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The Prototype of Orchid Plantation Monitoring and Control System Based on Internet of Things (IoT)

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Abstract

Orchids are ornamental plant that live in various kind of temperature depending on its type, but mostly in a cool environment. An orchid that planted in a soil media cannot live in the condition that is too wet or too dry. To keep orchid plant in good condition, a monitoring of the plant's condition is necessary. Internet of Things (IoT) is a technology that can enable communication between one components to others via internet. By using IoT, the control and monitor system of the orchid plantation system is able to be built wirelessly in a long distance. The system built using DHT22 as temperature sensor. YL69 used as humidity sensor and Arduino Mega 2560 used as the main controller. ESP8266 used as the communication board sothat the system can access the Blynk server. 16x2 LCD is used as the display and relay is put to control the connection of water pump and the fan. The result of this research is that the monitoring system is able to watch the data delivered by the sensor via internet. The control system also fully able trigger the water pump and the fan.

Keywords: *Internet of Things, DHT22, YL69, Arduino Mega 2560, ESP 8266*

1. Introduction

The control system technology nowadays is not a new thing in automation area. Microcontroller can be used as the implementation of automation system as the main controller. Automation system usually used in various kind of field to make the process become easier [1]. One of the field in automation area is in agriculture. The various needs in plantation process makes the automatic control system needed. The control system used in the plantation process usually is to control temperature, humidity, plant nutrition, watering, etc. Different plant also has a different need, so is the orchid plantation.

Orchid plantation is one of the commercial plant cultivated in Indonesia. Orchid is the type of plant that has a slow growth rate and it needs special treatment to be able to beautifully grow. For the mass moon (bulan) orchid plantation needs a special housing area to provide accurate climate condition as the real habitation [2]. Most of orchid is like human, it will beautifully grow with the right temperature. Some of the orchid specimesn are live in the mountains with low temperature (10-15˚C), the common orchid plantation lives in the 15˚C until 30˚C. Soil orchid will need higher temperature rather than the orchid that lives in a pot. The high temperature will cause dehydration and prevent the plant to grow. With the 30˚C temperature or higher needs to be adjust with the high humidity and a good air circulation [3].

This research focused on the development of the orchid monitoring and control system using temperature and humidity sensor based on microcontroller. There are some research about orchid plantation in automation area i.e. the watering system in orchid plantation using humidity sensor with Borland Delphi 7 [2] and Arduino UNO and watering system in plantation using YL69 and Arduino [4]. Both of the previous research are focusing in the plantation watering mechanism with the humidity as the main parameter and it also used as the refenrence of this research.

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2. Research Method

This research consist of several steps i.e. identificating the system, designing system, implementing the design to the system, testing and analyzing. The first ste is identificate the functional and non functional needs of the system. The system built with Arduino Mega 2560 as the main controller [5]. DHT22 is used as the temperature sensor [6]. YL69 is used as the soil humidity sensor [7]. Relay used as the actuator connection. 16x2 LCD used as the display. ESP8266 used as the transmission board. Blynk used as the server, monitoring and control system.

The functional needs of this system are first the system able to monitor the data collected from the temperature and humidity sensor. The second is the system can decrease the temperature automatically based on the condition put in the system. The third is the system able to watering theorchid plantation based on the collected data read by the sensor or manually by the button in the Blynk application. The forth is the system able to communicate with the Blynk application using wifi modul. The last is the system able to read the data from the sensor and display the data to LCD and to the Blynk application on the mobile phone.

The non-functional need of the system is that the system built using Arduino Mega 2560 as the main controller. The system works with 9V and 1A as the power. The system built with C programming in Arduino IDE. The prototype built as the housing area with water saving. Blynk application works in Asus Zenfone Max Z010D in Androis operating system version 6.0.1.

3. System Design

Designing the system consist of designing the hardware and the software used to built the system. The hardware of the system can be seen in Figure 1.

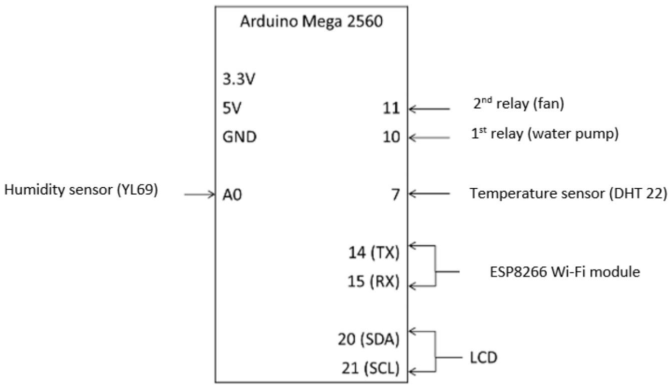

Figure 1. Hardware block diagram

The system controlled by ATmega 2560 microcontroller. The system input are DHT22 as temperature sensor and YL69 as humidity sensor. The system output are relay that connected with fan and water pump, also it is connected to 16x2 LCD using I2C module. In order to communicate with Blynk application, the system using ESP8266 as a wifi module in serial communication. Table 1 below show the interface used in the Arduino Mega and the components used in the system. The flowchart of the system can be seen in Figure 2. The system called the library and declared the constanta and the variables used. The system then worked with the `void setup()` function, and then continued with the `void loop()` function continuously. The `void setup()` function can be seen in Figure 3.

Table 1. Arduino Mega 2560 Pin Interface

No	Arduino Mega 2560 Pin Interface	Components Pin Interface
1	A0	YL69 Sensor Output
2	7	DHT22 Sensor Output
3	10	IN1 Relay
4	11	IN2 Relay
5	14 (TX3)	RX ESP8266
6	15 (RX3)	TX ESP8266
7	20 (SDA)	SDA LCD
8	21 (SCL)	SCL LCD

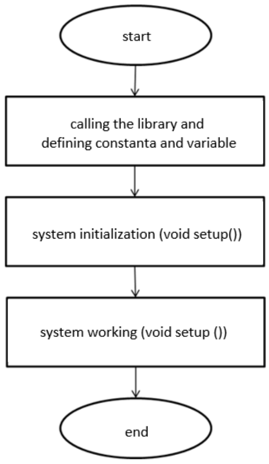

Figure 2. Software flowchart

In the void setup () function, configuration of relay pin, LCD initialization, serial communication for wifi module, and wifi communication initialization are happened. If in 50 seconds the system able to make authentification to wifi module, then it continued to `tryConnecting()` function. In the other hand, if it take more than 50 seconds, the system repeat the initialization process. In `tryConnecting()` function, there are two conditions, one when the connection is connected, the system works with the Blynk. When the connection is lost, the system still working but without Blynk while trying to keep making initialization to wifi communication. After `void setup()` function works, the system continued with `void loop()` function. Figure 4 shows the flowchart of `void loop()` process.

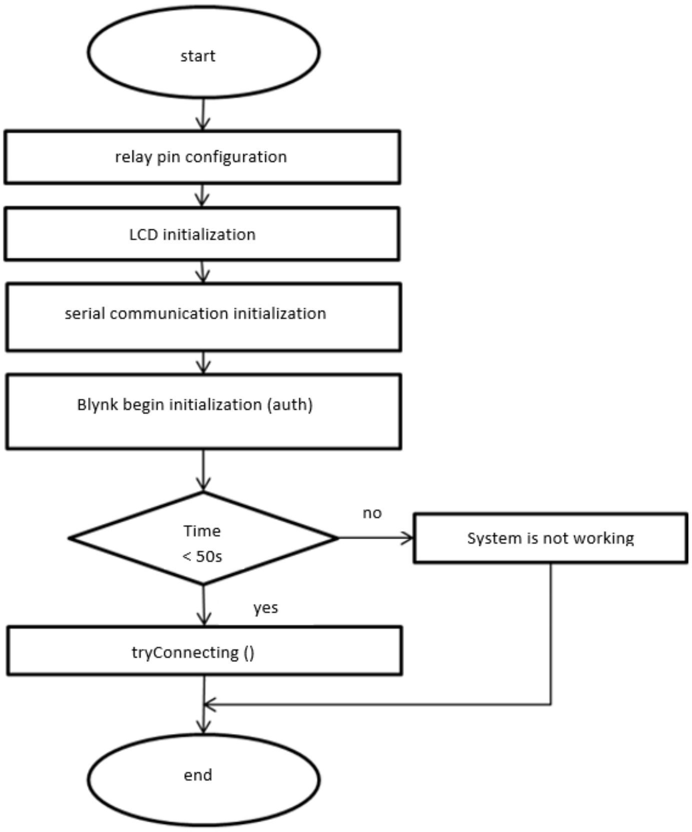

Figure 3. `void setup()` flowchart

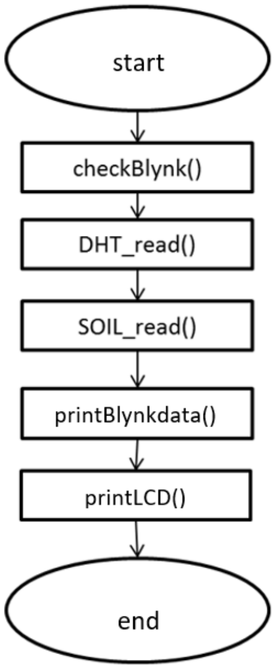

Figure 4. `void loop()` flowchart

Every command in the `void loop()` function will work repeatedly when the program function activated. The first command that executed is `checkBlynk()`, with 50 second connection check. The next is `DHT_read()`, command used to read the temperature sensor and `SOIL_read()` used to read the humidity sensor. Both of the temperature and humidity sensors used to activate the actuator with predetermined value. The last command are `printBlynkdata()` and `printLCD()`, it used to show the result from `DHT_read()` and `SOIL_read()` function. The flowchart for each sensor can be seen in Figure 5 and 6.

Based on the Figure 5, the temperature read every once in one second. The system has upper threshold 30ºC and lower threshold 26ºC. If the temperature goes 30ºC and above the system trigger the fan to be turn on. If the temperature goes bellow 26ºC the system trigger the fan to be turn off. Based on Figure 6 the soil humidity read every once in one second. If the soil humidity under 30% the system trigger the water pump to be turn on. If the soil humidity above 60% the system trigger the water pump to be turn off.

4. System Implementation

The system is implemented in orchid housing prototype using wood, wire, and ultraviolet plastic as the wall. Electronic circuit used to connect all of the component and the Arduino. Figure 6 show the electronic circuit and Figure 7 show the implementation of the system design to the prototype.

The software implementation consist of program to make the system work as the functional needs described before. The software used C language in Arduino IDE. there are three parts in Arduino IDE i.e. firt declaration, `void setup()`, and `void loop()`.

The system read the temperature and the soil humidity every one second. The system display the sensor reading in LCD and Blynk application. DHT22 sensor used to trigger the fan inside the prototype using relay. The fan turn on if the temperature reach 30ºC and turn off if the temperature decrease until 26ºC. YL69 sensor also used to trigger the water pump in the orchid housing prototype using relay. The water pump turn on if the soil condition dry or only have 30% humidity and the water pump turn off if the soil condition humid or have 60% humidity.

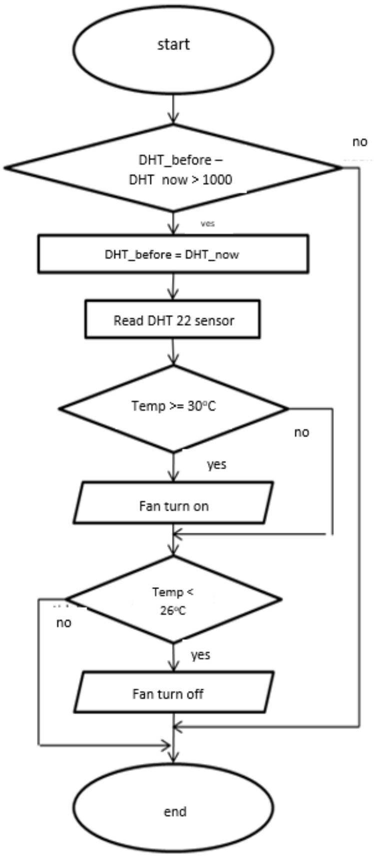

Figure 5. DHT_read() flowachart

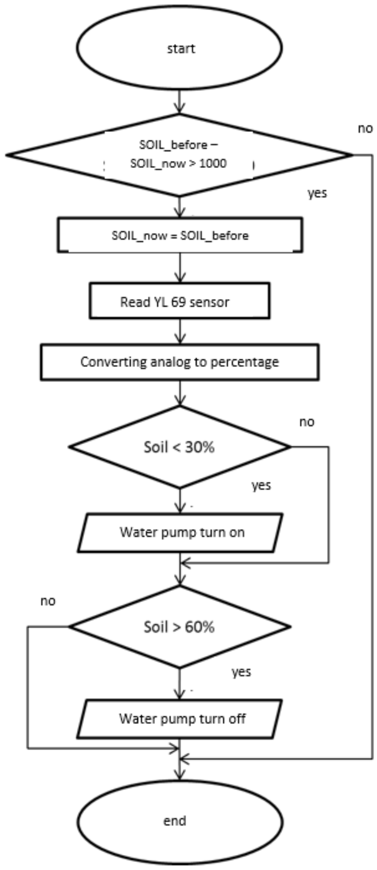

Figure 6. SOIL_read()flowchart

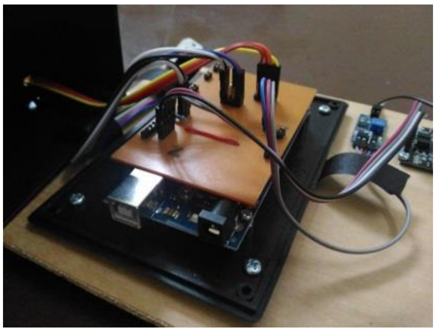

Figure 7. Electronic circuit system

Figure 8. Orchid housing prototype

5. Result and Analysis

The testing mechanism is comparing the result read from the sensor with the comparation tool. The DHT22 sensor compared to room thermometer and the YL69 sensor compared to soil meter. The testing done by recording the result showed in the sensors and the comparison tools in every ten seconds. Beside the sensor testing, the whole system also checked to know whether the system implementation meets the functional need described before.

The result of the testing shown in Table 2 until Table 6. The result for DHT comparison with room thermometer shown in Table 2.

Table 2. The comparison of DHT22 sensor data and room thermometer

Number	DHT22 Sensor Data (°C)	Room Thermometer Data (°C)	Comparison (°C)
1	27	27	0
2	26.9	27	0.1
3	26.8	27	0.2
4	26.7	27	0.3
5	26.8	27	0.2
6	26.7	27	0.3
7	26.6	27	0.4
8	26.5	26.9	0.4
9	26.5	26.9	0.4
10	26.6	26.9	0.3

It can be seen from Table 2 that the maximum comparison between DHT22 sensor and room temperature is 0.4°C with average comparison is 0.26°C. the second testing is comparing the YL69 sensor with soil meter. Both of the YL69 sensor and the soil meter are put in the same soil condition to get the best comparison data. The result of the comparison between YL69 sensor and soil meter can be seen in Table 3. The result from the soil meter used as the YL 69 indicator.

Table 3. The comparison of YL69 sensor and soil meter in the dry condition

Number	YL69 Sensor Data (%)	Note	Soil Meter Data (%)	Note	Comparison(%)
1	23	Dry	25	Dry	2
2	23	Dry	25	Dry	2
3	23	Dry	25	Dry	2
4	23	Dry	24	Dry	1
5	23	Dry	24	Dry	1
6	22	Dry	23	Dry	1
7	22	Dry	22	Dry	0
8	22	Dry	22	Dry	0
9	22	Dry	22	Dry	0
10	22	Dry	22	Dry	0

Table 4 The comparison of YL69 sensor and soil meter in the humid condition

Number	YL69 Sensor Data(%)	Note	Soil Meter Data (%)	Note	Comparison(%)
1	59	Humid	61	Humid	2
2	59	Humid	61	Humid	2
3	59	Humid	60	Humid	1
4	59	Humid	60	Humid	1
5	59	Humid	60	Humid	1
6	59	Humid	60	Humid	1
7	59	Humid	60	Humid	1
8	59	Humid	60	Humid	1
9	59	Humid	60	Humid	1
10	59	Humid	60	Humid	1

Table 5 The comparison of YL69 sensor and soil meter in the wet condition

Number	YL69 Sensor Data(%)	Note	Soil Meter Data (%)	Note	Comparison(%)
1	71	Wet	80	Wet	9
2	71	Wet	80	Wet	9
3	71	Wet	78	Wet	7
4	71	Wet	78	Wet	7
5	71	Wet	76	Wet	5
6	71	Wet	76	Wet	5
7	71	Wet	76	Wet	5
8	71	Wet	75	Wet	4
9	71	Wet	75	Wet	4
10	71	Wet	75	Wet	4

Based on the result, for the dry condition, maximum comparison between YL69 sensor and the soil meter is 2% with average comparison 3.6%. For the humid condition, maximum comparison between YL69 sensor and the soil meter is 2% with average comparison 1.2%. For the wet condition, maximum comparison between YL69 sensor and the soil meter is 9% with average comparison 5.9%.

Every data read from the sensor can be seen in the LCD and the Blynk application. Figure 8 show the Blynk application interface. the last test is whole system testing. The whole system testing can be shown in Table 6. Based on the result all of the functional need can be implemented to the system

Figure 8. Blynk application interface

Table 6. Functional testing

Number	Parameter	Result testing
1	System can read the temperature in the orchid housing prototype	Working properly
2	System can read the soil humidity in the prototype soil environment	Working properly
3	System can trigger the fan based on threshold in the DHT22 temperature sensor	Working properly
4	System can trigger the water pump based on the threshold in the YL69 humidity sensor	Working properly
5	System can display the DHT22 temperature sensor data in the LCD	Working properly
6	System can display the YL69 humidity sensor data in the LCD	Working properly
7	System can display the DHT22 temperature sensor data in the widget gauge in Blynk application	Working properly
8	System can display the YL69 humidity sensor data in the widget gauge in Blynk application	Working properly
9	System can watering the prototype manually using the buttom widget in the Blynk application	Working properly

6. Conclusion

The prototype of orchid plantation monitoring and control system based on internet of things can work 100% properly as the functional need described. The maximum comparison between DHT22 sensor and room temperature is 0.4ºC with average comparison is 0.26ºC. for the humidity sensor, for the dry condition, maximum comparison between YL69 sensor and the soil meter is 2% with average comparison 3.6%. For the humid condition, maximum comparison between YL69 sensor and the soil meter is 2% with average comparison 1.2%. For the wet condition, maximum comparison between YL69 sensor and the soil meter is 9% with average comparison 5.9%. The system also able to activate or deactivate the actuator based on the condition given by the threshold given or manually by Blynk application.

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