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Design and Implementation of an IoT Based Greenhouse Monitoring and Controlling System

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ABSTRACT

Environment is the key factor in the greenhouse system. To provide monitoring and controlling facility inside the greenhouse, IoT based system is more flexible and suitable solution. To maintain the proper environment inside the green- house, we have designed the system with heating, cooling and water supply facility by integrating the system with heater, cooling fan and water pump. The temperature, humidity and the soil moisture inside the greenhouse continuously monitored and controlled over online platform.

1. Introduction

Due to the massive advancement in electronic device technologies in terms of speed, feature size reduction and complexity (Lubaba et al. 2020; Mahdi et al. 2020; Hasan et al. 2020), intelligent, automated and smart systems have evolved in order to make human life easier and comfortable (Osman et al. 2017; Shammi et al. 2018). Nowadays, massive automation works have been going on in various fields in order to solve real-life problems by means of automated devices and systems (Hasan et al. 2019; Hasan et al. 2018). These automation works includes automation in home, office, cities, agriculture, energy generation and so on (Faisal et al. 2020; Debnath et al. 2020; Paul et al. 2017; Hu et al. 2020; Kim et al. 2020).

A greenhouse is an optimum solution to efficient harvest generation, seed generation and transplanting with the help of controlled environment inside the greenhouse. Due to global climate changing, sometimes it is difficult to maintain proper environment for the cultivation (Zaman et al. 2015). In such situation, green- house system can be the optimum solution for this scenario. However, to control the environment inside the greenhouse, monitoring is an important and unavoidable issue. To monitor the environment inside the greenhouse, the systems should be integrated with advance and smart features so that it could be controlled in an efficient way. At present, robots are used many places for better navigation and inspection (Chakma et al. 2019; Islam et al. 2017). Nowadays, Internet of Things (IoT) technology provide us a freedom of choice over many aspects such as controlling, monitoring, security etc. (Talukder et al. 2017; Morshed et al. 2015). However, IoT based system is more efficient because the devices can easily be collected as well as transferring data in between them without any kind of manual assistance (Alauddin et al. 2016; Hossain et al. 2017). The devices are smart enough to communicate with each other through internet (Uaday et al. 2019). The parameters that govern the environment inside the greenhouse such as temperature, humidity and moisture should monitor and control efficiently to achieve optimum output from the greenhouse. These parameters can be efficiently monitor and control by the IoT technology framework. As we know, Bangladesh is an agriculture-based country, the smart greenhouse system can play a pivot role to enhance the production performance of harvest.

In this work, we have developed an IoT based monitor and control system for maintaining necessary environment for greenhouse.

2. Literature Review

Bangladesh is an agriculture-based country and it con- tributes up-to 30 percent of its national GDP. So, to enhance the production rate, IoT based smart greenhouse technology can be a potential option. In (Elijah et al. 2018), the authors present IoT based ecosystem for agricultural area which includes four major components such as IoT device, communication technology, internet and data. They also provide clear classifications about IoT application in agriculture. Several applications domains and sensor and smart phone-based applications field briefly discussed in (Farooq et al. 2019). The privacy and security issue in IoT enabled architecture also presented in this paper. However, IoT based system provide total monitoring and controlling facility. Utilizing short distance wireless communication technology Zigbee in (Dan et al. 2015), researchers introduced a monitoring system for greenhouse which was cost effective. Utilizing IoT, cloud-based aggregate with store information system introduced in (Ramachandran et al. 2018), where the goal was to find the optimal parameters for irrigation. Both Arduino Mega and Raspberry Pi are introduced to design monitoring and controlling systems with different parameters aspect in (Tolentino et al. 2019). In (Sofwan et al. 2020), the authors introduced an ON-OFF mechanism system to control the plant growth parameters. Control of greenhouse windows/doors remotely depending on the environment parameters based on IoT is discussed in (Pallavi et al. 2017). A cost-effective design is also important consideration in IoT based monitoring and controlling systems. An economic and efficient measuring, monitoring automated system is discussed in (Li et al. 2009). Some recent works also consider pH level monitoring which is also an important parameter for greenhouse. Considering tomato crop production in (Lavanaya et al. 2018), they designed a system to controls the flow of water and chemicals to adjust required amount. In this paper, we focused to monitor and control three important parameters namely temperature, humidity and soil moisture by utilizing IoT technology.

3. System Design

The proposed system design is explained in the following sub-sections.

3.1 System Overview and Block Diagram

Block diagram of the proposed greenhouse control and monitoring system is presented in Fig. 1. Here, moisture sensors are used to monitor the soil moisture level so that the system can understand if the soil in the greenhouse has the required moisture level. In greenhouse, humidity needs to be controlled in order to provide necessary environment for crop production. Therefore, humidity sensors are being used to monitor and control humidity level of the greenhouse. Temperature plays an important role in greenhouse farming. For this reason, temperature sensors are installed to monitor greenhouse temperature. The temperature, moisture and humidity sensors work as input to the microcontroller. The microcontroller used in this system is Arduino Nano. Wi-fi module serves as the remote data transfer medium.

3.2 Working Principle

Working principle of the smart greenhouse system is described in this section. If the moisture level of soil is below the required level, the system turns on a water pump to enhance soil moisture level. If the temperature of the greenhouse rises very high, the system turns on a cooling fan. On the other hand, if the temperature becomes too low, the system turns on Light to make the environment warmer. All the values are displayed in the LCD display. In this system, everything is monitor as well as control remotely.

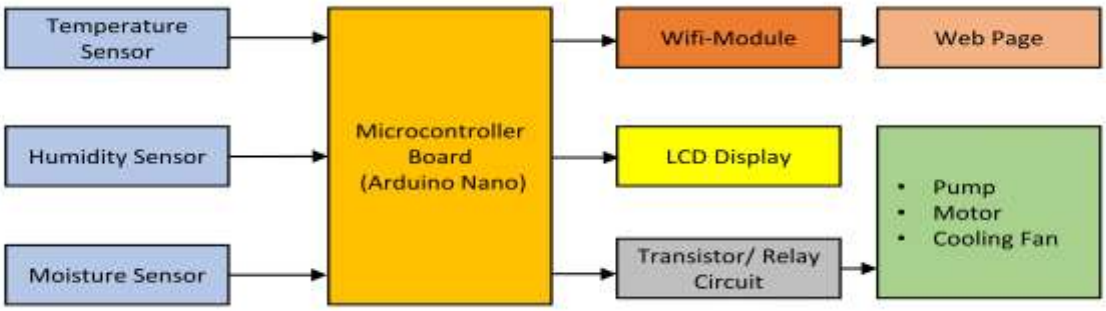

Fig. 1. Block diagram of proposed smart greenhouse system.

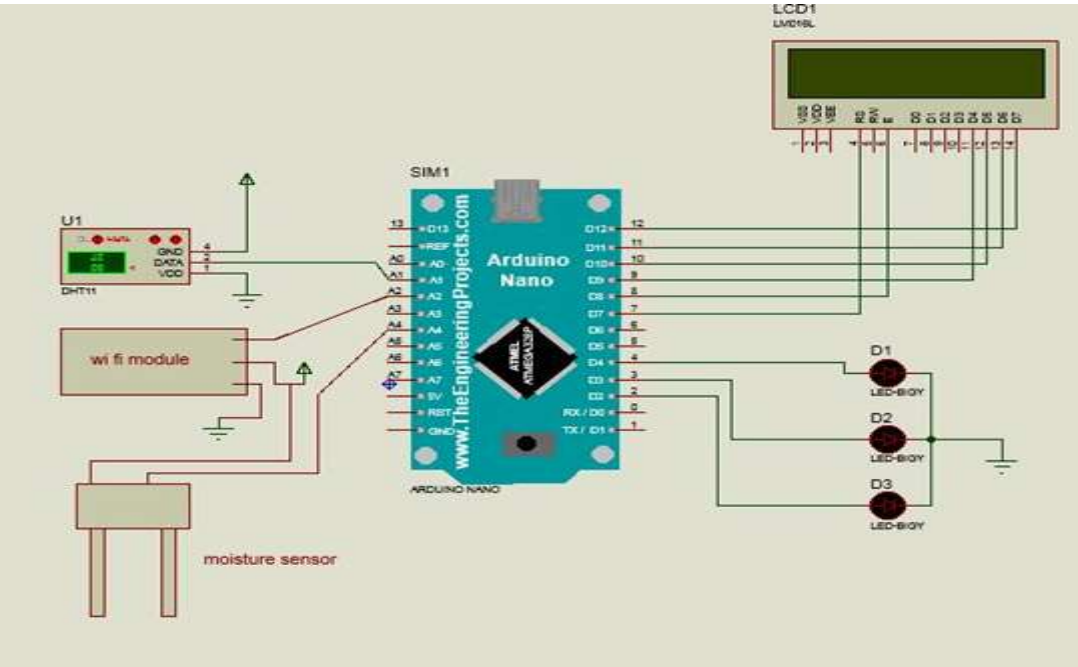

Fig. 2. Schematic design of smart greenhouse monitoring and control system.

3.3 Schematic Design in Proteus

In order to implement the greenhouse monitoring and control system, proper design is required. In order to do so, Proteus software has been used to create the schematic of the system. Full schematic of the smart greenhouse is presented in Fig. 2. All the sensors and modules are connected to the central microcontroller (Arduino Nano). The microcontroller works as the heart of the system which takes input from the sensors, processes the input signals and exhibits required instructions to the system.

3.3 Hardware Components and Equipments

The required components and equipments used to implement the smart greenhouse is presented in Table 1. The components are shown in Fig. 3.

3.3 Design Implementation

In order to implement the smart greenhouse, the components shown in Fig. 3 are connected as per connections made in Fig. 2. The final outlook of the smart greenhouse prototype is shown in Fig. 4.

Fig. 3. Components and Equipments Utilized.

Fig. 3. Implemented prototype of the smart greenhouse.

Table 1. Equipment and Component List

Device	Specifications	Quantity
Aurduino Nano	ATmega328	1
Humidity sensor	DHT-11	1
Moisture sensor	YL69	1
LCD	16x2 module	1
DC relays	5v DC power relay	3
Cooling fan	12v DC	1
water pump	12v	1
Wi-Fi module	ESP 8266	1

4. Results and Discussion

After completing the implementation of the design by connecting the components, the system has been tested for different conditons. The design worked successfully as per required. To check the performance of the system, we have also observed the different parameters conditions in the website through internet from different location. We can also smoothly controlled the systems through the website (Fig. 5). Hence, the smart greenhouse environment monitoring and control system can be an effective alternative for traditional process of greenhouse monitoring and control techniques.

5. Conclusion

A microcontroller based smart monitoring and control mechanism for greenhouse environment has been devoloped in this work. The greenhouse environmental monitor and control mechanism in the work used Arduino Nano as the central controller. Humidity, sensor and temperature sensors are being used in this work to provide necessary data inputs to the microcontroller. Attachment of wi-fi module enabled remote monitoring and control of the system which improves its usability. Due to the smart and automatic features available in the proposed smart greenhouse prototype, the system can be of great use in case of patronizing smart farming.

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Conflicts of Interest: The authors declare no conflict of interest.

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