Evolution in Electrical and Electronic Engineering Vol. 4 No. 2 (2023) 687-696
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EEEE

Homepage:http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

Smart Greenhouse Monitoring and Control System for Temperature and Humidity

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DOI: https://doi.org/10.30880/eeee.2023.04.02.083
Received 28 June 2023; Accepted 06 September 2023; Available online 30 October 2023

Abstract: The " Smart Greenhouse Monitoring and Control System for Temperature and Humidity" is a useful and effective method for keeping track of and controlling temperature and humidity in greenhouses. It continuously monitors and regulates the temperature and humidity levels to make sure the greenhouse's environment is perfect for crop development. The system uses sensors for real-time data collection and microcontrollers for precise control. For accuracy, responsiveness, energy efficiency, and all-around stability, it has been rigorously tested and assessed. The outcomes show how well the system works to keep the greenhouse at its best environmental conditions. In greenhouse farming, using this cutting-edge monitoring and control technology has various advantages. It guards against heat stress and encourages ideal growing conditions, increasing crop production. Additionally, it optimizes resource usage by using real-time data for automated and focused operations. By presenting an efficient and long-lasting solution, this initiative advances greenhouse farming methods. In conclusion, the "Greenhouse Smart Monitoring and Control System for Temperature and Humidity" project provides a small, clever system that optimizes greenhouse temperature and humidity levels. Through automated control mechanisms, it maintains the best growth conditions, increases crop output, and supports sustainable farming practices.

Keywords: Monitoring System, Greenhouse, Solar Energy

1. Introduction

Greenhouses play a crucial role in modern farming by providing controlled environments that optimize crop growth and protect plants from adverse weather conditions. They offer benefits such as the ability to adjust temperature, humidity, and light levels to suit specific plant requirements, thereby enhancing agricultural productivity and sustainability [1]. The controlled atmosphere also permits accurate nutrient management, optimizing fertilizer input and minimizing nutrient leaching [2].

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Greenhouses provide farmers with the opportunity to cultivate specialty and high-value crops that may not thrive in open fields. By allowing farmers to adjust the atmosphere to meet the specific needs of these crops, such as exotic fruits, vegetables, and flowers, greenhouses enable the production of crops that command premium prices in the market [3].

The control offered by greenhouses in adjusting environmental factors reduces stress on plants, enabling year-round agriculture, extending growth seasons, and enhancing crop quality. Furthermore, greenhouses serve as a protective shield against severe weather conditions like hail, frost, or heavy rain, thereby minimizing crop losses [4].

The idea of the monitoring system is to make it possible for users to efficiently gather, process, and analyze information. Based on the data gathered, the monitoring system enables us to calculate several measurements. The monitoring system is now integrated into every aspect of our everyday life, including security, healthcare, industry, forecasting, and agriculture.

This work focuses on the development of a greenhouse monitoring and control system that utilizes solar energy to regulate temperature and humidity. The system employs Arduino as the main component to control sensors and collect data for users. The key parameters monitored and controlled in the system are temperature and humidity.

2. Materials and Methods

This section will be conducted by using both software and hardware development to complete the project.

A. Method

Figure 1 shows the flowchart of the system. Themethod and the flow process of the project focus on step designing the software simulation and hardware for the prototype of the monitoring and controlling system in the greenhouse. This part also willexplain the components and software that will be used in this project. This project is mainly focused oncollecting information from the greenhouse. The system is a greenhouse smart monitoring system in hydroponic using solar energy.

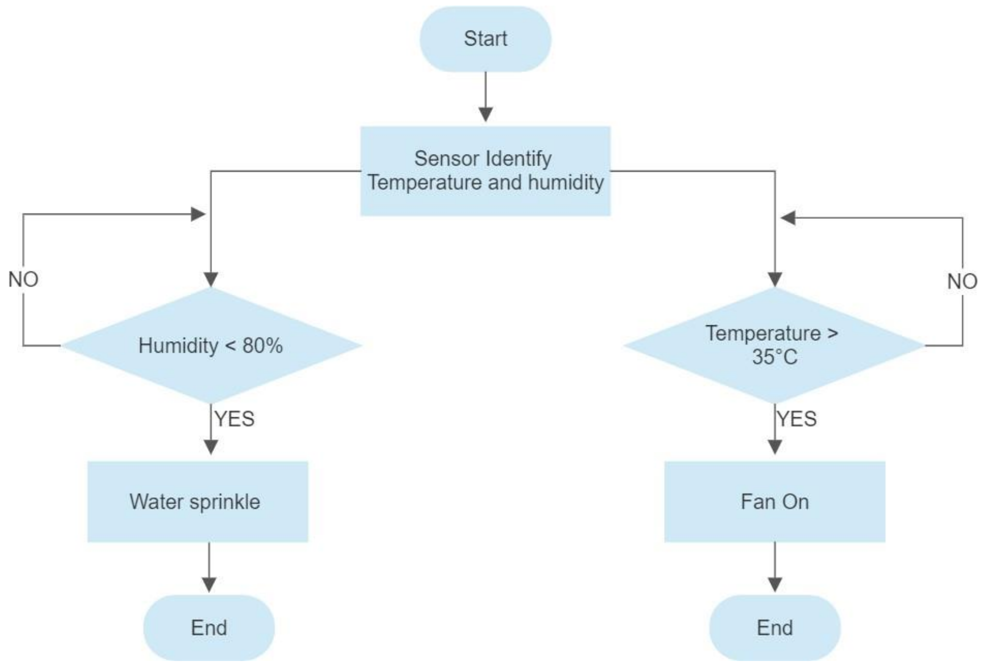

Figure 1: Flowchart of testing prototype

B. Material

For this project, the hardware components used to complete the project will be mentioned as follows:

(i) Arduino Board.

A microcontroller called an Arduino Uno (Figure 2) is used to operate a system by obeying commands sent bythe Arduino IDE. An open-source microcontroller called Arduino allows for quick programming, erasing, and reprogramming at any time [5]. Arduino Uno is used as a brain for the project that controls all the sensors and collects the data to display the result.

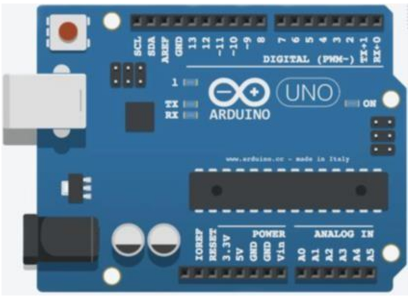

Figure 2: Arduino board

(ii) DHT 11

DHT 11 is commonly used to detect temperature and humidity as shown in Figure 3. These sensors are factory-calibrated and operate without any additional parts. It can start measuring relative humidity and temperature right away with just a few connectors and a little Arduino code. It offers measurements that are accurate to one decimal place for temperature and humidity, which is a benefit. The fact that they onlyoffer fresh data every couple of seconds is the only downside. [6].

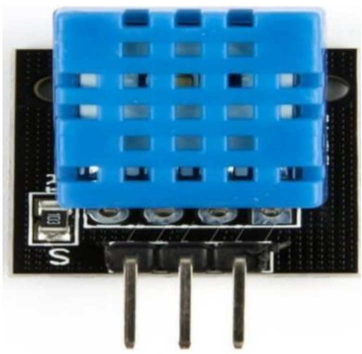

Figure 3: DHT 11

(iii) I2C LCD

This LCD (Figure 3) will display the data in the greenhouse which is on temperature and humidity so the farmer caneasily monitor the greenhouse with the data display. The type of LCD screen that has been used in this project is 16x2 with a 12C interface. 16x2 means that it can display 16 characters, each on 2 lines. That means it can display 32 characters in total. It only needs 4 pins for the LCD if connected with Arduino which are VCC, GND, SDA, and SCL. It can be connected by using a jumper wire. This devicecan be powered by only a 5V DC connection.

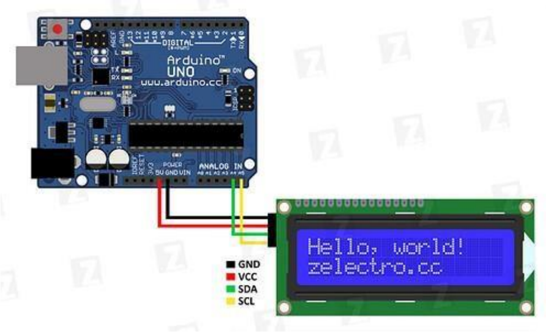

Figure 4: I2C LCD

(iv) Cooling fan and water sprinkler

Fan best suited to be installed in the warehouse processing plant factory and fan contaminated and ventilating fresh air. Thus, implementing a fan in the greenhouse will help to reduce the temperature inthegreenhouse. Other than that, to keep the humidity greenhouse, also use a water sprinkle to make the greenhouse maintain humidity and temperature. Figure 5 shows the cooling fan and Figure 6 shows the water sprinkler.

Figure 5: Cooling fan

Figure 6: Water sprinkle

3. Results and Discussion

The results can be divided into 2 phases. Phase 1 can be categorized as a simulation from software andPhase 2 is categorized as a simulation from hardware.

A. Simulation results

The circuit simulation will be drawn in the proteus 8 professional where the component consists of Arduino Uno, DHT11 sensor, I2C LCD, and 2 DC motors which DC motor A will represent a fan and DC motor B will represent a water sprinkle. For the circuit simulation testing the temperature and humidity that had been set up were 19℃ and 80% but for the hardware the temperature had been changing from 19℃ to 35℃ due to the accurate temperature in the greenhouse. Both DC motors will start to turnon when the temperature exceeds 19℃ and humidity is less than 80%. The motor will continue to run continuously until the temperature and humidity are at normal levels. Figures 7 and 8 show beforeand after the temperature and humidity change.

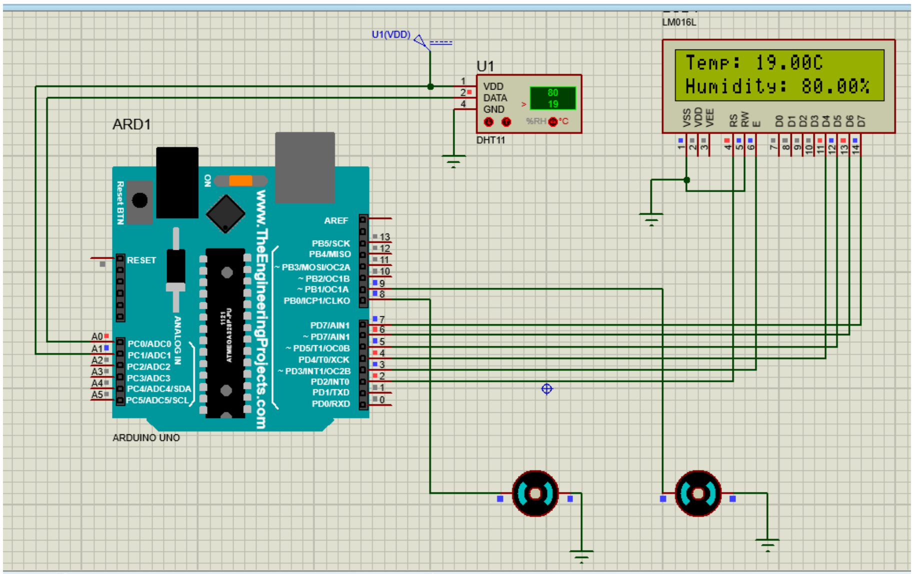

Figure 7: Before temperature and humidity change

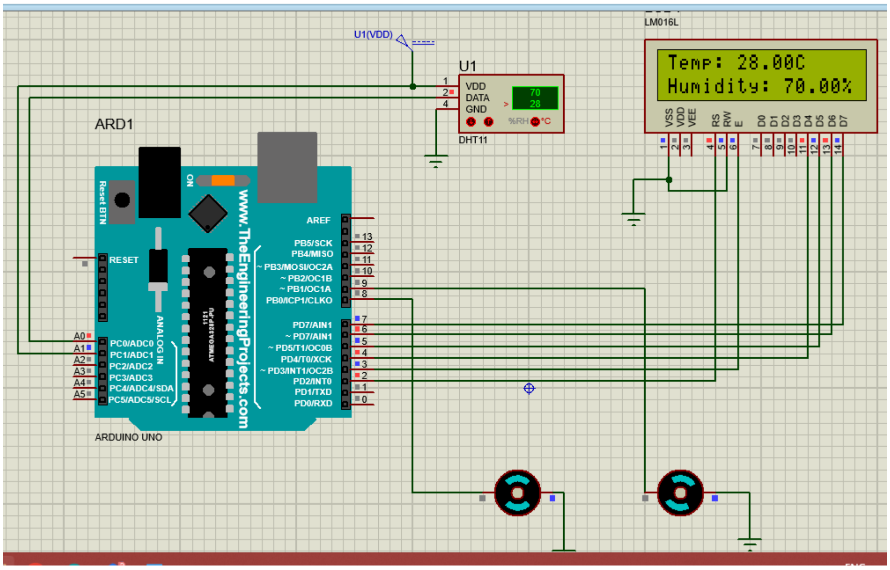

Figure 8: After temperature and humidity change

B. Hardware results

Figure 9 and Figure 10 show the prototype of the system that had been developed to monitor and control the temperature and humidity in the greenhouse. All the motor and sensor will be placed in the greenhouse once the sensor detects the temperature and humidity in the greenhouse are not normal it will send a signal to Arduino uno and Arduino uno will automatically turn both DC motor which is fan and water sprinkle.

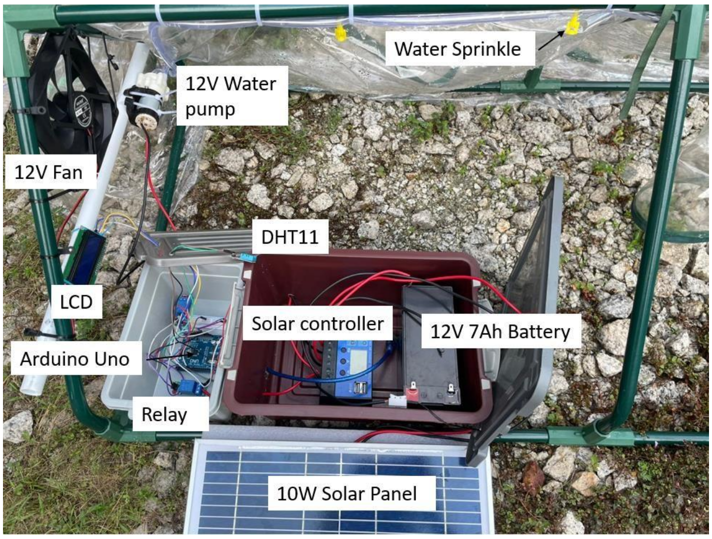

Figure 9: Prototype of the system

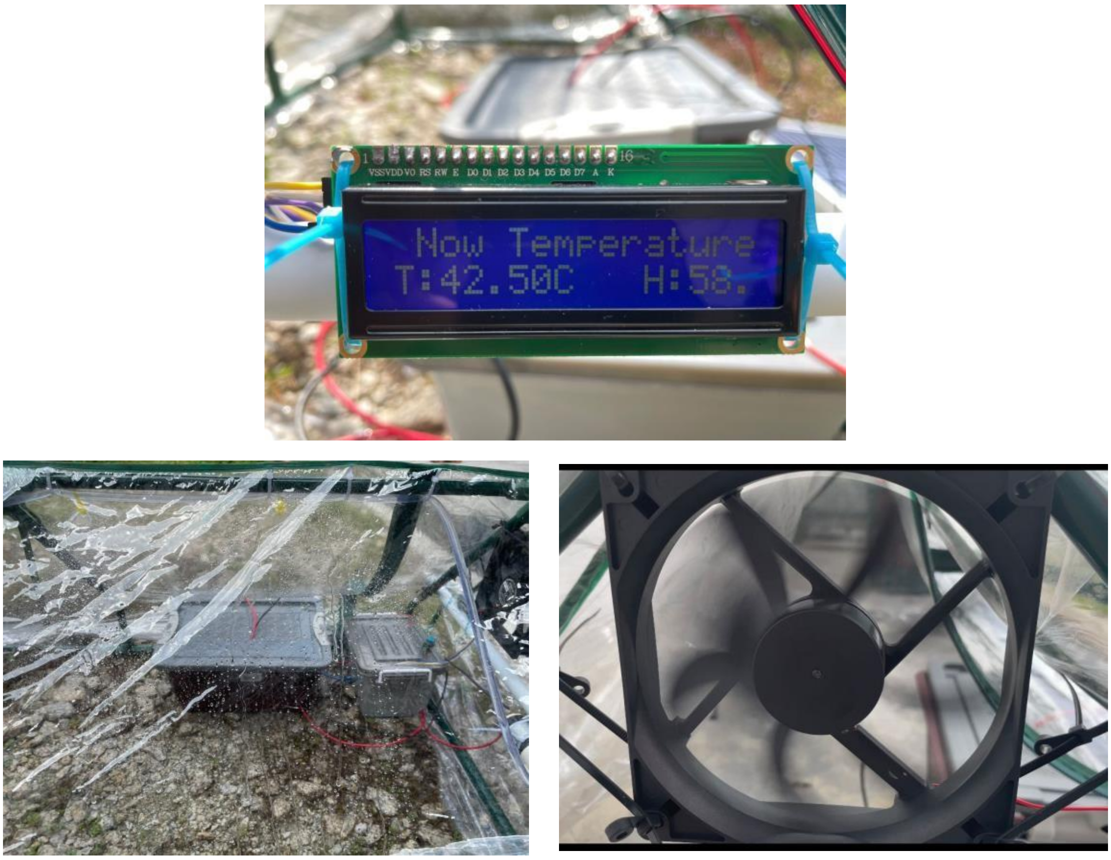

Figure 10: Prototype testing of prototype

C. Data collection

The results of the hardware prototype for monitoring and controlling systems in the greenhouse are discussed in this section. Table below shows the data collection for the 3-day performance of the greenhouse monitoring and controlling system.

Table 1 shows that the temperature started to exceed 35℃ at 12.00 P.M and it kept increasinguntil 2.00 P.M Then the temperature started to decrease at 3.00 P.M. Reading for humidity also started decreasing from 12.00 P.M which was 78% and it drops to 68% at 4.00 P.M. Fan and water sprinkler startedON at 12.00 P.M until 4.00 P.M.

Table 1: Day 1 data

Date	Time	DHT 11 sensor		Fan	Water sprinkle
		Temperature	Humidity		
14/6/2023	8.00 A.M	24.5℃	94%	OFF	OFF
	9.00 A.M	26.7℃	92%	OFF	OFF
	10.00 A.M	30.4℃	89%	OFF	OFF
	11.00 A.M	33.7℃	83%	OFF	OFF
	12.00 P.M	35.9℃	78%	ON	ON
	1.00 P.M	37.6℃	73%	ON	ON
	2.00 P.M	40.2℃	60%	ON	ON
	3.00 P.M	38.0℃	65%	ON	ON
	4.00 P.M	36.1℃	68%	ON	ON

Table 2 can be analyzed which is at 11. A.M. The water sprinkler started ON because the humidity in the house decreased to 76% but the fan remained OFF. But both of fan and water sprinkler started at 12.00 P.M. until 4.00 P.M. The temperature kept dropping from 36.5℃ to 45.1℃.

Table 2: Day 2 data

Date	Time	DHT 11 sensor		Fan	Water sprinkle
		Temperature	Humidity		
15/6/2023	8.00 A.M	25.3℃	93%	OFF	OFF
	9.00 A.M	28.5℃	91%	OFF	OFF
	10.00 A.M	31.5℃	88%	OFF	OFF
	11.00 A.M	34.8℃	76%	OFF	ON
	12.00 P.M	36.5℃	74%	ON	ON
	1.00 P.M	39.3℃	60%	ON	ON
	2.00 P.M	42.4℃	59%	ON	ON
	3.00 P.M	43.0℃	56%	ON	ON
	4.00 P.M	45.1℃	55%	ON	ON

Table 3 shows the process when water sprinkles turned ON at 11.00 A.M and kept remaining ON until 4.00 P.M but for the fans, it started ON at 1.00 P.M until 4.00 P.M. The highest temperature reading on that day was at 2.00 P.M which is 40.4℃ and temperature started to decrease to 39.5℃at 3.00 P.M and 38.6℃ at 4.00 P.M.

Table 3: Day 3 data

Date	Time	DHT 11 sensor		Fan	Water sprinkle
		Temperature	Humidity		
16/6/2023	8.00 A.M	25.3°C	93%	OFF	OFF
	9.00 A.M	28.5°C	91%	OFF	OFF
	10.00 A.M	31.5°C	88%	OFF	OFF
	11.00 A.M	34.8°C	79%	OFF	ON
	12.00 P.M	34.9°C	75%	OFF	ON
	1.00 P.M	39.9°C	70%	ON	ON
	2.00 P.M	40.4°C	68%	ON	ON
	3.00 P.M	39.5°C	65%	ON	ON
	4.00 P.M	38.6°C	69%	ON	ON

4. Conclusion

This project's goal is to design a monitoring and controlling system to monitor temperature and humidity in the greenhouse using Arduino uno, DHT11, fan, water sprinkle, and I2C LCD. The DHT11 sensor assists in plantation monitoring and controlling by reading the temperature and humidity in the greenhouse and I2C LCD will display the reading collected by the DHT11 sensor. Furthermore, the system's performance has been evaluated and proven to be successful in the project.

The user can use the Arduino IDE software to change any function based on the user's software programming criteria. The Arduino IDE is the leading programming software that is widely used aroundthe world, and there are numerous examples available on the internet. It is simple to compile and uploadto Arduino Uno.

Finally, the ability and cost of integrating software and hardware into a project is dependent on their ability and cost to integrate efficiently. Each component is vital for the system to function properly.

Acknowledgement

The authors would like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its support.

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