and light intensity. The interface also provides control for the actuators, allowing the user to turn on or off the fan, motor pump and Light Eimitting Diode (LED) light.

2.10 SYSTEM ARCHITECTURE:

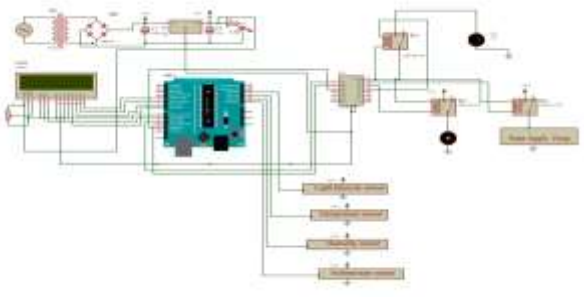

Figure 3. Proposed methodology architecture

The greenhouse environment monitoring and controlling project, based on IoT and Arduino, utilizes four sensors to detect temperature, light, humidity, and soil moisture levels inside the greenhouse. A temperature sensor is used to measure the temperature inside the greenhouse, with the readings sent to the microcontroller. The microcontroller is connected to relays, with one relay connected to a blower. If the temperature exceeds or falls below the threshold value, the microcontroller sends signals to turn on the fan. A light sensor is used to measure the amount of sunlight inside the greenhouse, with the readings sent to the microcontroller. If the sunlight exceeds the threshold value, the microcontroller sends signals to turn on a relay, which in real-time acts as a 'shade' to reduce the amount of sunlight. For demonstration purposes, a DC motor is connected to replicate a shade. Similarly, a humidity sensor is used to measure the humidity value, and a soil moisture sensor with two probes dug in the soil is used to measure the soil moisture. If the humidity value exceeds the threshold value or if the soil moisture reduces, the microcontroller turns on a blower to decrease humidity and opens a water outlet to increase moisture in the soil. For demonstration purposes, a DC motor is connected in place of the blower and water outlet.

3. HARDWARE DESCRIPTION:

3.1 ARDUINO IDE:

Arduino IDE software makes it easy to write code and upload it to the board. The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. An integrated development environment (IDE) is a software application that helps programmers develop software code efficiently. It increases developer productivity by combining capabilities such as software editing, building, testing, and packaging in an easy-to-use application. The two main, required functions in any Arduino sketch are setup() and loop(). The setup() function runs once at the beginning of a sketch to initialize settings like pin modes and serial communication. The loop() function then runs repeatedly, executing the program's main logic until the board is reset or powered off.

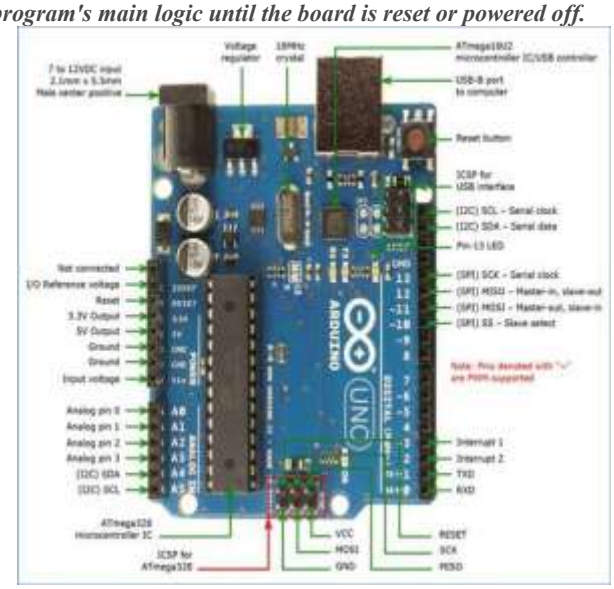

Figure 4. Arduino IDE

3.2 DHT11 SENSOR:

It is used to measure the temperature and humidity. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and then outputs a digital signal on the data pin. The DHT11 is a low-cost digital sensor that measures both air temperature and relative humidity, outputting a calibrated digital signal to a microcontroller. It uses a capacitive sensor for humidity and a thermistor for temperature, requiring a single data pin for communication and easily interfacing with platforms like Arduino and Raspberry Pi. While simple to use and offering long-term stability, its readings have a limited accuracy and a sampling rate of no more than once per second.

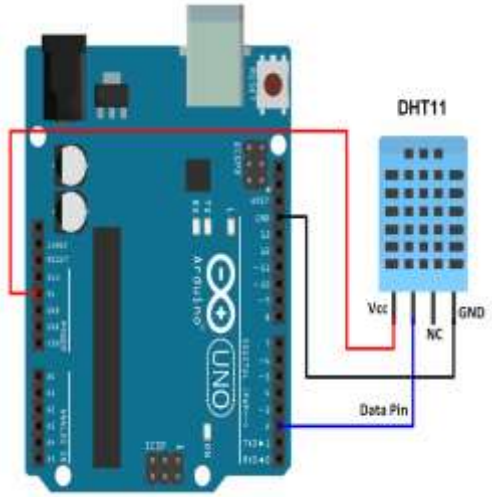

Figure 5. DHT11 sensor

3.3 SOIL MOISTURE SENSOR:

It measures the volumetric water content in the soil. A soil moisture sensor is a device that measures the water content in soil, essential for optimizing plant growth and managing irrigation. It works by detecting the soil's electrical conductivity or dielectric properties, which change with moisture levels, and translating this into an electrical signal. Common types include simple resistance-based sensors for hobbyists and more advanced TDR (Time Domain Reflectometry) and FDR (Frequency Domain Reflectometry) sensors used in precision agriculture.

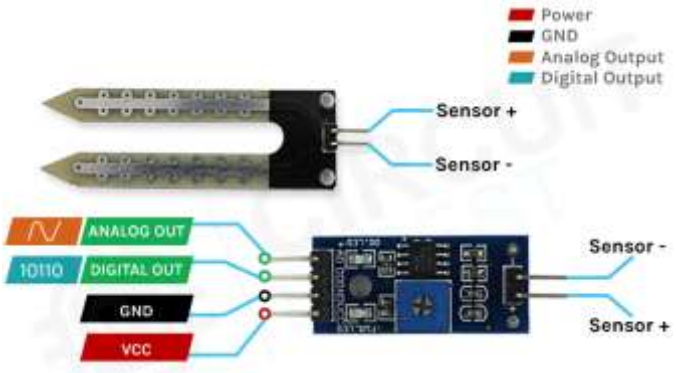

Figure 6. Soil Moisture Sensor

3.4 LED:

A Light Emitting Diodes (LED) is small energy efficient light. It emits light when current flows through it. Common in electronics for indicators and displays. A light-emitting diode (LED) is a semiconductor device that emits light when an electrical current pass through it, a process called electroluminescence. As a type of p-n junction diode, it converts electrical energy directly into light energy by the recombination of electrons and holes, releasing the energy as photons. LEDs are energy-efficient, long-lasting, and are found in many applications, from display screens and lighting to data communication.

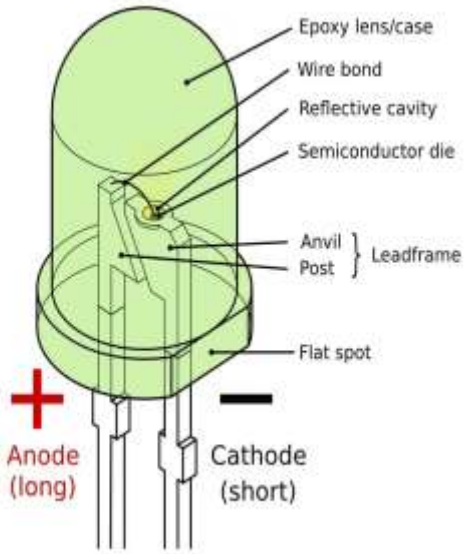

Figure 6. Soil Moisture Sensor

LED (Light Emitting Diode) is an optoelectronic device which works on the principle of electro-luminance. Electro-luminance is the property of the material to convert electrical energy into light energy. It is specially doped p-n junction diode made up of specific type of semiconductors.

3.5 LCD DISPLAY:

The LCD displays humidity and temperature levels inside the greenhouse. It also displays the status of pumps and fans. This technology uses liquid crystals, which are substances with properties of both liquids and solids, to create images on a screen. When an electric current is applied, the liquid crystals align to allow or block light, creating the images you see on the display.

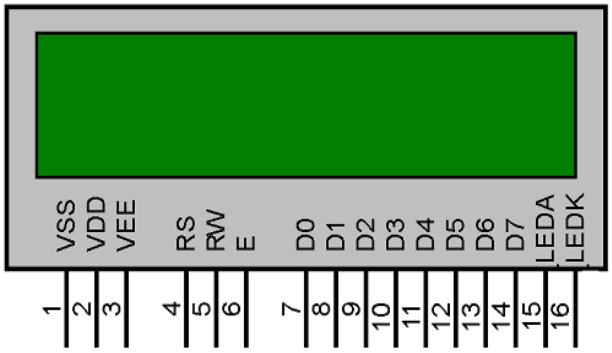

Figure 7. LCD display

3.6 FAN:

It is used to regulate temperature and humidity, prevent overheating and mold, ensuring healthy plant growth in controlled environment. which creates airflow inside the computer case. The fan draws in cool air from the surroundings and pushes it over the heat-generating components like the central processing unit (CPU) and graphics processing unit (GPU).

Figure 8. Fan

3.7 ***WATER PUMP:***

Automates watering system, providing precise and efficient irrigation for plants, ensuring optimal moisture level for growth. Centrifugal Jet Pumps – These provide a steady and strong flow of water with the water coming from underground. Depending on the depth, you can get a centrifugal deep well jet or a shallow well jet pump. These pumps can lift water from > 25 Feet depth. Centrifugal jet pumps are also efficient and easy to install.

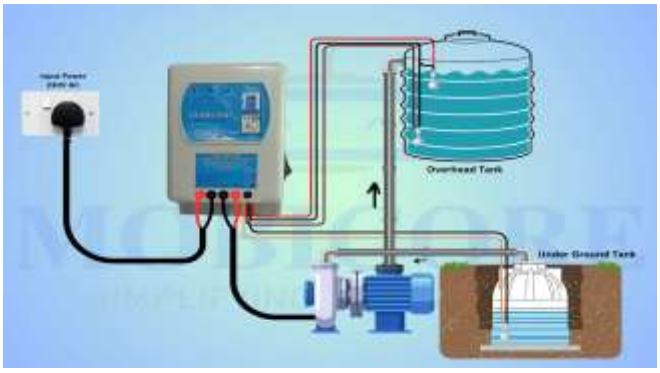

Figure 9. Water pump

3.8 LDR:

Light intensity is used to regulates light for plant growth, crucial for photosynthesis, ensuring optimal conditions for healthy and thriving plants. "LDR" can refer to a Light-Dependent Resistor, a component whose resistance changes with light intensity, or a Long-Distance Relationship, a romantic relationship between geographically separated partners. In other contexts, it can also mean a Loan-to-Deposit Ratio, a financial metric, or a Labor-Delivery-Recovery Room, a hospital room for childbirth.

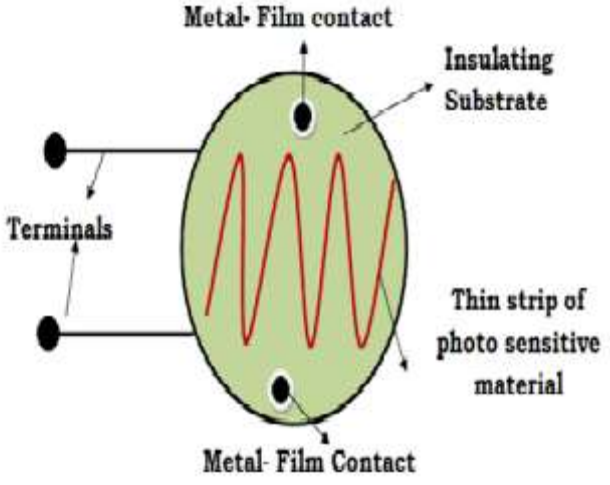

Figure 10. Light-Dependent Resistor

3.9 BH1750 LIGHT INTENSITY SENSOR:

This sensor is used to accurate light measurements for optimizing plant growth and adjusting artificial lighting conditions accordingly.

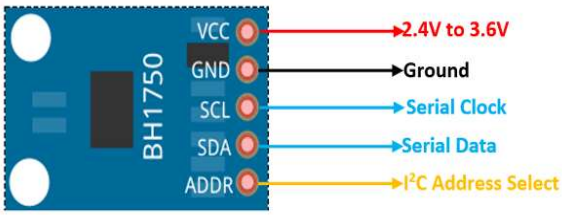

Figure 10. Light-Dependent Resistor

3.10 POWER SUPPLY:

The supply power connects to the Arduino and provides the necessary voltage and current for its operation. It also powers the sensors, relays, and other components in the system.

4. CONCLUSION

The developed cost-effective greenhouse model can be used to monitor and control temperature, light intensity, humidity and soil moisture of a greenhouse in order to increase productivity in farming where there is ample risk of insect infestation, harsh climate and increasing demand of food with the decrease of fertile land. The model is fully automatic and so, does not require human interaction to smooth monitoring the plant. In order to analyze the data, an Internet of Things based databases has included in this model.

REFERENCES:

[1] Aditya Vishwakarma; Ankit Sahu; Nadeem Sheikh; Peeyoosh Payasi; Saurabh Kumar Rajput; Laxmi Srivastava, (2020) 'IOT Based Greenhouse Monitoring And Controlling System', International Research Journal of Engineering and Technology (IRJET), Volume: 07, Issue: 03, Mar.

[2] Sultana Jahan Soheli,Nusrat Jahan,Md Bipul Hossain,Apurba Adhikary,Dr. Md. Ashikur Rahman Khan,M. Wahiduzzaman "Smart Greenhouse Monitoring System Using Internet of Things and Artificial Intelligence"June 2022.

[3] Fotohi, R., & Pakdel, H. (2021). A lightweight and scalable physical layer attack detection mechanism for the Internet of Things (IoT) using hybrid security schema. Wireless Personal Communication, 119, 3089–3106.

[4] Srivastava, A., & Das, D. K. (2021). A comprehensive review on the application of Internet of Thing (IoT) in smart agriculture. Wireless Personal Communication.

[5] Marietta, J., & Chandra, M. (2020). Review on routing in Internet of Things. Wireless Personal Com-munication, 111, 209–233.

[6] R. Mythili, Meenakshi Kumari, Apoorv Tripathi and Neha Pal, "IoT Based Smart Farm Monitoring System", International Journal of Recent Technology and Engineering (IJRTE), vol. 8, no. 4, November 2019.

[7] Aisha Yahaya, Yusuf Aleshinloye Abass, Prof. Steve A. Adeshina, (2019) 'GREENHOUSE MONITORING AND CONTROL SYSTEM WITH AN ARDUINO SYSTEM', 15th

International Conference on Electronics, Computer and Computation (ICECCO), 978-1-7281-5160-1/19 IEEE.

[8] Safaa Najah Saud Al-Humairi, Prasad Manimaran, Muhammad Irsyad Abdullah, Junaidi Daud, (2019) 'A Smart Automated Greenhouse: Soil Moisture, Temperature Monitoring and Automatic Water Supply System (Peaty, Loam and Silty)', 978-1-7281-3276-1/19 IEEE.

[9] ***Harshit, B., Brij, B., & Nagesh, K. (2019). IOT: The current scenario and role of sensors involved in smart agriculture. International Journal of Recent Technology and Engineering (IJRTE), 8(4), 12011–23***