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Automatic Roof Cooling & Monitoring System

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Abstract: Recently, Industrial Revolution4.0(IR4.0) changes the landscape of industrial in Malaysia. The internet of things (IoT) is one out of nine technology-driven in IR 4.0 which requires internet as the fundamental for physical devices connection. Many companies have been transforming their products in a complex context such as the home automation system market. Unfortunately, not all users can afford to own this home automation system due to its high price. The home automation system is important because it can facilitate people and shorten the time to turn on and turn off the electrical appliances. Most home automation systems use manual ways as the medium in which this factor may hinder the benefits for users who prefer to turn on and turn off their electrical appliances in simpler and easier ways. To overcome such limitation, this paper proposes a development of home automation system via sensors and microcontroller to develop an automatic system in the building. The proposed system functionality was evaluated using real electrical appliances and it successfully worked with the use of sensors. The proposed system was developed at a low cost and it could be commercialized at an affordable price. Hence, this project could narrow the gap between all different stages of society (i.e.B40, M40 and T20 groups) in realizing the concept of IR4.0 in their daily lives.

Keywords: Internet of Things (IoT), Node MCU, Industrial Revolution 4.0(IR4.0), Automatic System, Home Automation System

1.0 INTRODUCTION

Temperature is most important characteristic for a building. As the outside temperature increase due to sunny day, the roof temperature also increase. This will rise the indoor temperature beyond the room temperature which is 27°C. Hot weather makes people feel uncomfortable and can ruin their mood. Hot ambience can increase body temperature that cause heavy sweating, clammy skin, dehydration, tiredness, headache and dizziness[1].

Based on the issue, this project a prototype were created for study about the method to preventing temperature in the building increase above 27°C. This project has developed an automatic, sustainable and cost effective cooling system that prevent indoor temperature increases beyond room temperature. This project is using water as the cooling agent by sprinkling it on the roof surface using Node MCU as the microcontroller. This project also works as a monitoring system for building temperature which monitor the roof and indoor temperature through phone or personal computer using Blynk apps.

During the testing duration, this project have been changed and modified on some parts to achieve the objective and the best result for it. The changes an modified duration takes around 1 – 2 weeks to trial and error until it success. It take some time because when the outside temperature are so high, it is difficult for the system to remain the roof temperature low due to time taken for roof getting hot is faster during that situation.

After several testing and evaluation for one month, the cooling system successfully works automatically. The monitoring apps works according the plans and it takes the accurate reading of the temperature. This project prototype has successfully prevent the temperature rise beyond 27°C and remain below room temperature as the data was taken. The cooling agent which is the water was also found to be a reliable cooling agent since the indoor temperature remain 27°C and below for one month of testing.

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2.0 MATERIALS AND METHODS

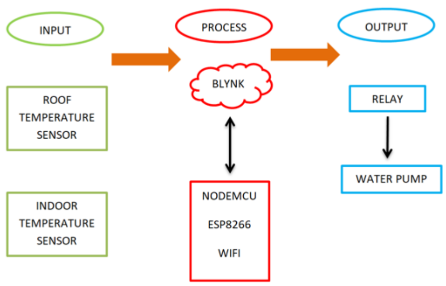

Figure 1: Block diagram

Figure 1 shows the three main parts which are consist of the input, process and output. The first part is input is the application of temperature sensors. There are two temperature sensors (DHT 22) that will read the roof and indoor temperature. The information collected from the sensors will be transfer to NodeMCU (ESP8266 Wi-Fi) as the process. When the sensors transfer the data, the NodeMCU will analyze the command and automate turn on the relay (15V) which is connected with water pump (12V). NodeMCU then send the real time data such as temperature reading, humidity reading and relay status to Blynk apps as the monitoring system. To allows NodeMCU send every real data to Blynk, the NodeMCU microcontroller must be connected with internet.

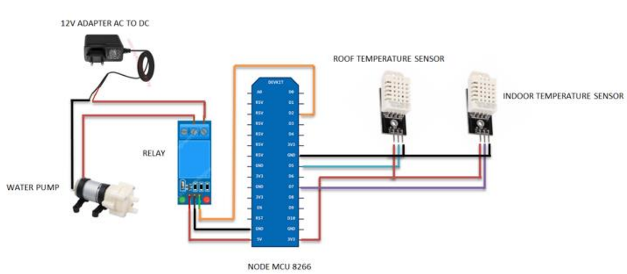

Figure 2: Wiring Diagram

Figure 2 shows wiring diagram of the project which both sensors are connected to NodeMCU as the input. First sensor is placed on the ceiling to reads the roof temperature for NodeMCU to turn on the output when it reaches limitation of the temperature. The second sensor is placed indoor to monitor the temperature inside the building. The relay is connected to the NodeMCU as the output of the project. 12V adapter AC to DC is used for water pump power supply and it connected to relay to synchronize with the system.

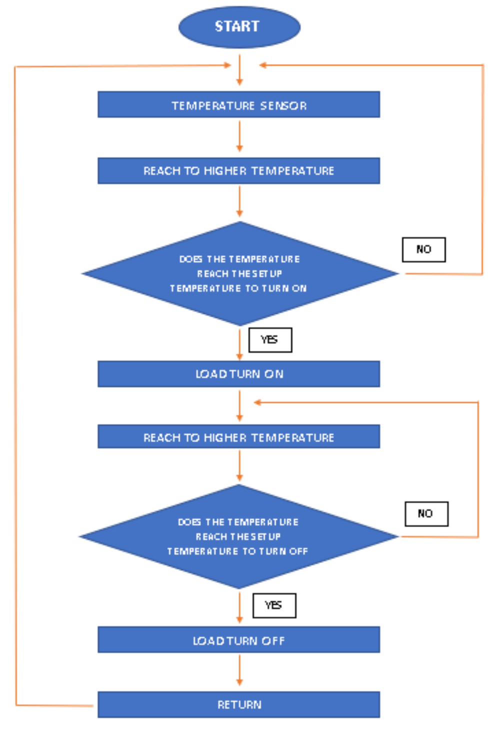

Figure 3: Flow Chart

Figure 3 shows the flow chart of the automatic roof cooling system project. As the project turn on, the system will start and standby until the roof temperature reaches the temperature limitation which is set in Blynk apps. If the temperature reaches the limitation, the NodeMCU will turn on the load which is relay. When the relay is turn on, water pump will pump the water and it will lower the roof temperature. As the system cooling the roof for 30 minutes, the system will turn off the relay and going back to standby mode at start.

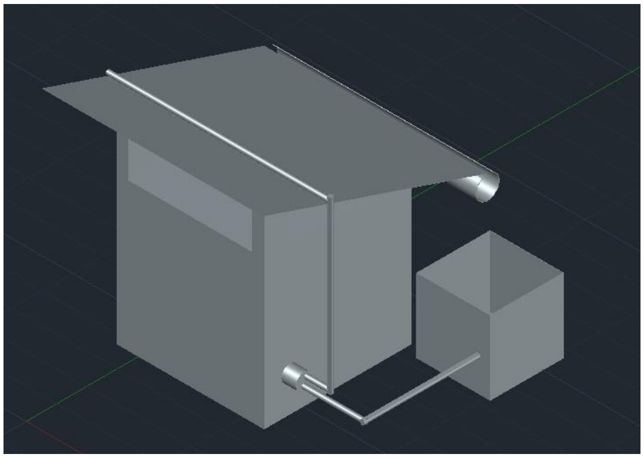

Figure 4: Project design drawn using AutoCAD

Figure 4 shows the design of the project. the software used is AutoCAD software. By using this software, the designing process become easier and faster. The design drawn before the prototype were built to make sure the building process are easier.

3.0 RESULTS

Figure 5: Project prototype

Figure 4 shows the actual design of the project prototype which being built based on AutoCAD drawing. There is some improvement were added to the project in design and material.

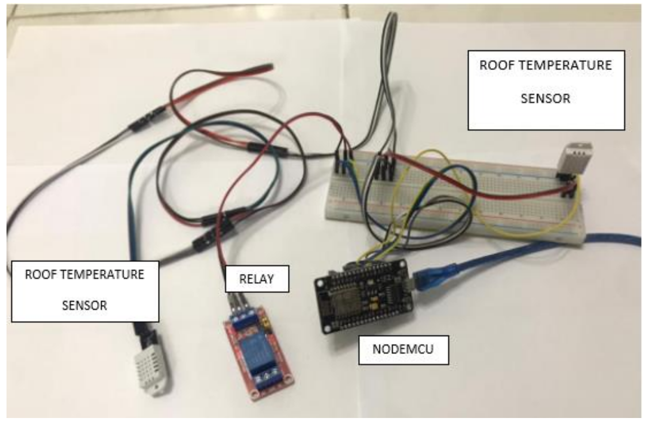

Figure 6: Project system hardware

Figure 6 shows the hardware of cooling system for this project. The breadboard was used to facilitate troubleshooting work. The sensor for indoor are connected at the breadboard to reduce uses of cable. The roof sensor is connected to longer cable because it is placed in the ceiling that is higher from the breadboard.

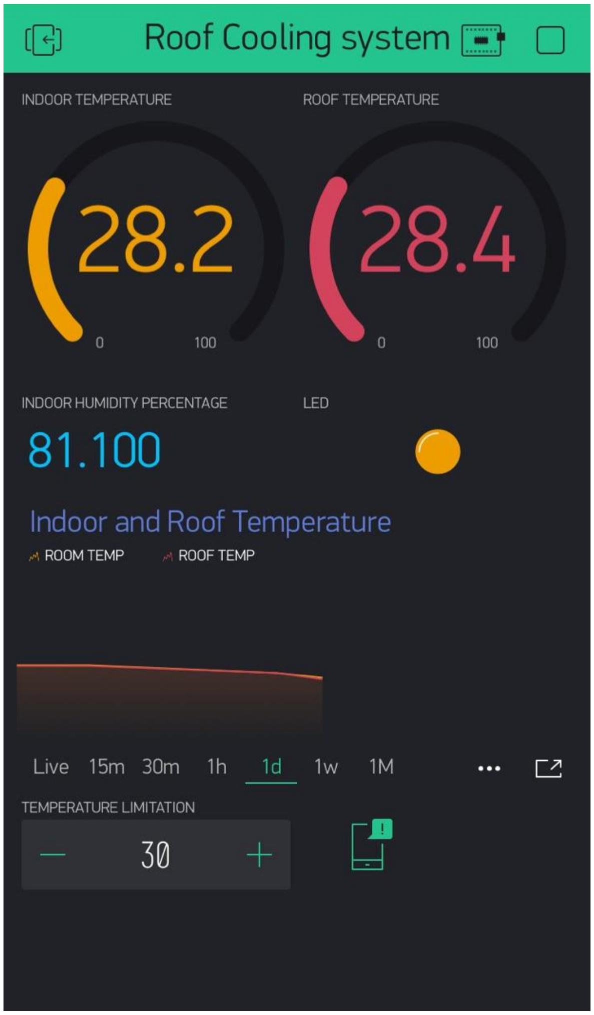

Figure 7: Blynk apps interface

Figure7 shows the monitoring apps for the cooling system interface on the phone. This application shows the roof temperature, indoor temperature and humidity, graph for both temperature reading and temperature limitation for roof sensor regulator. The limitation can be set through the apps using the temperature regulator. The LED shows the status of relay, if the relay is turn on then it will turn on. this apps also will send notification to the phone if the system is offline so that user will be notify. By looking at the figure, LED shows that relay are still turn on even the temperature has dropped below the setup temperature. it is because coding the cooling system have been setup to turn on the relay for 30 minutes when temperature above the limitation. The graph shows that the temperature are droping from 30°C to 28°C by looking at the line in the graph.

Time	**Roof temperature** (°C)	**Indoor temperature** (°C)
9.00 A.M	24	25
10.00 A.M	31	30
11.00 A.M	37	35
12.00 P.M	41	37
1.00 P.M	40	37
2.00 P.M	40	38
3.00 P.M	39	39
4.00 P.M	27	28
5.00 P.M	25	26
6.00 P.M	23	24

Table 1: Temperature before cooling system applied

Table 1 shows the temperature of both roof and indoor before cooling system was applied. The data was collected in September 2021 at Ipoh, Perak. The average high temperature was around 33°C on that month[3]. The highest temperature of the roof can reach until 41°C which is too hot for a building. Highest temperature was happened on afternoon where it usually sunny at that time.

Time	**Roof temperature** (°C)	**Indoor temperature** (°C)	**Relay status**
9.00 A.M	24	25	OFF
10.00 A.M	29	27	ON
11.00 A.M	28	26	OFF
12.00 P.M	29	27	ON
1.00 P.M	29	27	ON
2.00 P.M	29	27	ON
3.00 P.M	29	27	ON
4.00 P.M	27	27	OFF
5.00 P.M	25	26	OFF
6.00 P.M	23	24	OFF

Table 2: Temperature after cooling system applied

Table 2 shows the temperature of both roof and indoor after cooling system was applied. The table shows that cooling system have success in preventing the indoor temperature rise above the room temperature. It also prove it can remain the roof temperature on 29°C for hours. The relay will turn on when roof temperature reach the limitation that have been setup in the Blynk apps.

DATA TAKEN FROM 4 – 10 OCT		
Day	**Total Time Relay Turn On**	**Highest Temperature Outside (°C)**
1	2 Hours	33
2	2 Hours	33
3	2 Hours 30 Minutes	35
4	3 Hours 30 Minutes	36
5	3 Hours	35
6	2 Hours	32
7	3 Hours 30 Minutes	36

Table 3: Total time relay turn on in a week

Table 3 shows total time relay turn on for each day in one week. The data was taken on 4-10 October in Ipoh Perak. The table shows that relay will frequent turn on when temperature on that day is high. The longest time relay turn on is on 4th and 7th day which means it turn on 7 times in a day.

4.0 DISCUSSION

As the discussion, the result shows both temperature sensors has read the ambience temperature accurately for roof and indoor. The user need to turn on the system to start it. The system will operate as it have programmed. When the temperature is rising and dropping, ever data will be send to Blynk apps. As shows in Figure 7, both temperature data pop-up on the gauge display and every reading will constructed in the graph the bottom of it. The system is turns on, it will be on standby until the roof temperature reach the limitation value. The relay will automatically turn on when temperature reach the limitation value and cooling phase will started for 30 minutes. The temperature sensors used are not water resistance so their need to placed in the dry place.

From table 1, it shows the result of roof and indoor temperatures are very high before the cooling system was applied to the prototype due to sunny day when the data was taken. Table 2 shows the result of 9 hours reading after cooling system was applied to the prototype and the indoor temperature has remain under the room temperature.

Besides, the result from table 3 shows the total time of the relay turn on for every day. As the result shown, it can be conclude that the higher the temperature outside, the often relay will turn on.

5.0 CONCLUSION

As the conclusion, the Automatic Cooling & Monitoring System is a successful system. In the cooling parts, it is proven can prevent indoor temperature rise above 27°C. For monitoring parts, it is successful reads both temperature accurately and display them in the apps. For a prototype it can define as a successful prototype. This device is an automatic system that cam ease user works and help them to monitor their building. For the application it can be applied in field of animal husbandry, small workshop and housing purposes based on the size and material used of the building. Nowadays, technologies are getting advance from time to time. Appliances and machines are now can be controlled and monitored using smartphone or any personal computer from anywhere. This device were developed on order to help user to adapt with IoT and enhance the uses of IoT in the country.

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