Automatic Humidity and Temperature Monitoring in Automotive Painting Spray Booth

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Abstract

Basically, the objective of this paper is to propose to build prototype of an improved version of spray booth. The DHT 22 sensor was used to detect and display the temperature and humidity of surrounding at LCD display. When the temperature detected in the spray booth is not in the range, the water pump will pump the water to a span. After water being pumped, the 4-blade motor propeller which is located in front the span will rotate and allows the cool air to circulate inside the spray booth. The speed of the 4-blade propeller motor can be controlled according to surrounding temperature and humidity. When the temperature detected is higher, the propeller motor will rotate at higher speed. This process will be repeated until the temperature of the spray both return to its normal range which is between 20-24-degree Celsius and humidity between the range of 65-75%. An exhaust fan which will always rotate is used in this prototype to allow the air circulation. The temperature and the propeller blade speed will be displayed in the LCD display and also can be viewed in GUI MATLAB from the control room.

Keywords: temperature, humidity, spray booth

1. Introduction

Automated humidity monitoring is a prime concern in automotive painting spray booth day-today life. Everyone wants to be as much secure as possible. An access control to know the value of temperature and humidity for spray booth. Basically, in a spray booth, the temperature and the humidity must be maintained so that the spray can have the ideal or perfect effect on the car. In conventional way, the temperature and the humidity are being maintained manually.

When the temperature and humidity in the spray booth is not in the desired range, the worker will switch on the button which is responsible to allow the water flow. After the water is being allowed to flow, the cooling fan will be switched on so that it can flow the cool air by sucking the cool air which is supplied by the water pump that is being switched on earlier.

In this paper, the spray booth prototype includes an automated system in supplying water using water pump for cooling process to take place. The operation of the water pump is being carried out together with the rotation of the dc motor which is connected to the propeller fan.

2. Problem Background

Nowadays, there are lacks awareness to the significant of temperature and humidity in spray booth. Suitable temperature and humidity level are needed to get a good quality of painting. The problem occurs in the existing current spray booth are as follow:

a) The water supply that is being supplied manually controlled for cooling processes is inefficient in the term of water usage due to uncontrolled amount of water released during the painting process.

b) In terms of fan functionality, the cooler fan is being switched on and off for cooling process is waste of time.

3. Literature Review

From the literature review, the previous projects done by other researchers also showed a certain weakness. It is very important to improve and to develop a good project. There are some useful ideas that can be implemented in this project from other similar projects.

The research in Ref. [1] discussed the design, prototyping, and testing of a remote monitoring system that is used to study seed germination under various controlled conditions. This research helps biologists in determining the optimal conditions for after-ripening in seeds, which are necessary for successful seed storage and germination.

Besides, the chicken farm monitoring system is proposed in Ref. [2] and developed based on wireless communication unit to transfer data by using the wireless module combined with the

sensors that enable to detect temperature, humidity, light and water level values. This system is focused on the collecting, storing, and controlling the information of the chicken farm so that the high quality and quantity of the meal production can be produced. This system is developed to solve several problems in the chicken farm which are many human workers is needed to control the farm, high cost in maintenance, and inaccurate data collected at one point. Based on the research that has been carried out, the system that can monitor and control environment condition (temperature, humidity, and light) has been developed by using the Arduino microcontroller. This system also can collect data and operate autonomously.

Ref. [3] aims of automatic humidity monitoring and pumping system for farmers project. The project is to monitor and record values of humidity of natural environment and to pump the plants water at required humidity level in order to achieve maximum plant growth and yield. It also possible with the help of a drip irrigation system, through solar power, using vocal commands through the mobile phone and wireless sensor network. This paper also consists of wireless sensor network for real time data sensing and control of an irrigation system. It introduces an automatic module to supply appropriate amount of water to the field by sensing the crop humidity requirement. It even reduces probability of soil erosion and protects the crop rotting due to over irrigation during heavy rainfall with advanced rainfall unit. This system will be economical in terms of hardware cost and power consumption. It also introduces a humidity sensor and temperature sensor at field where sprinkling must be done with respect to the quantity of water needed. The circuit monitors the water level of the tank, to prevent dry run and damage to pump. An integrated liquid crystal display (LCD) is also used for real time display of data acquired from the sensor and the status of the device. The design is quite flexible as the software can be changed any time.

Next is the effect of different temperature range that will affect the speed of the DC motor rotation. The range of temperature in spray booth have an ideal effect, and that leads directly to an increase in the DC motor rotation speed [4]. Other techniques, such as installing and automated humidifier so that the temperature of the spray booth can be regulated. One particularly promising approach to improve the display of both temperature and humidity and as well as the speed of the DC. Therefore, in a spray booth, it is important to maintain the temperature and humidity in a required range so that the spray can have an optimum effect on the car [5].

4. Methodology

The general block diagram of the project is shown in Figure 1. The current value of humidity and temperature inside the protype of spray booth was sensed by the sensor (DHT22) and feed to the microcontroller unit. If the value of humidity and temperature were below or above the acceptable ranges, a pump will pump the water at the water circulation part and the fan will circulate until the temperature and humidity achieve the desired value. Here, the temperature and humidity must be maintained at 20 to 24 ℃ and 40 to 50%, respectively.

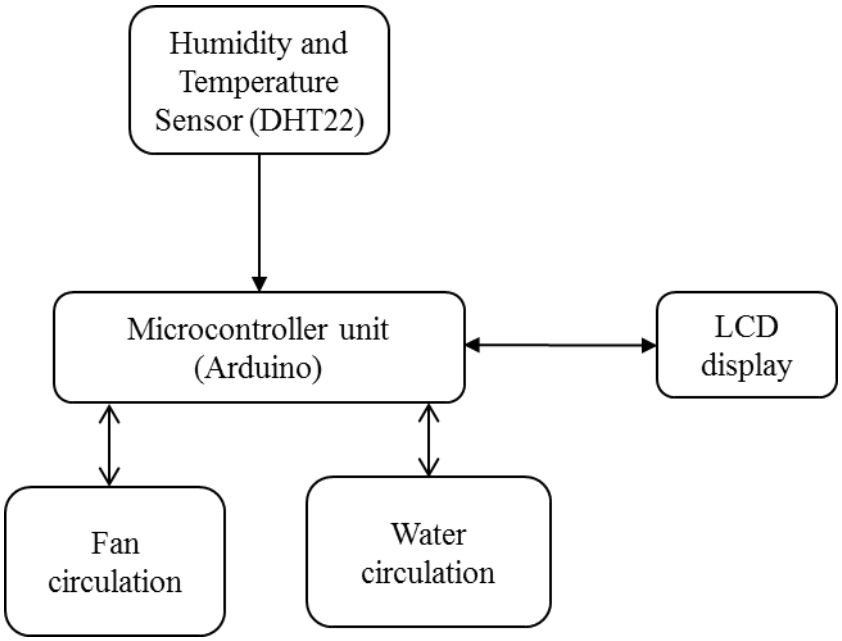
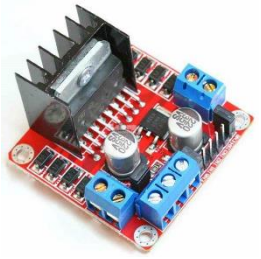


Figure 1. Block diagram of the system

The selection of components and its specifications used in this project are as follow (see Table 1):

Table 1. Components and its specification

Num.	Components and specifications	Picture of components
1	**Exhaust fan** • DC 12 V / 0.15 A • SIZE:120mmx120mm	
2	**Temperature and humidity sensor (DHT22):** • Humidity range: 0 – 100% • Temperature range: -40 to 125°C • Sampling rate: 0.5Hz • Body size: 15.1mm x 25.1mm x 7.7mm • Operating voltage: 3 – 5V • Max. current: 2.5mA	
3	**ARDUINO UNO** • Operating Voltage 5V • Input Voltage (recommended) 7-12V • Input Voltage (limits) 6-20V • Digital I/O Pins 14 (of which 6 provide PWM output) • Analog Input Pins 6 • DC Current per I/O Pin 40 mA • DC Current for 3.3V Pin 50 mA • Flash Memory 32 KB of which 0.5 KB	
4	**16 x 2 LCD Display** • 8-bit data pins • Supply voltage: 5V • Backlight VCC (5V) • Backlight ground (0V)	
5	**5V DC Motor** • Operating Voltage:3-6 V • Nominal Voltage: 5V • No Load Current:0.27A • Long:25mm • Diameter:21mm • Shaft Diameter:2mm	

6	**L298N 2 Channel Dc Motor Driver** • Terminal Supply Vs: 5-35V • Peak Io: 2A (Max Single Bridge) • Input Voltage Range: 0-5V • Dimensions: 55mm x 44mm x 27mm • Weight:28g	
7	**Channel Relay Module 5V DC** • Max Current Rating:10A • Max Voltage Rating: AA250V / DC 30V	
8	**Mini Water Diaphragm Water Pump 2L** • Input Voltage: 6-12 V Dc • Flow Rate: 1.5-2 L / Min • Operating Temperature: 80℃ • Operating Current:0.5-0.7 A • Suction Distance: 2m(Max) • Life Of Pum: 2500hour • Size: 90x40x35m	

Moreover, this project is divided into two parts; simulation part and hardware part.

4.1 Simulation part

Proteus software was used for the schematic capture and simulation of the project design before prototyping project design into the hardware. First, project circuit was designed in Proteus software with proper connection between all the components as well as the programming using Arduino software. Figure 2 shows the connection between microcontrollers in Proteus software.

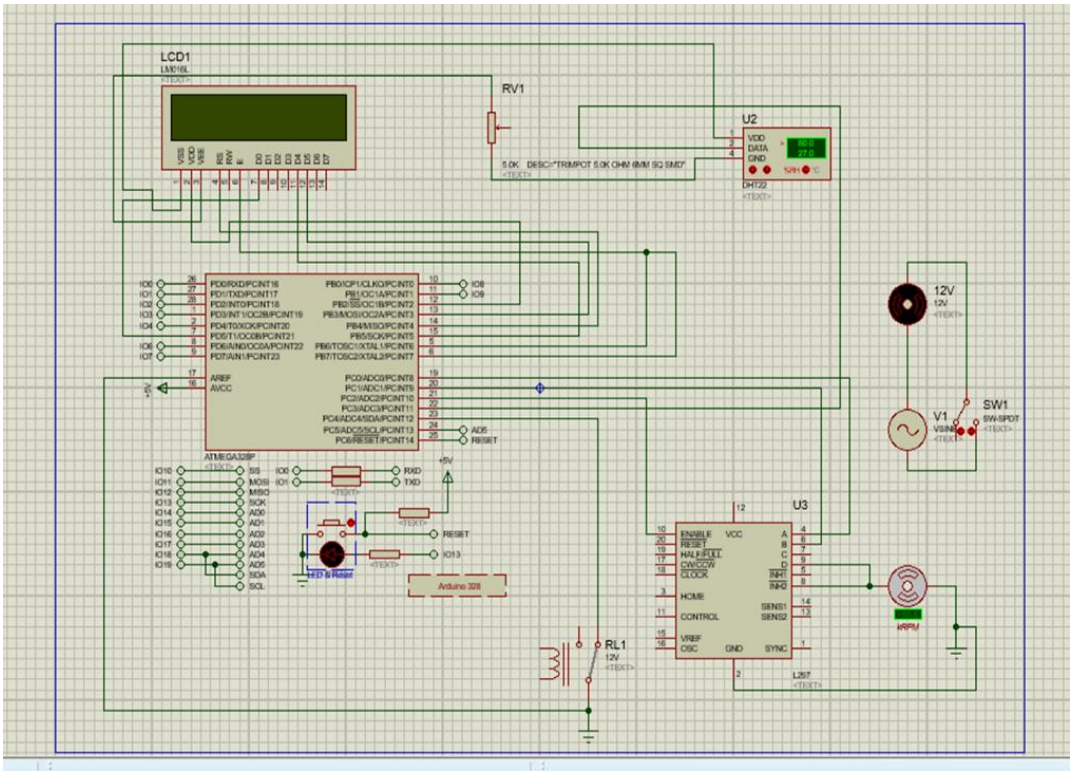


Figure 2. Simulation in Proteus Software

4.2 Hardware part

After done with all the planning and research, the final stage is prototyping the project design into the hardware. Figure 3 and Figure 4 show the design and prototype of the project. The design of the prototype of the spray booth was done using AutoCAD software.

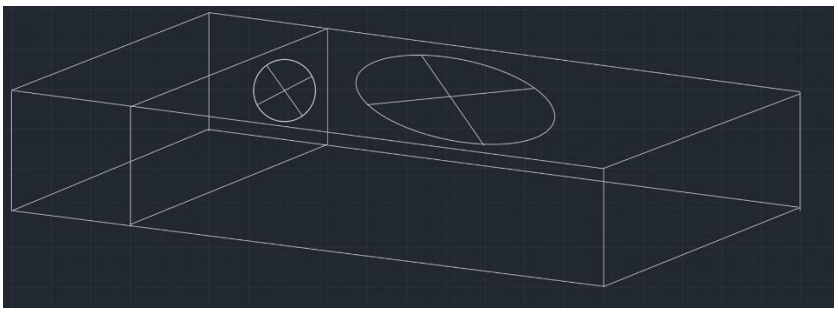


Figure 3. Design of prototype of spray booth

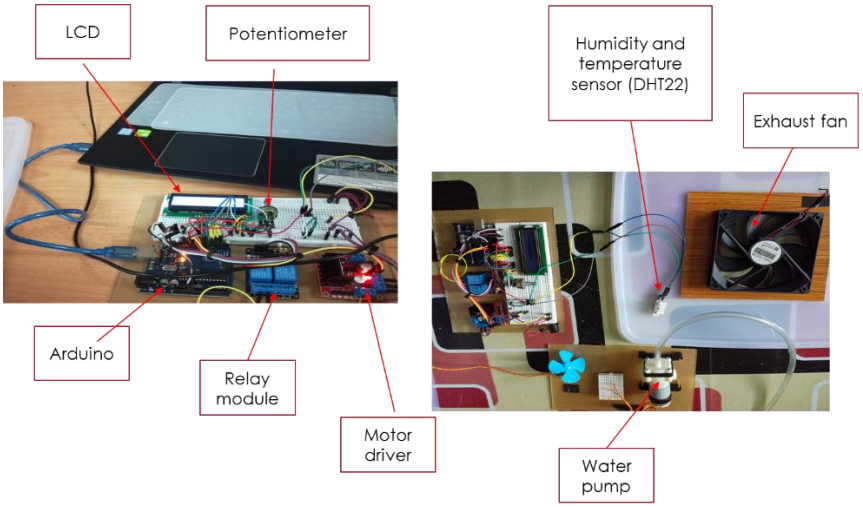


Figure 4. Prototype of spray booth

5. Results and Discussion

When turn on the portable monitoring system, DHT22 sensors would detect the humidity valve. The humidity value displayed on LCD. If the humidity below than 40%, water pump will be running in high rpm until the standard humidity value in painting which is 40%-50% is obtained. However, when the humidity reading is over 50%, the water pump will be running slowly to maintain the humidity value. The user cannot go to the room and look the condition room. From that device, the water pump can act early after the DHT22 knows the condition of the room. If it is in unstable condition, then the water pump automatic running until it reaches the standard humidity value.

Same goes for the condition of the temperature. When the temperature is below 20℃, the fan will turn slowly until the standard temperature is achieved. But, when the temperature is too high (above 24℃), the fan will turn faster to reduce the temperature inside the spray booth until the temperature at standard range is obtained.

When turn off this monitoring system, the system will be deactivated and nothing will happened. Figure 5 shows the example of results display on the LCD.

Figure 5. Example result display on LCD

6. Conclusion

As conclusion, the project was able to regulate the temperature inside the spray booth depending to the surrounding. The temperature and humidity were able to be maintained at 20℃ to 24℃ and 40% to 50%, respectively.

References

[1] T. Balachandran, S.M. Sbenaty, J. Walck, Remote humidity and temperature real-time monitoring system for the study of the after-ripening process in seeds, in: ASEE Annu. Conf. Expo. Conf. Proc., 2013.

[2] N.S. Amir, A.M.F.M. Abas, N.A. Azmi, Z.Z. Abidin, A.A. Shafie, Chicken Farm Monitoring System, in: Proc. - 6th Int. Conf. Comput. Commun. Eng. Innov. Technol. to Serve Humanit. ICCCE 2016, IEEE, 2016: pp. 132–137. https://doi.org/10.1109/ICCCE.2016.39.

[3] https://www.coursehero.com/file/49987881/Automatic-Humidity-Monitoring-And-Pumping-System-For-Farmersdoc/

[4] https://www.bodyshopbusiness.com/behind-the-booth-inside-your-spray-booth/

[5] https://www.smartfog.com/importance-of-paint-booth-humidification-systems.html