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Internet of Things

Prototype of Temperature and Humidity Control System in Dry House or Coffee Drying Dom Using NodeMCU ESP8266

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A B S T R A C T

Coffee is a very popular plant in the world as a raw material that has a distinctive taste and aroma. One of the most important post-harvest stages is the drying of coffee beans, because it can affect the quality of coffee beans so that the bargaining value of coffee prices can increase. Farmers in general still do drying traditionally by drying coffee beans in an open room. IoT currently provides the ability to connect various devices and sensors in a centralized network. as an advantage of IoT technology, it provides a solution for the owner of the temperature and humidity control system in the coffee warehouse to monitor the temperature and humidity in the coffee warehouse directly or remotely. This study aims to develop a prototype of a temperature and humidity control system in a dry house for coffee drying dom that can be viewed remotely via a smartphone and can be seen directly through the tools that have been designed. The DHT22 sensor is used to detect air temperature and humidity conditions. This temperature detection process will be active if the read temperature conditions exceed normal limits. The IoT platform as a process of sending data and reading data on this system uses the Blynk application. The result of this research is the design of a temperature and humidity control system in a coffee warehouse using a DHT22 sensor that works according to what has been programmed on the NodeMCU ESP8266 so that it can see the temperature and humidity of the air through the Blynk application on a smartphone and the system can work automatically so that when the temperature is above 34 ° C the system raises a warning sign on the device that has been designed and raises a notification on the Blynk application. Dry house is an important building in coffee processing to maintain the quality of coffee beans during the drying process. In this research, we design and implement an automatic system that uses microcontroller-based temperature and humidity sensors to control environmental conditions in the dry house. The development method includes analyzing system requirements, designing hardware and software, and testing the system to verify its performance and reliability. The results show that the developed prototype is able to maintain temperature and humidity within the optimal range during the coffee drying process, which is expected to improve efficiency and quality of the final product. The practical implication of this research is the development of technology that can be applied in the coffee processing industry to improve process control and reduce yield loss due to uncontrolled environmental changes.

INTRODUCTION

Coffee is a very popular plant in the world as a raw material that has a distinctive taste and aroma. One of the most important post-harvest steps is drying coffee beans, because it can affect the quality of coffee beans so that the bargaining value of coffee prices can increase. Farmers generally still dry the coffee beans traditionally by drying them in open spaces [1,2,3].

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In general, coffee farmers will dry ripe coffee beans until dry, but in this case the time period for each coffee bean is different. The indication is that if the ripe coffee beans are dry, they can be continued to the next stage. Usually around 13% -15% of the water content in dried coffee beans will be stored by farmers, and the standard for coffee for export generally has a water content of 13% (Silaban, et al. 2020). According to [4,5], drying with sunlight will be effective at temperatures around 35 ° C to 45 ° C. However, the use of sunlight is sometimes less profitable because of the changeable weather conditions. The disadvantages of drying coffee beans in this way are fluctuating weather, product cleanliness is less guaranteed, and requires a large space. Delays in drying coffee beans can also occur if the weather is cloudy or rainy, this condition will accelerate the damage of coffee beans due to microorganism activity so that the quality of coffee beans becomes low [6,7,8].

Therefore, one effective way to improve the quality of coffee beans in the drying process is to develop a temperature control system tool in a coffee dry house or coffee drying. Utilization of coffee temperature control technology with the Prototype and PID methods can reduce the problem of land difficulties for coffee farmers, when carrying out the traditional coffee bean drying process which often causes farmers to have to use outdoor coffee drying or outside the coffee warehouse as a medium for drying coffee beans.

From the description of the problem above, the author will dry coffee beans using the Prototype temperature control method and PID can be monitored using Internet of Things (IoT) technology.

METHOD

Research Stage

At this research stage there are several research stages or research designs which are systematic steps in conducting research.

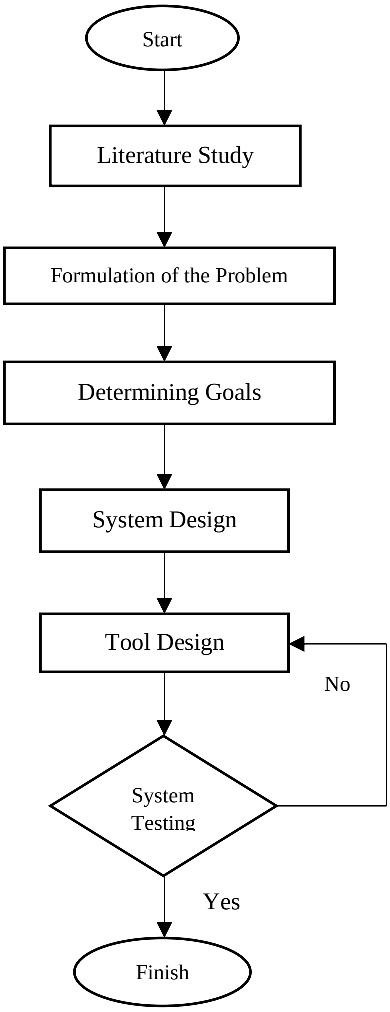

Figure 1. Research Stage

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The following is an explanation of the research stages in the image above.

1. Literature Study
   The researcher conducted a literature study by collecting and understanding theoretical references from theory books, research journals, and other authentic library sources related to the research topic, namely the temperature and humidity control system, NodeMCU ESP8266, DHT22 Sensor, LCD I2C, Jumper Cable, blynk and Arduino IDE.
2. Problem Formulation
   At this stage, the researcher formulated the problem which is the reason this research was conducted. This problem formulation aims for researchers to know the problem specifically so that it can be easier and more focused to solve the problem through research.
3. Determining Objectives
   The researcher determined the research objectives, namely to create a temperature control system control tool with the Prototype method which is monitored using IoT technology. The data monitored is in the form of controlled temperature values and humidity percentages to make it easier for coffee farmers in the coffee bean drying stage, this is because this tool has 2 drying systems, namely, in the morning utilizing the heat of sunlight and at night utilizing the temperature control system.
4. System Design
   System This stage is the design stage of the system design or model of the tool to be made. The system design consists of a system block diagram and an overview of the system as a whole.
5. System Design
   At this stage, the researcher carries out product design consisting of hardware design and software design. Hardware design consists of mechanical design and electrical design. While software design consists of Bot design on the blynk Application, and program design on the NodeMCU ESP8266 and DHT22 sensor via Arduino IDE.
6. System Testing
   Product testing is carried out to determine the level of success of the tool that has been made. At this stage there are two types of testing, namely hardware testing and software testing.

Equipment Used

In designing this system, several tools, materials, and supporting application programs are needed, which are grouped into 3 parts, namely hardware, software, and supporting tools. The hardware used includes a laptop, Smartphone, NodeMCU ESP8266, DHT22 Sensor, I2C LCD, Jumper Cable, Blynk, and Tools. The software used includes the Windows 11 operating system, Arduino IDE 1.8.19, and the Blynk Application. Meanwhile, the supporting tools used in building this tool include an electric soldering iron, bolts, glassboard, cutting pliers, and a screwdriver.

Circuit Design

Circuit design that has a specific function and is interconnected helps the system. The circuit tool in this study is controlled by NodeMCU ESP-8266, DHT22 Sensor and I2C LCD. For more details will be discussed in the next stage.

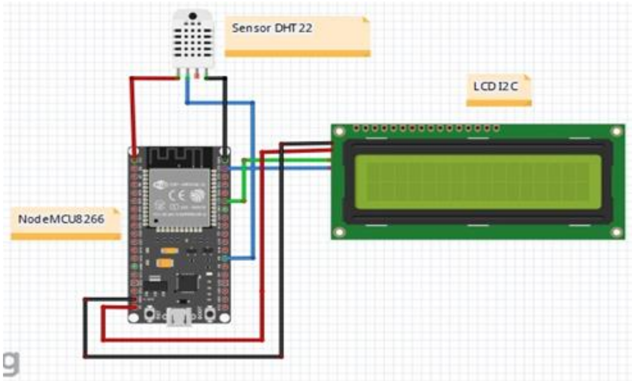


Figure 2. Research Series Design

RESULTS AND DISCUSSION

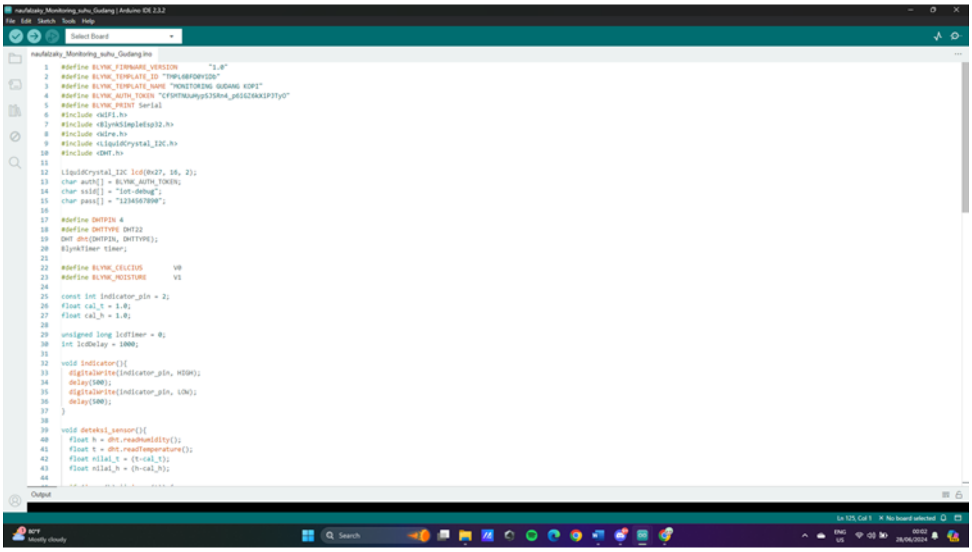
Design Results of the Tool

Hardware design is the next stage after the previous design and some components that are already known. At this stage, the design begins with the NodeMCU ESP8266 and temperature and humidity sensors that will run the tool through temperature and humidity until it detects automatically. There are a number of components included in the system workflow of the device in this automatic temperature and humidity control system, which includes hardware and software testing tools. The design results are shown in Figure 3.

Figure 3. Prototype Results of Tool Design and Construction

Testing Software Programs on NodeMCU ESP8266

Testing software programs on NodeMCU ESP8266 consists of testing on Arduino IDE and testing WiFi settings. This testing is done so that NodeMCU Esp8266 can connect to wifi and the blynk application. In the WiFi testing experiment, the Arduino IDE is first configured through a program such as Figure 4.



(a)

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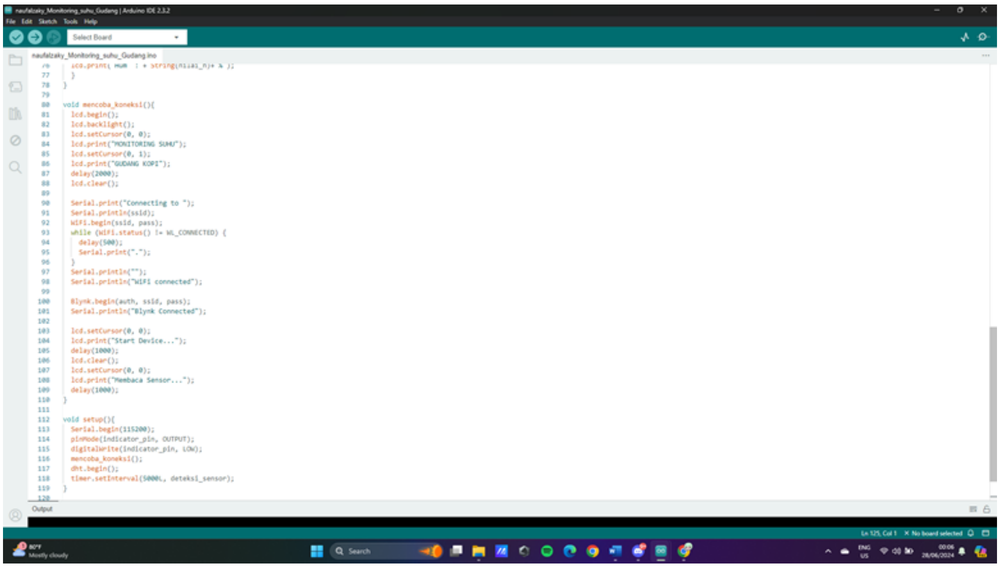

(b)

Figure 4. Software Testing Program on NodeMCU ESP8266; (a) Arduino IDE Testing and (b) WiFi Setting Testing

Overall Tool Testing

The overall testing of this tool is a combination of the tests that have been carried out for each previous component. Testing using a monitoring system is carried out according to the system design shown in Figure 3.2 above. When the monitoring system is activated, the program will run, and the DHT22 sensor, known as the air temperature humidity sensor, will measure the humidity level of the air temperature in the coffee warehouse. Continued by sending the results of the measurement of the humidity level of the air temperature to the NodeMCU ESP8266, which is set in the program. To find out the temperature and humidity levels in the coffee warehouse, the values can be seen on the LCD (Liquid Crystal Display) and Blynk. The results of the temperature values on the LCD are shown in Figure 5.

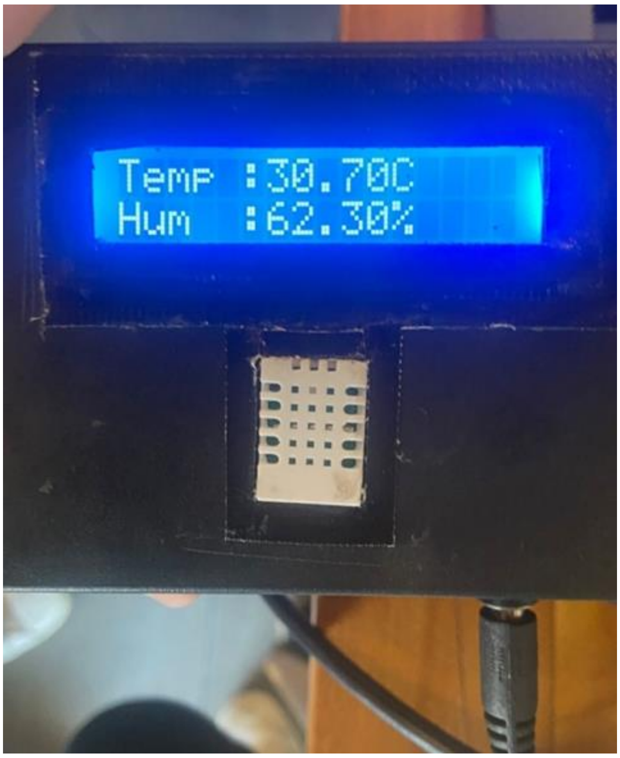

Figure 5. Display of Temperature Value Results on LCD (Liquid Crystal Display)

If the temperature level in the coffee warehouse is below 34°C then it is considered normal, and if the temperature level in the coffee warehouse shows a temperature above 34°C then it is considered abnormal, NodeMCU ESP8266 and DHT22 sensor send signals that have been set through the ArduinoIDE tools to Blynk to display a warning notification to the Blynk user that the temperature is not normal, which allows to open the ventilation in the coffee warehouse so that the temperature returns to stable or normal to prevent the occurrence of unfitness in the coffee beans. The results are shown in Figure 6.

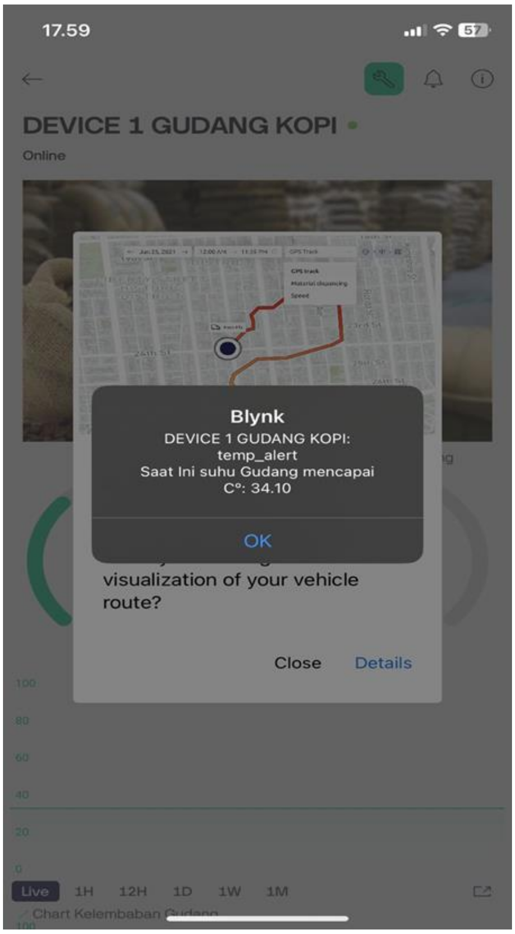

Figure 6. Temperature Value Warning Notification Display on Blynk

Prototype Testing Data and Results

At the tool and system results stage, testing was carried out to determine the function and purpose of the temperature and humidity control system in this coffee warehouse so that it is in accordance with expectations. This data collection was carried out using the results of the temperature control system tool design and using the blynk application with sampling every 10 minutes starting from 12.30 to 14.30. The data that has been obtained from monitoring for 2 hours is 10 data from sampling every 10 minutes. Based on the data from the temperature and humidity control system tool test results carried out from 12.30 to 14.10, for testing the temperature and humidity control system in the coffee warehouse, the following data was obtained:

Table 1. Test Result Data on Temperature and Humidity Control System Equipment

Duration Test Temperature	**NO**	**DHT22**	
		Temperature (C)	**Humidity (%)**
10 Minutes	1	27,8	42,9
	2	27,8	42,4
	3	27,7	41,7

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4	27,6	41
5	28,4	43,05
6	30,5	43,8
7	33,4	44,05
8	34,2	52,5
9	33,4	40,2
10	33,2	39,5

From the test results of the design of the temperature and humidity control system in the coffee warehouse carried out within 2 hours, the temperature and humidity values on the LCD (Liquid Crystal Display) and Blynk screens are in accordance with the data in table 4.5. when the temperature and humidity of the coffee warehouse are at 12.30, the temperature and humidity are below 34 ° C so that the temperature looks normal, making the warning sign on the LCD not display a temperature sign that exceeds the limit and does not display a notification on the Blynk application. It can be seen at 13.50 to 14.00, the temperature and humidity values in the coffee warehouse increased due to the temperature value above 34 ° C within 10 minutes, so that a warning sign appears on the temperature control system that is designed can be seen via its LCD and displays a notification on Blynk automatically because the temperature has exceeded its normal limit. Based on the tests carried out, it can be concluded that the temperature and humidity control system in the coffee warehouse works according to the DHT22 sensor programmed on the NodeMCU ESP8266.

CONCLUSION

After going through the design and overall testing stages, the following conclusions were obtained: The design and construction of the temperature and humidity control system in the coffee warehouse using the DHT22 sensor works according to the programming on the NodeMCU ESP8266 so that it can monitor and see the temperature and humidity values on the designed device and can be seen via the blynk application on the smartphone. Based on the tests carried out, the device and system can work automatically so that when the temperature and humidity are above 34°C, the system will display a warning sign on the designed device and display a notification on the blynk application.

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