Smart IoT-Based Greenhouse Monitoring System

Agilesh Saravanan. R, Gowri Priya, Sai Nishanth, Praveen Sai, and Vasanth Kumar

1 Introduction

The greenhouse is the location where we can grow fruit and vegetables. Every plant or crop has a specific environment to grow. Nowadays, the environment, temperature, and humidity are changing every day. As a result, plants do not grow well, and few crops end without any benefit. I think it is the main reason to lose a crop by farmers. As a result, this project can reduce damage to crops/plants and help plants to live for a long time.

In this chapter, we observe the surrounding environment of plants and crops like temperature, humidity, light intensity, and soil moist by using DHT11, light dependent resistor (LDR), and soil moisture sensors, respectively. Here, we use a DC fan to cool down the temperature, light bulbs, and a water pump to wet the soil [4]. Here, we add a WI-FI module ESP8266 to monitor parameters and notification when the fan or blub or water motor is switched on/off. Earlier instead of Wifi Azevedo et al. [1] use the Zigbee network for Application layer.

Temperature, humidity, soil moisture, and light intensity will be collected by project till the end of the project. In today's greenhouses, the monitoring of parameters is important for the good quality and productivity of plants. However, certain parameters such as temperature, humidity, soil moisture, and light intensity are required for higher plant growth in order to achieve the stated consequence [13]. Thus, Node MCU has been developed primarily as a greenhouse control unit using sensors. The Node MCU is used for this project. Node MCU can receive feedback from a wide range of sensors and can control generators, lights, and various actuators. Few sensors are used to measure few parameters. DHT11 sensor is used to

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measure temperature and humidity values. The soil moisture sensor tests the water content of the soil [10]. The LDR sensor is used at a modest depth. The exhaust fan, water pump, and artificial light are also connected to the Node MCU.

All environmental parameters are dispatched to android cell phone via offline. A cloud is used to ship environmental parameters to server. As a result, when less than 50% of the soil loses its moisture, the motor pump will immediately turn on to sprinkle the water and start sprinkling the water until the moisture drops to 55% and the pump is turned off after that. At a given time, sensor information will be sent to the ThingSpeak Server so that it can be monitored from anywhere in the world [14]. ThingSpeak enables instant viewing of the data that the computers have transmitted to ThingSpeak. With the power to execute MATLAB programming in ThingSpeak, you will do online data interpretation and processing because it comes in. ThingSpeak is additionally used for prototyping and proof of IoT concept applications involving analytics. When the temperature is raised to or greater than 40 degrees, the fan is switched on and when the temperature is a smaller amount than 28 degrees, the fan is transitioned. Similarly, where the light level is less than the normal amount, the electric lights are switched on automatically and off when there is enough sunlight. So, a person can track the parameters with an Android phone. This device is very useful for farmers to observe and monitor environmental parameters in their fields. Farmers do not need to head to their farms. Any variance within the environmental criteria may result in monetary losses in the agricultural and pharmaceutical industries and may pose a life-threatening danger to consumers of biomedical industries. These losses can be stopped by managing them instantly.

2 Literature Review

In Vimal and Shivaprakasha [16], the project is about a system using GSM and Ethernet, which reduces the power consumption, maintenance, and complexity. That project can be used in agricultural field, in nursery, and in botanical garden. Used technologies are GSM module and Ethernet. Easy to communicate and monitor are the advantages. System costs high is a drawback. In Chen & Liu et al. [2] introduced the CAN Transport Based Intelligent Greenhouse Control System, this creates a great advance and revolution in Green house Monitoring. The author S.Li. [9] introduce the STM32 for monitor CO_2 concentration in the Green house which help in stabilization of Oxygen level in greenhouse .

In Geng et al. [3], a four-layer device architecture was developed with outstanding motion control functions using mobile acquisition. Layers used are perceptual (physical) layer, control layer, transmission layer, and application layer. Raspberry pi and Arduino chip were combined to work as data server. Due to compact size, Raspberry pi and sensors were integrated into mobile system. Cycle redundancy check (CRC) was used to reduce data loss at transmission layer. Advantage of this project is that it monitors the highest and lowest values at a given point in time.

In [15] authors Subahi et al. devoloped the advance intelligent system for controlling and monitoring the temperature of Green house condition with advanced sensor interface and cotrolling system. A hybrid wired/wireless networking infrastructure for greenhouse management is developed by Mirabella et al. in [11].

In [6], authors said that "Some complications arose during field experiments. Because of the EMI power source, some incorrect records were recorded. Salt deposition and thus incorrect measurements were observed on the soil wetness sensor probes. The total SMS loss was 0.5%." According to Tseng et al. (2006), this amount of SMS loss is appropriate. The missing records were not consecutive and were insignificant on the remote server (1.8%). R.L. Njinga et al. [12] undergone the research in Examination of essential elements for plants development utilizing instrumental neutron activation analysis at extreme level of outcome.

In paper [17] the author D. Visser et al used the Advancing light system in which the nursery used a 3D model of tomato and a beam tracer. In Xia et al. [19], authors had designed monitoring of greenhouses and a framework focused on MSP430. The CC2530 module is introduced in this article. The method has the benefits of stable service, low power consumption, durability, and convenient usage, thus meeting a great deal with modern requirement for greenhouse production.

Kitpo et al. [7] provided a survey report on agricultural problems. Many tools have been used to boost words of the farmers. This paper reflects on a major irrigation crisis. There are a lot of irrigation schemes and they are automated. The study allows us to learn about different IOTs GSM related methods used in the irrigation system. This paper contains a section-wise explanation of the previous work. So that, we will hear more about the problems of agriculture. This report is helpful to learn about the developments in agriculture for 10 years to enable a detailed survey to be undertaken to help farmers.

Xing et al. [20] aimed at the greenhouse in facility agriculture and developed intelligent knowledge monitoring system, and the conclusion can be made as follows:

(i) The star network control structure was constructed.
(ii) Used ZigBee to set up wireless sensor network.
(iii) A kind of cooperative control method based on time control, manual control, automatic control, intelligent control, and remote control was proposed.

3 Design of Greenhouse Monitoring

3.1 Greenhouse

Growing plant is the combination of both art and science. Due to the modern development in technology, it creates newer dimension in growing the plant. Greenhouse technique is unique method to affording such an environment to the plants. Even though the man faced a lot of challenges in growing plant, he learned how to grown

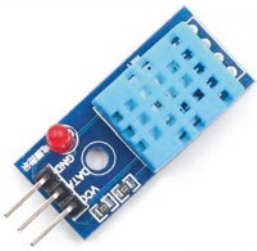

Fig. 1 DHT11 sensor module

plant not only in normal condition but also in extreme adverse condition with the help of advanced technology, which is called as "green house monitoring."

In the green house monitoring to maintain the environment and increase the productivity, some sensors are used. They are magnetic sensor, humidity sensor, temperature sensor, light sensor, and moisture sensor.

Many supportive components are used to control the environment in the green house such as bulb, fan, motor, and heater, and all these get control with respect to the collecting data from the sensor. Sensors are the basic components to sense various physical parameters such as light, heat, pressure, and humidity. The above are the basic factors controlled in green house for the better production.

A. Humidity and temperature

Temperature and humidity are measured using the DHT11 sensor and it is shown in Fig. 1. If the humidity of green house is below the defined level, water is sprayed to maintain humidity level. If it is less than the defined value, the spray will switch off the water. For the temperature of more than critical value, the fan has to switch on and value of the sensor is transmitted using Node MCU and the data is maintained in cloud and monitored through ThingSpeak.

B. Soil moisture

For the irrigation, the water supply is the major concern, and for that purpose, we use water pump, and soil moisture sensor shown in Fig. 2 is used for detecting the moisture in soil. If moisture is less than threshold value, water pump is switched on until the soil moisture attained the threshold level, and value of the sensor is transmitted using Node MCU and the data is maintained in cloud and monitored through ThingSpeak.

C. Light intensity

Light is the important factor for plant growth. The intensity of the light is provided by 100-watt bulb and it is controlled by sensor called light dependent resistor (LDR) as shown in Fig. 3. It turned on/off depending on threshold level. If light intensity is more, it turned off the bulb. If not, it switched on the bulb. The sensor value is monitored through ThingSpeak.

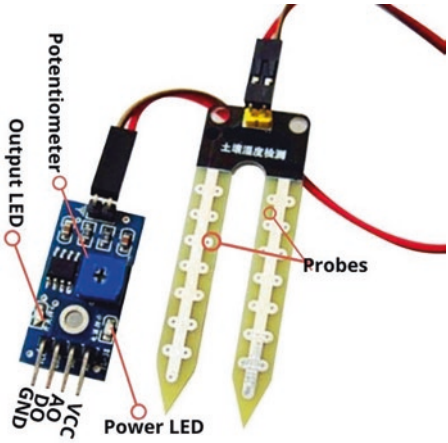

Fig. 2 Soil moisture sensor module

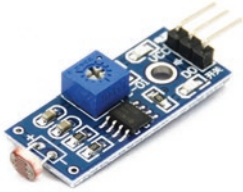

Fig. 3 LDR sensor Module

The ultimate aim of green house monitoring is to improve efficiency and effectiveness of your management, save money, and provide better crop.

The method for monitoring and controlling the green house is focused on the calculation of the light intensity, soil moist, temperature, and humidity of the sensor situated at the locations. The result can be seen in ThingSpeak.

3.2 IoT Technology

Nowadays, Internet is an adequate thing to this world. In that, we knew Internet of Things (IoT) is more attractive and expanding technology. We are very closed or controlled by internet. The advantage of the internet is the hyper connected technology as we use on mobile and laptop. It is an adequate and helpful connection with sensor application. The way it helps is to connect the device from the farther distance to communicate and get connected. It is a very great achievement compared to other contrasting and communicating devices.

IoT will support a huge amount of development in our day-to-day lives. We can enable a device in public and private places. It helps to adapt our situations such as environment, education, safety, commercial, comfort, and personal well-being.

The IoT network can manage the following application such as medicare, smart automation maintenance, security surveillance, transportation, and industrial purpose. The IoT devices transform our lives in many aspects. New IoT products such as internet operated appliances can be controlled by Internet such as home automation, and energy management devices are turned toward the innovation of "Smart Home," giving more security, highly controllable through security locks and alarm even controlled by home appliance too.

In addition, there are several personal Internet of Things (IoT) gadgets available, including wearable fitness trackers and medical surveillance tools, such as health monitoring monitors.The utilization of monitoring devices and networkconnected medical devices has become integral to the provision of healthcare services, offering enhanced and intensive monitoring capabilities for patients. The utilization of Internet of Things (IOT) facilitates seamless and expeditious connectivity to patients, enabling continuous monitoring of healthcare conditions.

Even IOT systems like networked vehicle advanced traffic system which helped to turned toward a metropolitan as "Smart Cities" help to minimize the congestion and consumption. With the help of the IoT, the huge development in the agriculture industry products development is done by providing Internet to agro-based application and giving access and controlling remotely by the mobile application such as thingSpeak.

3.3 Green House Monitoring Using IoT Technology

As compared to open field cultivation, the greenhouse will produce more crop per square meter. The microclimatic parameters are monitored and controlled to maintained an optimum temperature in greenhouse. The automated green house system is controlled by a sensors and actuators that are controlled by microcontroller driving a computer program.

The two important stations in a system are remote monitoring station and actuator/sensor station. The controller with the help of sensor checks if the climatic condition in the greenhouse is in predefined values programmed in Node MCU. The sensor values are transmitted through the Node MCU to Cloud and it is monitoring through thingSpeak all over the time.

Block diagram of IoT-based greenhouse monitoring is shown in Fig. 4. The change in environment is sent to Node MCU by different sensors such as soil moisture sensor, LDR, and DHT11 and it analyzes the data and sends commands to respective controlled devices such as water motor, artificial light, and exhaust fan. This data is uploaded to cloud-based platform called ThingSpeak using in-built Wi-Fi module called Node MCU.

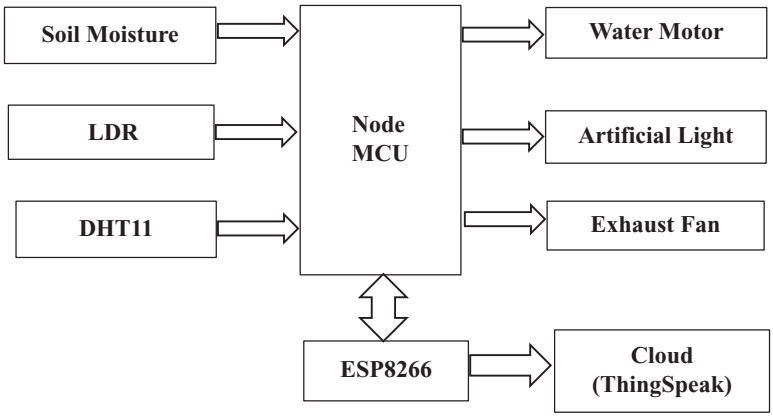

Fig. 4 Block diagram of greenhouse monitoring

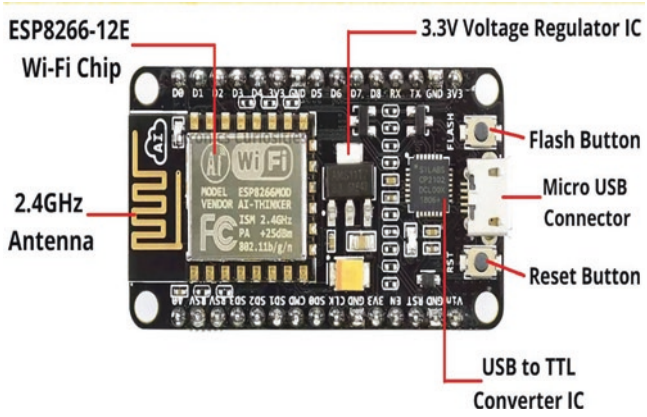

Fig. 5 Node MCU

3.4 Hardware Description

Today, due to the development of IOT application, the sensor that interfaces with the microcontroller is getting more and more critical. Node MCU is the open source platform which helps to connect sensors and allow the sensors to transfer the data through the WiFi Protocol and it is shown in Fig. 5. It also includes the basic feature of basic microcontroller such as GPIO, PWM, and ADC. It has capability to control many application separately.

The unique feature of this Node MCU board is as follows:

1. Having internal antenna
2. Feasible in event driven API application
3. Containing 13 GPIO pins, 10 PWM channels, I2C, SPI, ADC, UART, and 1-Wire
4. Offered as access point or station

Greenhouse monitor hardware is designed to monitor all the data that come from various sensors, which have different parameters like light intensity, soil moisture, humidity, and temperature. Every sensor senses the change in their respective domain and transfers this change to the Node MCU that is shown in Fig. 5. For example, soil moisture sensor senses the moisture level in the soil and transfers the information to the microcontroller. As Node MCU itself consists of Wi-Fi module, it can be used to upload all the data to the ThingSpeak, a cloud-based platform.

3.5 Software Description

The software is designed to process the humidity, temperature, light intensity, and soil moist value from sensor to Node MCU microcontroller. Then, it continues to monitor the parameters from microcontroller. The microcontroller Node MCU is to convert analog to digital, send the value of sensor through serial communication to computer, and control the water motor, artificial light, and exhaust fan according to the parameter's values.

It is very convenient to schedule part of this project. The DHT library is used in this software to read the humidity and temperature sensor (DHT11 basic) from the humidity and temperature sensor, which can be monitored using ThingSpeak.

4 Methodology

The key purpose of this research work is to focus on monitoring the greenhouse and acting on soil moist, and air and lighting services. The components used are as follows:

- Node MCU
- ESP8266 Wi-Fi module
- Soil moisture sensor
- LDR
- DHT11

Node MCU is an open source IoT platform. The Node MCU is a platform for Internet of Things (IoT) that is open source in nature. The system comprises firmware that operates on the Espress IC Systems ESP8266 Wi-Fi SoC, as well as hardware that is built upon the ESP-12 Module. The sensors employed in this study are the temperature and humidity sensor (DHT11), soil moisture sensor, and light-dependent resistor (LDR). The exhaust fans, water pump, and artificial light can be classified as the terminal devices or end equipment. The exhaust fans, the water pump, and the artificial light are the end equipment.

In the event that the dirt dampness esteem is underneath the expressed level, the motor turns on and siphons the water through the tubing [5]. It very well may be performed consequently and constantly until the characterized edge esteem has been met. Here, all limit esteems are taken from the perception of the rancher. It is utilized to decide the power of the light inside the nursery. In the event that the sunshine level is like the sting, the LED activates consequently and off within the event that it is not equivalent.

DHT11 screen detects temperature and mugginess. In the event that the temperature esteem is higher than or equivalent to the limit esteem, the fumes fan turns on consequently and off in the event that it is not exactly the edge esteem. In the event that the dampness esteem is not exactly or equivalent to the limit esteem, the fan turns on consequently and draws the ventilate of the nursery and off in the event that it is more than the edge.

The suggested method fits well and has shown effective outcomes. End equipment such as light source, water pump, and fans within the greenhouse have been triggered according to the threshold conditions of parameters such as temperature, humidity, and soil moisture values. The data obtained from the MCU Node is sent to the ThingSpeak server and the data is reflected on the server.

Here, the data is read from the different sensors that the sensed data is sent to the ThingSpeak IoT network through the internet using the ESP8266 module installed on the unit [8].

The framework portrays the assortment of exercises completed by the various modules, for example, temperature, humidity, LDR, and soil wetness. It tests whether the estimations of the boundaries are underneath or over the edge esteems [18]. The actuators are set off and deactivated considering the present situation.

5 Result

ThingSpeak is an IoT platform that helps to capture, interpret, and visualize data. It has TCP/IP to send and receive data. That is why we build channels in ThingSpeak. The sensed data is seen in the generated channels. Here, we use ThingSpeak as a cloud platform.

Finally, we have created a webpage in ThingSpeak. We gathered all sensors data and uploaded in ThingSpeak website using Node MCU, and it analyzes the data and represents it in graphical format as shown in Fig. 6. Here are some of the data such as temperature, humidity, soil moisture, and light intensity gathered from sensors and displayed in ThingSpeak. Here, the data may be varied from time to time so that we get up and down in the graphical representation of data.

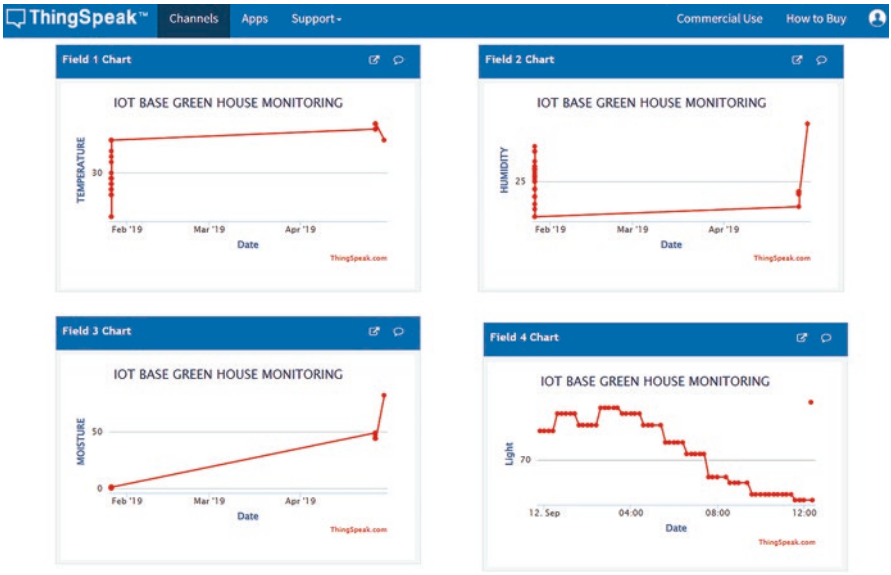

Fig. 6 Sensors data shows on the ThingSpeak dashboard

6 Conclusion

The key benefit of this project is that all tasks to be done by controlling devices such as exhaust fan, artificial lights, and water motor and to monitor climatic conditions such as temperature, relative humidity, light intensity, and soil moisture levels in the greenhouse atmosphere, which are automated and do not require human intervention. We can also add GSM module to send SMS to the user's phone to reduce the expense of the internet and users can get alerts without internet access to their phone.

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