IoT based Green House Monitoring and Controlling System

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Abstract

The greenhouse business is the quickest developing area around the world. The smart greenhouse helps in isolating the harvest from the climatic changes. It shelters the plant growth from immediate sunlight and outside weather conditions. To provide a monitoring and control facility within the greenhouse, a framework based on the Internet of Things will be more flexible and sensible. The research focuses on developing a smart, climate-controlled greenhouse for vegetable cultivation. This is achieved by using a low-cost, highly efficient programmable module to monitor and control the greenhouse's climate. The boundaries of the greenhouse are adjusted based on the specific requirements for optimal harvest production. The ESP12F NodeMCU module is utilized for this purpose. The areas that require improvement include the soil's water content, the temperature, and the moisture levels of the field. The plan involves checking with a soil sensor and a DHT11 sensor. The information gathered through the sensors are sent to the NodeMCU that is connected to the IoT or the web connection through a HTTP convention. The farmer is capable of receiving the information in his mobile phone with the help of the IoT. In the field of agriculture, innovation has rapidly advanced and continues to evolve, aiming to enhance and achieve optimal plant growth in the agricultural sector. A precise framework would undoubtedly have an impact on the world of Android/IDS smartphone applications.

Keywords: AC, DC, DHT11, ESP8266, IoT

DOI: https://doi.org/10.36548/jsws.2023.3.003
Received: 03.07.2023, received in revised form: 01.08.2023, accepted: 17.08.2023, published: 28.08.2023

1. Introduction

1.1 Background

In this modern era, where there is automation in almost every sector of development, the agriculture sector, which has been long practiced in our country, has been unable to cope up with the pace of development. Having a 66% population engaged in agriculture, it only contributes to 23.13% in the economy (in 2020 A.D.) Though a large number of the population is involved in agriculture, the country's economy has not taken a steady growth. This indicates a need to improve the system.

The Agriculture Sector has a lot of potential in developing the economy if handled smartly. If the crops planted tend to produce as expected, the production of crops will increase steadily solving many economic problems of the country.

For a proper development of the crops, there should be balance on the humidity level, soil moisture level and temperature for a particular crop. A suitable environment is essential for cultivating a specific crop, and it needs to be continuously monitored and controlled. In case the environmental conditions become unfavorable, this can be achieved by implementing IoT technology for greenhouse monitoring and control. [1]

1.2 Problem Statement

Manual monitoring of the parameters can be tiring and time consuming. Additionally, the person performing the monitoring must be physically present near the area of concern. The implementation of IoT for greenhouse monitoring and control solves the problem of monitoring parameters such as humidity, soil moisture, and temperature. This can be done even when a person is not physically present, as long as they have a Wi-Fi connection. Additionally, necessary control actions can be taken if the situation becomes unfavorable, saving both time and effort.

1.3 Objectives

• To design a system that constantly monitors agricultural parameters such as temperature, soil moisture, and humidity, and also controls the operation of the bulb (AC), cooling fan, and motor through relays using a smartphone.

• To develop an Android app that provides a user interface for monitoring and controlling parameters.

1.4 Scope and Limitation

Greenhouse monitoring and control using IoT implementation can help create a suitable environment for the crop of your interest. It provides real-time data on parameters that are important to you. It provides efficiency in creating a favorable environment through the digitalization of parameters, saving time and effort for humans. Drawback of a project are:

- The app should constantly be connected to the Wi-Fi for real time monitoring and control.
- Higher technical complexity, more maintenance is required.
- Unreliable performance when sudden changes happen in the external environment.

2. Related Work

Anuj Kumar Considered and explored how to develop a DSP-based EMS to continuously monitor the climatic conditions that directly or indirectly influence the growth of greenhouse plants. [1].

“Yongxian Song, Juanli Ma, Xianjin Zhang, Yuan Feng” By examining and researching the qualities of horticulture observed the framework, and introduced a framework plot based on a remote sensor network. This framework utilizes the Atmega128L chip and CC2530, a low power RF chip from TI, to design the sink hub and sensor hubs in the WSN. [2].

“B. Guraiah”. In this method mainly used an ARM7 microcontroller, which works as a controlling unit. ARM7 loaded with the keil software code using the flash magic was used in monitoring and controlling the greenhouse. . [3]

“Xiaoxia Wang and Haibo Yu” Suggested a greenhouse control framework to satisfy the receiving, sending and remote monitoring of the sensed data’s. The greenhouse control system of the Internet of Things has been tested and analyzed, and the experimental results demonstrate that the system can achieve the desired greenhouse effect. [4].

"Ioannis Gravalos, Zisis Tsiropoulos, Dimitrios Moshou and P.Xyradakis developed a framework to implement a system using a computer that is accessible through a webpage, in order to collect and manage real data. Information sources include air temperature, video signal measured with digital devices, and soil moisture content detected by soil moisture sensors. It allows remote end-users to access agricultural information through a computer network. [5].

"Mustafa Alper Akkaş and Radosveta Sokullu" carried out the greenhouse monitoring and control using the WSN prototype and Internet of things enabling the farmers to manage the greenhouse operations remotely . [6]

3. Proposed Work

3.1 Block Diagram

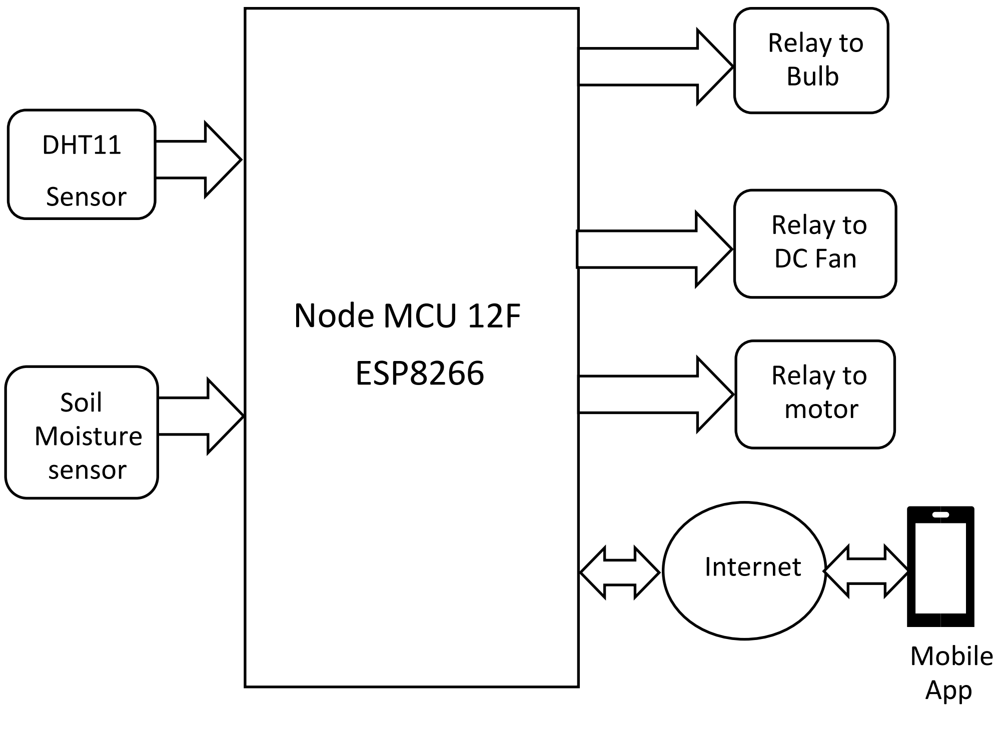

Figure 1. Block Diagram

The proposed design is straightforward model. It consists of three major components, namely. Mobile App, Firebase, and NodeMCU System.

(i) Mobile App:

It is a graphical user interface that plays a major role in the system for IoT approach.

This is the user interactive body of the system. User only need to have app to control and monitor greenhouse. Mobile app gets the data from the firebase real time database and displays it on the interface. The information observed through the sensors about the temperature, humidity, and moisture level of the greenhouse, can be controlled by the user with the help of devices like motor, humidifier, fan and bulb.

(ii) Firebase:

Firebase is the cloud database service provided by the Google. It also provides the facility of real time database, which is being used by the study to transfer data between mobile app and Nodemcu system. It works as a mediator between software and the hardware. The data passed by Nodemcu is stored in the real time database of the Firebase and it is further fetched by the mobile app. And again mobile app sends controlling signal to firebase which is fetched out by the Nodemcu.

(iii) NodeMCU:

It is the microcontroller based on ESP8266 wi-fi module. Sensors and the controlling devices are connected to this processor and with wi-fi module attached with the processor it connects with firebase real time database. It gets data from DHT11 and moisture sensor. DHT11 sensor is the sensor which can measure temperature and humidity of the environment. These data are send to Firebase and controlling signals are fetched by Nodemcu and finally turning on/off the devices connected with relay modules according to controlling signals send by the user.

3.2 Flowchart

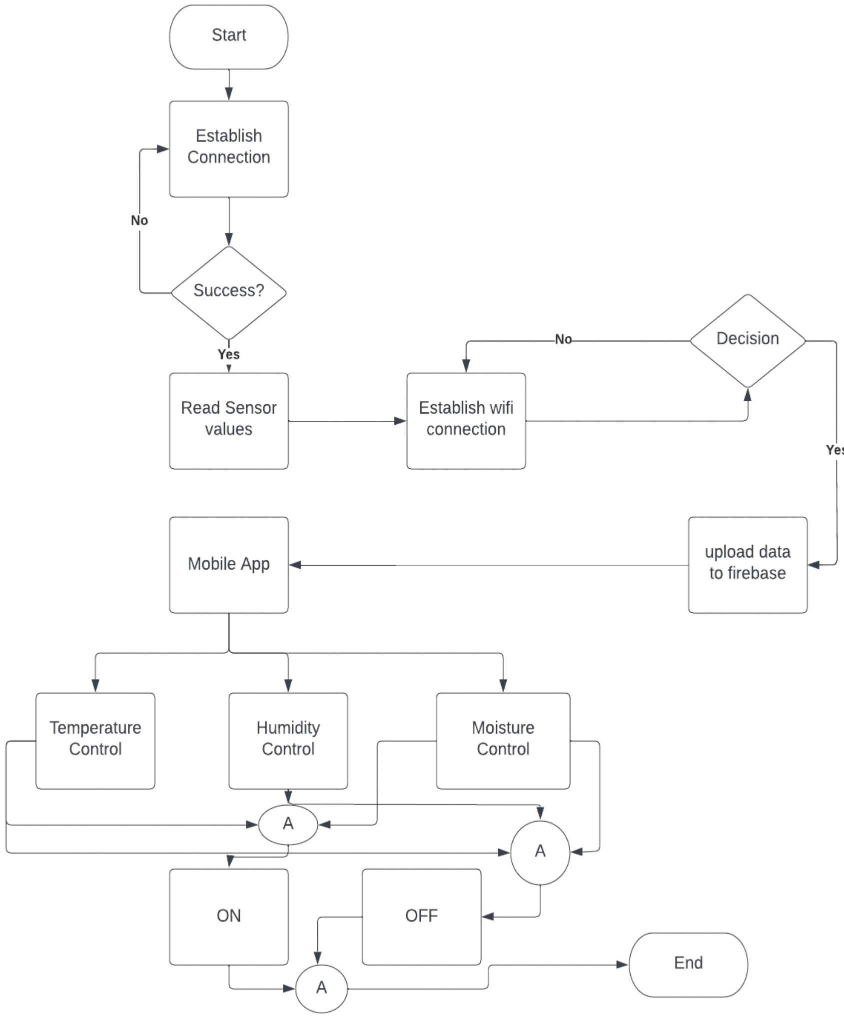

Figure 2. Flow Chart of the project

The working of the device starts after the connections are established successfully. The hardware components are connected precisely and accurately to read accurate data. The sensor values are read using the soil moisture, temperature and humidity sensors send to the processor. Processor tries to establish the connection with Firebase with the wi-fi module through the local wi-fi network. After establishing the connection successfully data is transferred to the firebase server. That transferred data is now fetched by mobile app with the internet connection from firebase and gets displayed in the mobile app interface. And the user can monitor the change in values of the parameters through the android app screen.

For controlling the parameters of the green house environment there are buttons to control the operation of ac bulb, dc motor and fan in the mobile app. By pressing these buttons it sends the signal to the firebase and which is further fetched by NodeMCU and takes action according to the signal. By controlling the operation of connected devices the parameters like fan, motor and bulb and sensors like soil moisture, humidity and temperature are controlled. For example, if the temperature of greenhouse environment goes above the desired value, fan is turned on through the android app which helps to maintain the temperature of the greenhouse in desired condition.

3. 3 Circuit Diagram

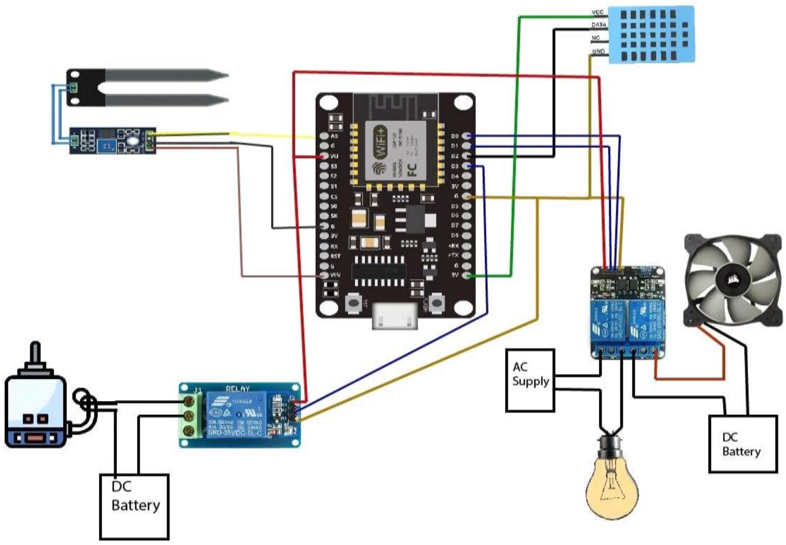

Figure 3. Circuit Diagram

The circuit diagram of the green house monitoring and controlling framework is as displayed in the figure.3 above. It consists of a NodeMCU, a 2-channel relay, a single channel relay, a soil moisture sensor, a DHT11 sensor, a DC motor, 2 DC batteries, an AC bulb, and an AC power supply.. Every part is connected using jumper wires. The soil moisture sensor is connected to the A0 pin, while the DHT11 sensor is connected to the D2 pin. Their VCC and Ground pins are interfaced with the corresponding pins on the processor. One transfer is associated with D3, and one more is associated with D0 and D1. Their VCC is associated with the VU pin of the processor, which provides the necessary 5V supply for transfer. Also, finally, AC bulbs are powered by AC supply, while DC motors and fans are powered by DC batteries.

3.4 Components Used

The green house monitoring and control system using IoT implementation has the following electronic components:

3.4.1 NodeMCU 8266

Node MCU(Node Micro Controller Unit) is an open- source software and tackles development terrain grounded on a low- cost system- on- chip(SoC) called ESP8266. Developed and manufactured by Espressif Systems, the ESP8266 contains the essential rudiments of a computer. CPU, RAM, network(WLAN) and indeed the rearmost operating systems and SDKs.thus, it's ideal for all kinds of Internet of Things(IoT) systems.

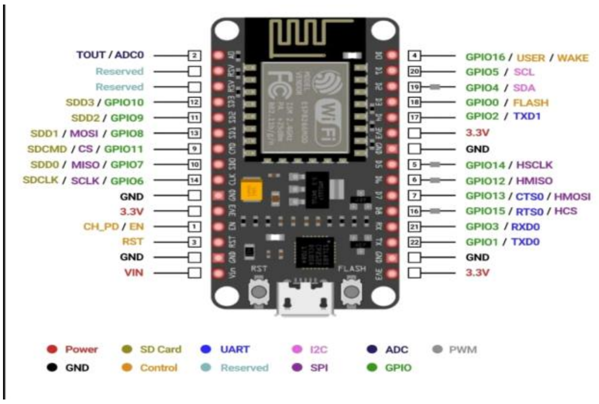

Figure 4. NodeMCU8266 [7]

3.4.2 DHT11 Sensor

The widely used DHT11 temperature and humidity sensor has an exclusive NTC for temperature measurement and an 8-bit microprocessor that delivers temperature and humidity values as serial data.

Figure 5. DHT11 Sensor [8]

3.4.3 DC Motor

An electrical device that transforms electrical energy into mechanical energy is a DC motor. Direct current electrical energy is used in a DC motor to create mechanical rotation.

Figure 6. DC motor [9]

3.4.4 Bread Board

A breadboard is a solderless device for temporary prototyping of electronic circuits and testing of component designs. Most electronic components in an electronic compass can be connected to each other by inserting leads or terminals into holes and connecting them with lines as required. Breadboards have strips of conductive material that connect holes on the top surface of the board. The substance lists are laid out like this. Note that the top and bottom rows of holes are connected horizontally and meet in the middle, while the remaining holes are connected vertically.

Figure 7. Breadboard [10]

3.4.5 AC Bulb

The AC bulbs converts electrical energy into heat and light energy. The bulbs are used in order to provide light quality closer to natural sun light

Figure 8. AC Bulb [11]

3.4.6 Jumper Wires

Jumper wires are commonly used on breadboards and other prototyping tools to establish connection across the components.

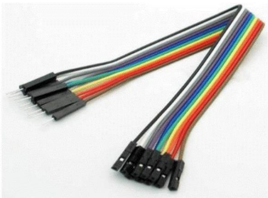

Figure 9. Jumper Wires [12]

3.4.7 Two Channel Relay Modules

Various microcontrollers, such as Arduino, AVR, PIC, and ARM, can directly control the 2 Channel 5V Relay Module, which is a relay interface board. The relay is controlled by a low-level trigger control signal that ranges from 3.3 to 5 VDC. The relay's typically open or normally closed contacts are activated when it is triggered. Circuits for automatic control are commonly used. Fundamentally, it is an automatic switch designed to control a high-current circuit with a low-current signal. The 5 to 05 volt relay input voltage range. (VCC) System Power Supply Relay for Power Supply: JD-VCC. VCC and JD-VCC may be abbreviated.

Figure 10. 2-Channel Relay module [13]

4. Results and Discussion

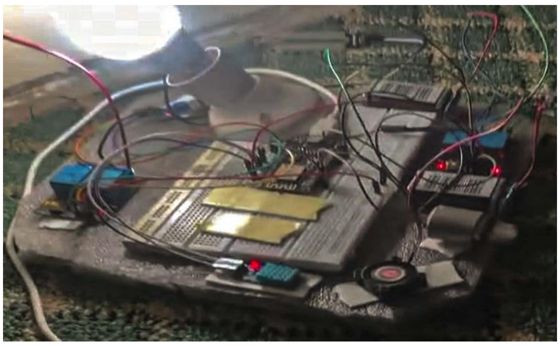

Figure 11. Proposed Prototype

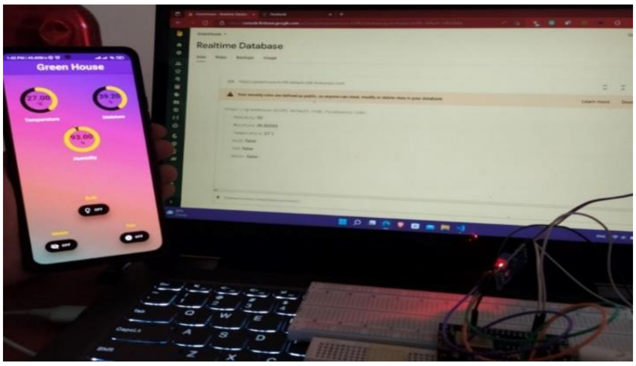

Figure 12. Mobile User Interface Output

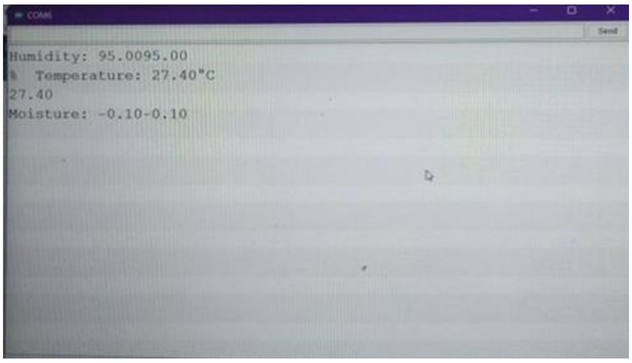

Figure 13. Arduino Output

In these snapshots, it is represented that the hardware is getting data of the temperature, humidity and moisture. And those data are respectively transferred to Firebase realtime database and mobile app interface. A figure .12 represents data from greenhouse transferred to realtime database and then sent in mobile to the user and figure .13 represents data from Arduino.

The proposed greenhouse monitoring system utilizes IoT technology to monitor and control various environmental parameters within the greenhouse. This includes monitoring temperature, humidity, soil moisture. By collecting real-time data from sensors placed throughout the greenhouse, a comprehensive understanding of the greenhouse's conditions can be created. One of the key advantages of the system is its ability to provide remote access and control. Users can monitor and control the greenhouse parameters from anywhere using a web or mobile application. This allows for greater flexibility and convenience in managing the greenhouse, as adjustments can be made and alerts can be received even when users are not physically present. The prototype of the proposed system is shown in figure.11

To improve the performance of the system, several enhancements have been implemented. The system has been integrated with weather forecasting services. By combining real-time sensor data with weather predictions, changes in weather conditions can be anticipated and the greenhouse parameters can be adjusted accordingly.

The IoT-based greenhouse monitoring system offers an approach to greenhouse management, providing real-time monitoring, remote access, and intelligent control. Ongoing research and development aim to further enhance its performance and contribute to sustainable agriculture practices.

5. Conclusion

The proposed method for monitoring and controlling greenhouse system with the help of NodeMCU processor and sensors, like DHT11 and Soil moisture sensor. The use of mobile application provides the total control over the system using the firebase real time database to provide the interface between mobile app and the hardware system. It provides the solution for complete monitoring of any vegetation system inside the green house by measuring temperature, humidity and soil moisture. It also provides remote control over these parameters and hence improves the time management and quality management.

As it provides better quality management and time management at a low cost, it plays an important role in improving production within a greenhouse system.

Appendix:

Green House Monitoring System app using flutter and Arduino code link https://drive.google.com/file/d/1OTvI_VR5VF15tZxBawOWkom1na_0IKgT/view?usp=sharing

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