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IOT Based Greenhouse Monitoring and Controlling System

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ABSTRACT
This paper proposed an automated greenhouse monitoring and controlling system that integrates Arduino Uno with a variety of sensors, including DHT11 sensors along with environmental factors of the greenhouse. The Internet of Things (IoT) is also used to process the information collected, store it in a database, and then transfer it to Android apps designed for user monitoring and control of greenhouses. Additionally, by analysing environmental characteristics, the suggested greenhouse system is economical, effective, and efficient. The cost of deploying the suggested greenhouse model is also examined in this research, and it is shown to be relatively inexpensive for farmers and worthwhile.

Keywords: IoT, Wireless sensor, DHT11 sensor.

1 Introduction

One of the environmentally friendly methods of smart agricultural cultivation is the greenhouse. In order to quickly and efficiently reach the desired climatic temperature while conserving energy, modern greenhouses require certain equipment. It is regarded as a different approach to dealing with the food issue brought on by rapid population increase, climate change, and environmental pollution. Even in harsh climate zones, this technology can support off-season crops inside the enclosed space [5-6]. Real-world objects are becoming smarter devices thanks to) an emerging paradigm and Internet of Things (IoT). Through the provision of intelligent solutions for greenhouse management, precision farming, and livestock monitoring, this domain has begun changing the agriculture sector [7]. To create a data gathering system with autonomous monitoring and control. The monitoring and control parameters for this system include keeping track of the temperature, soil moisture, air humidity, and reservoir water level [4]. The deployment of SN and IoT is used to modify climate parameter values the deployed SN is low cost, multi-functional, and designed for volume. For faster data collection to the gateway, the sensors are each connected to a single node and dispersed at random on the required places. The gateway transmits this information to experts in agriculture over the internet [9]. A daily activity data database on the web collecting and used for monitoring and manage the farming area, and the system is composed of commercially available, reasonably priced wireless sensor network devices. Based on an agro climatic metric called growing degree day, the crop microclimate environment was observed. [2]. Aquaculture pond water quality, water temperature and dissolved oxygen sensors, as well as the temperature and humidity of leaves from hydroponic plants, crop leaf temperatures and humidity in greenhouses, and other variables are all monitored in real-time [3]. The problem of converting the mean daily temperature into the time series of the temperature setpoint and the problem of converting the generally forecast weather into the weather time series must be solved by the receding horizon optimization of the greenhouse climate setpoint [8]. Along with providing autonomous control of the operational conditions of the greenhouse, the air humidity, proprietor or supervisors can remotely control the greenhouse via the Internet. The proprietor also keeps watch the growth of the crops planted in the greenhouse [10]. Users and farmers can register their greenhouse equipment on the suggested platform as a result. A request to the REST API is used to store data from sensors and actuators in the database. Depending on the variable to be preserved, measurements produced by various devices are stored using a variable sample time between 1 and 10 minutes. The platform's available API services for internal climate, agricultural production, and irrigation models are calibrated and integrated using stored data [1]. The benefit of greenhouse production is that, when certain control measures, including as heating, fogging, and CO_2 injection, are used, the greenhouse climate may be precisely controlled to create a suitable growth environment [8].

Furthermore, the suggested study illustrates a greenhouse controlling and monitoring system employing an inexpensive Smart Controller that communicates with an IoT platform that offers vast storage capacity and quick data accessibility. The following summarizes how the paper is organized: The conventional work is described in Section 2. The planned work and its performance presented in Section 3. The suggested work and its application are summarized in Section 4.

2 Recent Works

Xingzhen Bai et al [2019] have discusses the problem of data fusion for the greenhouse monitoring system using wireless sensor networks. The proposed greenhouse monitoring system uses a hierarchical structure of WSNs and a two-stage data fusion method for the hierarchical network. The geographical consistency and gradual modification of the greenhouse environmental data are taken into account in both of these concerns. Additionally, it is recommended that WSNs match the system's information sensing capabilities while using less energy by operating in the multi rate measurement mode.

Rakiba Rayhana et al [2020] have proposed a new method that the population growth and reduction of agricultural land, solutions are needed to maintain sustainable agriculture and a steady supply of food in the future. Growing crops indoors, especially in difficult outdoor environments, is regarded to be a viable alternative and sustainable option to managing the local environment.

Ahmad F. Subahi et al [2020] have introduced a highly scalable intelligent system for managing and tracking greenhouse temperature is using IoT technology. This system's major objectives are to maintain favourable circumstances that boost productivity while controlling the greenhouse environment and consuming less energy.

Ahmed Ouammi et al [2020] have been created to make it easier to switch to smart greenhouses for the production of sustainable and healthy food. This monitoring system is based on a support tool. The decision framework aims to effectively regulate and control the microclimate settings of linked smart greenhouses. Because of an improved water desalination method, every connected smart greenhouse is a self-water generating greenhouse. The main advantage of the current technique is that the greenhouses can locally produce their water loads.

Xia Geng et al [2019] Effective control requires knowledge of the environment in each area of a big greenhouse, necessitating multipoint monitoring. In response to the challenges with the current greenhouse environmental monitoring system, a mobile Internet of Things-based greenhouse environment monitoring system was developed. To increase the quality of the data, it was denoised using a weighted average filtering approach in addition to a limiting filtering algorithm.

3 Proposed Work Explanation

As illustrated in Figure 1.1, environmental elements including temperature, humidity, and others are continuously monitored and controlled to ensure that plants grow as efficiently as possible. This system is required for our greenhouse or agriculture system. Design of a specific model in which these environmental parameters from several greenhouses are gathered at a single location, i.e., on a PC via LAN connectivity, and are then given to a Web Page over Ethernet. To access and operate the devices remotely, use the Arduino platform in conjunction with IP connectivity like Ethernet. This technique is very adaptable and inexpensive. On the developed page, the proposed system will display real-time temperature and humidity along with controlling variables like a fan and humidifier. For plants to grow, the atmospheric or climatic conditions are crucial. The most crucial environmental parameters or elements for greenhouse automation are temperature and humidity. Therefore, it is essential to have efficiency in greenhouse crop production in order to achieve the adjustments of optimal growth to obtain great yields of plants at lower costs, good quality, and minimal environmental loads.

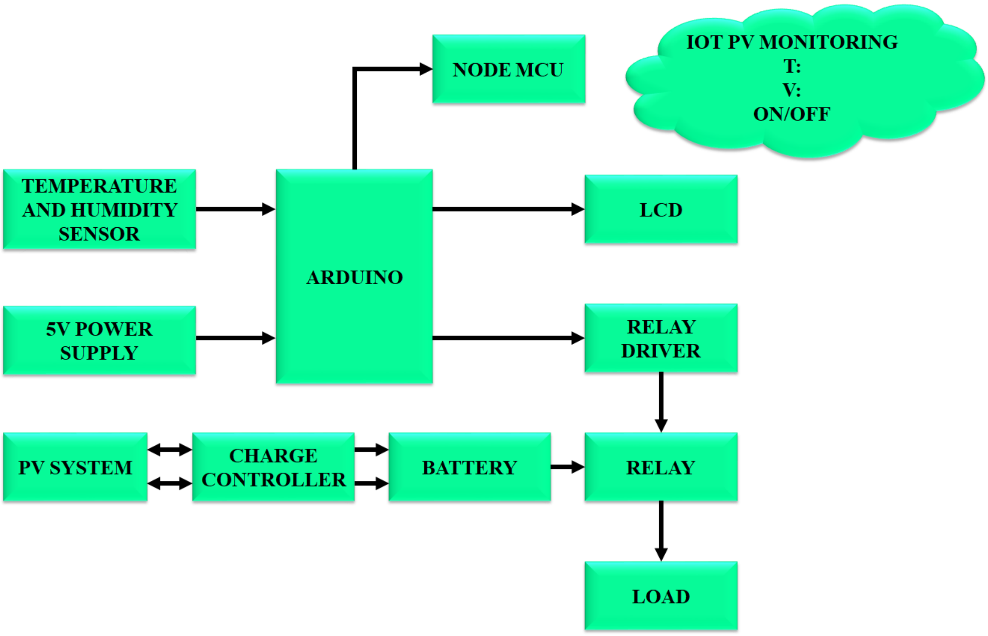

Figure 1.1: *Block diagram of proposed system.*

The Internet of Things (IoTs) is the intelligent networking of ordinary objects like smart phones, Internet TVs, actuators and sensors to the internet. This enables new types of communicating with things and one another as well as between things and people. This monitoring and control system, which uses an Atmega 328 microcontroller, is inexpensive and adaptable. It enables users to examine parameters directly online without requiring a forecasting agency to access and manage parameters. Here, a web application built on a microcontroller controls the various parameters automatically. The proposed system offers the communication protocol to control and monitor the greenhouse environment with capability beyond simple switching, unlike other systems that need a dedicated server PC. It is anticipated that these connections will grow and develop into a fully formed dynamic network of IoTs because anyone, anytime, anyplace can now have connectivity for anything.

3.1 DHT11 Temperature Sensor

The DHT11 is a single-wire digital temperature and humidity sensor and the outputs measurements of both humidity and temperature. The relative humidity data in percentage and the temperature values reported by this sensor are both in degrees Celsius. This sensor uses resistive humidity measurement and NTC temperature measurement components. Figure 1.2 shows the DHT11 Sensor module.

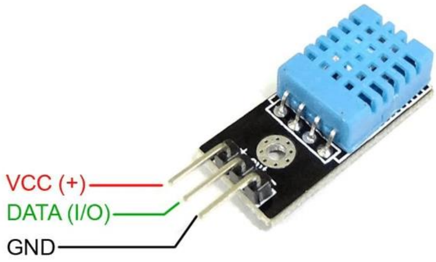

Figure 1.2: *DHT11 Sensor module.*

3.2 Relay

A magnetic connection between two electrically isolated circuits is made via a relay, an electromagnetic device. They are extremely useful instruments that make it possible to switch between completely independent circuits. These are widely used as an interface between electronic circuits with low voltage and electrical circuits having high voltage. Using a 5V DC battery circuit, a relay, for instance, may switch a 230V AC mains circuit. The below Figure 1.3 shows the Relay module.

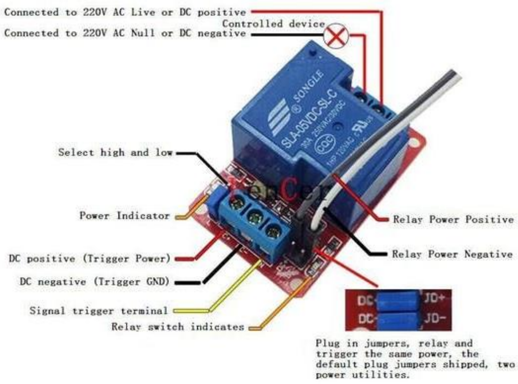

Figure 1.3: *Relay module.*

4 Results and Discussion

As illustrated in Figure 1.4, a system for controlling and monitoring greenhouses demonstrated. IoT sensors and devices could be used to remotely monitor greenhouse conditions like PH, humidity, moisture content, CO2, temperature, and irrigation. Using a one-wire interface, the DHT11 single wire digital humidity and temperature involves varying serial readings for both variables. IoT-based greenhouse farming patterns were thoroughly discussed using the emerging IoT technology.

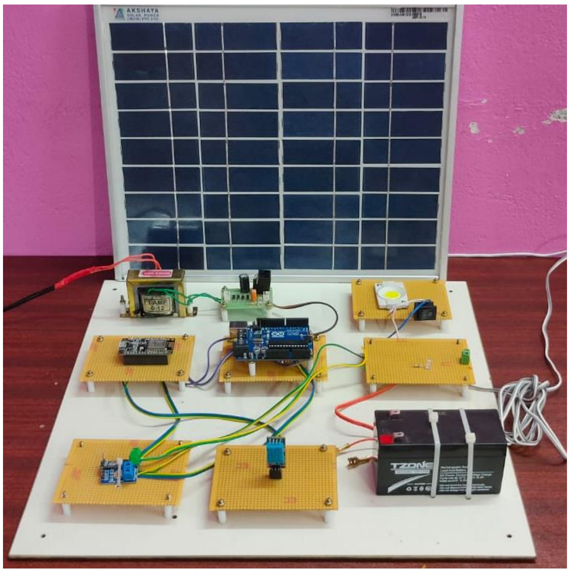

Figure 1.4: *Hardware setup.*

The microcontroller is an Arduino Uno equipped with an ATmega328p chip. The microcontroller makes use of sensors including temperature and humidity sensors. With the ESP8266 Wi-Fi Module, a self-contained system on chip (SOC) with a built-in TCP/IP protocol stack, any microcontroller can connect to your Wi-Fi network.

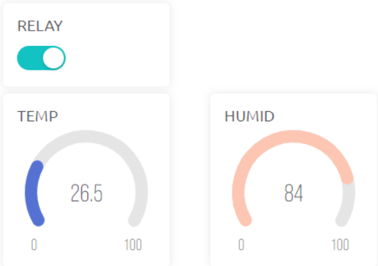

Figure 1.5: *Software Result.*

The Arduino Software allows users to construct computer programs called sketches (IDE). The IoT-based greenhouse stem that will be used to monitor and regulate climate factors is demonstrated in Figure 1.5. This demonstrates the assembly of the proposed system's specified components, and the output is displayed on LEDs. The sensors are presented in the right area of the diagram, the sensor live readings are shown on the LCD on the right side, and the relay module is presented in the center. Temperature has been measured at 26.5 C0 when the normal/set value is 35 C0 for climate factors. The user can quickly view the monitoring results by entering the link, whether using a smartphone or a Personal Computer (PC). Other users may find it simpler to read status data without logging in if you use this website to monitor greenhouses.

4 Conclusion

In order to implement this, sensor devices must be placed in the greenhouse for the purpose of gathering and analyzing data. By using sensor technology, the environment is made possible and may communicate with other items over a network. The end user will then have access to gathered data and the analysis' outcomes over Wi-Fi. In this paper, various models are used to demonstrate an intelligent method of parameter monitoring and an effective, low-cost embedded system. The functions of several modules were covered in the suggested architecture. Two factors were experimentally monitored using a temperature and humidity monitoring system with an Internet of Things architecture. Additionally, it uploaded sensor data to the cloud. This information can be easily shared with other end users and will be useful for upcoming analyses.

Reference

1. M. Muñoz ; J. L. Guzmán ; J. A. Sánchez-Molina ; F. Rodríguez ; M. Torres ; M. Berenguel, Year: 2022, "A New IoT-Based Platform for Greenhouse Crop Production", in IEEE Internet of Things Journal, Vol: 9, no: 9, pp. 6325 – 6334.

2. Rubanga Denis ; Hatanaka ; Katsumori ; Shimada ; Sawahiko, Year: 2019, "Development of a Simplified Smart Agriculture System for Small-scale Greenhouse Farming", Sensors and Materials, Vol: 31, no: 831.

3. Zhang S ; Guo Y ; Li S ; Ke Z ; Zhao H ; Yang J ; Wang Y ; Li D ; Wang L ; Yang W ; Zhang Z, Year: 2022, "Investigation on environment monitoring system for a combination of hydroponics and aquaculture in greenhouse". Information Processing in Agriculture, Vol: 9, no: 1 pp. 123 – 134.

4. Mas ; Feri Aditya Ridwan ; Sri Wahyu Suciyati ; Gurum Ahmad Pauzi ; Junaidi Junaidi, Year: 2022, "Smart Greenhouse Monitoring With Soil Temperature and Humidity Control on Internet of Things (IoT) Based Orchid Plants", Journal of Energy, Material, and Instrumentation Technology, Vol: 3, no: 3, pp. 79 – 88.

5. Fei ; Xiao ; Wu Xiao-Long ; Xia Yong, Year: 2021, "Development of energy saving and rapid temperature control technology for intelligent greenhouses", IEEE Access, Vol: 9, pp. 29677 – 29685.

6. M. S. Farooq ; S. Riaz ; M. A. Helou ; F. S. Khan ; A. Abid ; A. Alvi, Year: 2022, "Internet of Things in Greenhouse Agriculture: A Survey on Enabling Technologies, Applications, and Protocols", in IEEE Access, Vol: 10, pp. 53374 – 53397.

7. M. S. Farooq ; O. O. Sohail ; A. Abid ; S. Rasheed, Year: 2022, "A Survey on the Role of IoT in Agriculture for the Implementation of Smart Livestock Environment", in IEEE Access, Vol: 10, pp. 9483 – 9505.

8. Y. Su ; L. Xu, Year: 2021, "Greenhouse Climate Setpoint Optimization: An Online Decision Strategy", in IEEE Access, Vol: 9, pp. 140298 – 140314.

9. Arshad ; Jehangir ; Rizwan Tariq ; Saqib Saleem ; Ateeq Ur Rehman ; Hafiz Munir ; Noorbakhsh Amiri Golilarz ; Aamir Saleem, Year: 2020, "Intelligent greenhouse monitoring and control scheme: An arrangement of Sensors Raspberry Pi based Embedded System and IoT platform", Indian Journal of Science and Technology, Vol: 13, no: 27 pp. 2811 – 2822.

10. Ibrahim ; Hassan ; Norhan Mostafa ; Hassan Halawa ; Malak Elsalamouny ; Ramez Daoud ; Hassanein Amer ; Yasmine Adel ; Amr Shaarawi ; Ahmed Khattab ; Hany ElSayed, Year: 2019, "A layered IoT architecture for greenhouse monitoring and remote control", SN Applied Sciences, Vol: 1, no: 3, pp. 1 – 12.

11. Xingzhen Bai ; Zidong Wang ; Li Sheng ; Zhen Wang, Year: 2019, "Reliable Data Fusion of Hierarchical Wireless Sensor Networks With Asynchronous Measurement for Greenhouse Monitoring", IEEE Transactions on Control Systems Technology, Vol: 27, no: 3,pp. 1036 – 1046.

12. Rakiba Rayhana ; Gaozhi Xiao ; Zheng Liu, Year: 2020. "Internet of Things Empowered Smart Greenhouse Farming", IEEE Journal of Radio Frequency Identification, Vol: 4, no: 3, pp. 195 – 211.

13. Ahmad F. Subahi ; Kheir Eddine Bouazza, Year: 2020, "An Intelligent IoT-Based System Design for Controlling and Monitoring Greenhouse Temperature", IEEE Access, Vol: 8, pp. 125488 – 125500.

14. Ahmed Ouammi ; Oumaima Choukai ; Driss Zejli ; Sami Sayadi, Year: 2020, "A Decision Support Tool for the Optimal Monitoring of the Microclimate Environments of Connected Smart Greenhouses", IEEE Access, Vol: 8, pp. 212094 – 212105.

15. Xia Geng ; Qinglei Zhang ; Qinggong Wei ; Tong Zhang ; Yu Cai ; Yong Liang ; Xiaoyong Sun, Year: 2019, "A Mobile Greenhouse Environment Monitoring System Based on the Internet of Things", IEEE Access, Vol: 7, pp. 135832 – 135844.