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Design and Build Temperature and Humidity Control Equipment in IoT-Based Rice Storage

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Abstract

This research aims to design and build a temperature and humidity control device in an Internet of Things (IoT)-based rice storage bin using the Blynk platform, ESP8266 module, DHT22 sensor, buzzer, 2-channel relay, fan, and lamp. The quality of rice is greatly affected by the conditions of the storage environment, especially temperature and humidity. Therefore, a system is needed that is able to monitor and control these two parameters in real-time to maintain the quality of rice during storage. The system is designed to use a DHT22 sensor to detect temperature and humidity, and then the data is sent to a ESP8266 microcontroller. A 2-channel relay sets the fan and lights to adjust the temperature and humidity, while the buzzer serves as a warning alarm. In addition, the system is equipped with an automatic notification feature through the Blynk application that informs users if the temperature or humidity exceeds a predetermined limit.

***Keywords**: Temperature, Humidity, Rice Storage, IoT, Blynk, ESP8266, DHT22, Notifications*

1. Introduction

In an era of increasingly rapid technological advancement, the application of the Internet of Things (IoT) in various aspects of life has provided efficient and effective solutions. IoT technology allows for real-time monitoring and control of environmental conditions, which is very useful for rice storage. By using IoT-based sensors and control systems, the temperature and humidity in the storage area can be automatically monitored and adjusted to maintain optimal storage conditions.

The quality of rice stored in warehouses is greatly influenced by environmental conditions, especially temperature and humidity. Temperatures that are too high or too low as well as uncontrolled humidity can damage rice, such as mold growth, discoloration, and decreased nutritional quality. This not only has an impact on financial losses for warehouse owners, but also reduces consumer confidence in the products produced. On the other hand, manual monitoring and control of warehouse conditions is often ineffective and time-consuming, so a more efficient and accurate solution is needed [1], [2].

2. Literature Review

2.1. Design

Design is the act of presenting, planning, and sketching or arranging several separate elements into a whole, functional whole. Therefore, the definition of design is the activity of converting the results of analysis into software and then creating a system or improving an existing system [3].

2.2. Operating System

The control system is a collection of methods and techniques learned from human work habits and must pay attention to the quality of work so that it has the characteristics that were originally expected. From the description of the control system, we can conclude that the control system is a combination of several interconnected components that operate continuously to achieve certain goals that have been originally planned [4].

2.3. Temperature

Temperature is a quantity that expresses the degree of heat or cold of an object, and the tool used to measure temperature is a thermometer. In everyday life, people tend to use their sense of touch to measure temperature. However, technological developments have created thermometers capable of measuring temperature effectively [5].

2.4. Humadity

Humidity is the amount of water vapor in the air or atmosphere. The amount depends on the entry of water vapor into the atmosphere through evaporation from seawater, lakes, river water, and groundwater. It is also produced by transpiration, which evaporates from the plant. In contrast, the amount of water in the air depends on many factors such as water availability, steam source, temperature, pressure, and wind.

2.5. Internet of Things

The Internet of Things (IoT) is a network that connects various objects by identifying IDs and IP addresses. This allows objects to communicate with each other and share information about themselves and the environment they perceive. Objects in IoT can use or produce services and work together to achieve a common goal [6], [7], [8].

2.6. DHT22

The DHT22 sensor is a digital relative humidity and temperature sensor. The DHT22 sensor uses capacitors and fog to measure the ambient air and signals are emitted on the data pins. The DHT22 sensor is very stable, reliable, and provides very accurate results with a calibration feature so that it is also very easy to implement on Arduino-type microcontrollers.

2.7. ESP8266

ESP8266 is a serial Wifi transceiver module, an integrated chip component designed to meet the needs of today's connected world. The chip provides a fully integrated Wi-Fi network solution that can be used as an application provider or to separate all Wi-Fi network functions from a separate application processor.

2.8. Relay

Relay is an electrically operated Switch and is an Electromechanical component consisting of 2 main parts, namely Electromagnetic (Coil) and Mechanical (a set of Switch Contacts). The relay uses the Electromagnetic Principle to drive the Switch Contact so that with a small electric current (low power) it can conduct electricity of higher voltage.

2.9. Fan

A fan is one of the tools that produces wind. The general function of a fan is to cool, refresh, ventilate (exhaust fan), and dry air (usually with heat-producing components). A fan mechanism is a device that converts electrical energy into mechanical energy. By using an electric motor that converts electrical energy into kinetic energy. The electric motor has a moving iron coil and a pair of U magnets on its fixed part. When a current flows through a wire coil inside an iron coil, this phenomenon converts the iron coil into a magnet.

2.10. Buzzer

A buzzer is an electronic device that converts electrical vibrations into sound vibrations. Basically, a buzzer works like a speaker. The buzzer consists of a coil attached to the diaphragm. Buzzers are usually used as indicators that a process has completed or the device has encountered an error.

2.11. Incandescent

An incandescent bulb is a lamp that produces light by heating a metal filament to a high temperature. Incandescent bulbs work on the principle of incandescent, i.e. current flows towards the filament when the switch is turned on. Current flows through the connecting wires. This creates free electrons that move away from the negative pole (-) to the positive (+) pole and constantly collide with the atoms in the filament. The energy generated by the collision causes the atoms to vibrate. As a result, the electronic bonds inside the vibrating atom push the atom to its highest position. When the energy returns to normal levels, the electrons release additional energy in the form of photons. These photons cannot be seen with the naked eye. But if heated to a temperature of 2,200°C, light similar to the light bulb we use every day can be seen.

2.12. Blynk

Blynk is an application service to control microcontrollers through the Internet. The application provided by Blynk itself must be compiled according to its needs. The use of the Blynk application in this study is due to the simplicity of the implementation of the Blynk program using a microcontroller, ease of installation on smartphones, the ability to adjust the appearance of the application according to preferences, and the Blynk application is free [9], [10].

2.13. Arduino IDE

Arduino IDE is a software that is used to enter a program that contains commands and upload them to a microcontroller for the application. The creation of program code is carried out to provide instructions using the C programming language for the purpose of running the system so that the system can operate according to the program code entered into the Arduino. Program code is the most important part of making a tool, so without it the system cannot function.

3. Analysis and Design

3.1. System Design

The system that will be studied at this time is a temperature and humidity control system in rice storage using the Internet of Things. This control system requires an internet network and ESP8266 as a general requirement in designing a temperature and humidity control system. and requires a Blynk that will be connected to a microcontroller as a controller or regulator of temperature and humidity in the rice storage area [11].
This temperature control process will be carried out using the Internet of things where Blynk is the medium in control. Blynk will send the data to the microcontroller, then the microcontroller will give commands to the DHT22 sensor which will regulate the temperature and humidity in the rice storage area.

3.2. Block Diagram Network Tool

The design of a diagram block network is the design of electronic components in such a way that they have the desired function. Broadly speaking, the design planning of the tool is as follows:

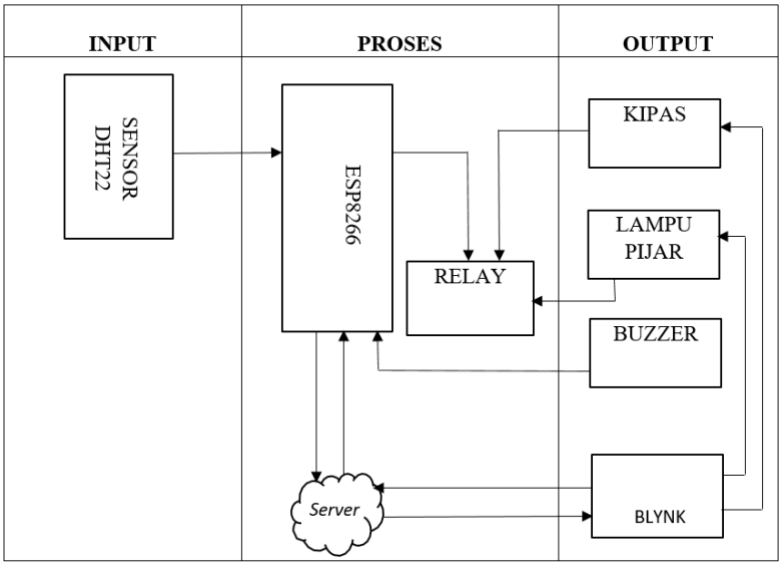

Fig. 1: Block Diagram Network Tool

The series of diagram blocks in figure III.2 that the first process is to connect Blynk, then NodeMCU receives command data from Blynk to set the temperature aimed at the DHT22 sensor. Then, the Buzzer will turn on when the temperature =>29º, and the humidity =>65º. And then the DHT22 sensor also sends the received data to the microcontroller, then the microcontroller ESP8266 will send information to Blynk to regulate the temperature and humidity in the rice storage area. The relay serves to regulate the high voltage on the fan and lamp.

3.3. Overall Tool Set

The following is an overview of the electronic circuit diagram of the temperature and humidity control system in IoT-based rice storage:

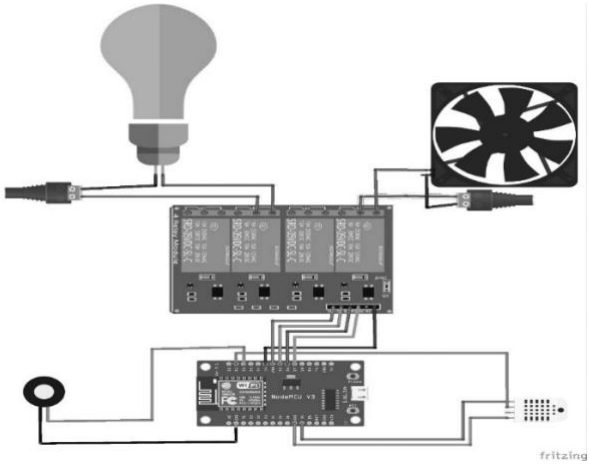

Fig. 2: Overall Tool Set

In this prototype design, the researcher will use several components such as, NodeMCU ESP8266, jumper cable, 4-channel relay, LED light, DHT22 sensor, buzzer and DC fan. The VCC and GND pins on the NodeMCU are connected to the VCC and GND pins on the

Relay, the GPIO14 pin on the NodeMCU is connected to the N1 pin on the Relay as a communication series, the GPIO12 pin is connected to the N2 pin on the Relay as a data receiver. The GPIO15 pin is connected to the N3 pin on the Relay as the data sender.

3.4. System Flowchart

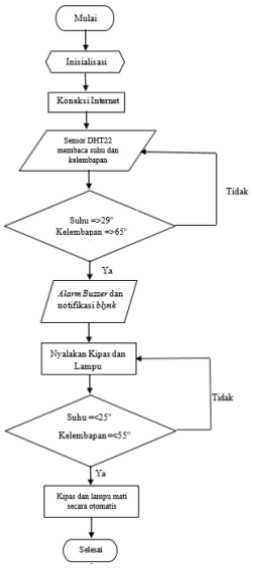

Fig. 3: Flowchart System Control

Description:

1. Get started.
2. System initialization.
3. Connect Blynk and the tool to the internet.
4. Next, the DHT22 sensor will detect the room temperature and humidity in the rice warehouse.
5. Then, when the temperature =>29º and humidity =>65º the buzzer will light up.
6. If not, then the sensor will re-read the temperature and humidity on the rice warehouse.
7. After the buzzer is turned on, the blynk will receive a notification that the temperature and humidity are unstable.
8. Next, the blynk will turn on the fan and light at the same time so that the temperature can return to normal.
9. If, temperature=<25º and humidity=<55º, the fan and light will turn off automatically
10. Done.

4. Discussion and Implementation

4.1. Discussion

In this chapter, the author describes and explains the results of the research by conducting tests. The tests that will be carried out are Software and Hardware testing. The program made in this study is a program to detect the temperature and humidity in the rice storage area, then the working processes of this tool so that the temperature and humidity in the rice storage area can return to normal. The results of this program will be uploaded to the microcontroller, users can also do results by testing the tool through the Blynk application.

4.2. Software Testing

To test the program, the initial steps in this experiment are as follows:

1. Open the Arduino IDE software with the unfilled program like this:

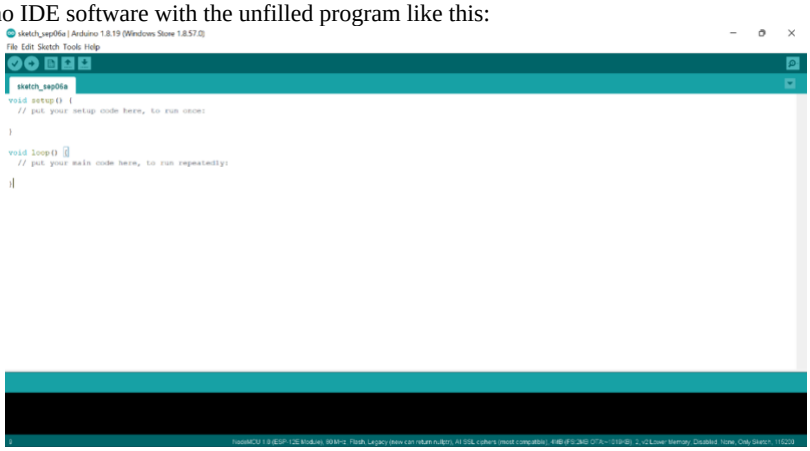

Fig. 4: Arduino IDE Initial Look

2. Next, the program for internet connection and Blynk by creating the SSID to be used and the Wi-Fi Password and creating data for the Blynk application to be intended such as AUTH TOKEN as the program written below:

```
#define BLYNK_TEMPLATE_ID "TMPL602yYk-Lx"
#define BLYNK_TEMPLATE_NAME "New Template"
#define BLYNK_AUTH_TOKEN
"5K9NwsMO_9vawwGmWi2xP85jRNRpbv0i"
#define BLYNK_PRINT Serial


#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include "DHT.h"


#define DHTPIN D2
#define DHTTYPE DHT22
DHT dht(DHTPIN, DHTTYPE);


char ssid[] = "IOT";
char pass[] = "IOT123456";
```

Fig. 5: Blynk Connection Program

3. Continue the program with the program for Blynk connection as well as the working process of the fan and light with High and Low sets as a way to turn off the fan and light automatically:

```
void setup() {
  Serial.begin(9600);
  Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);
  dht.begin();
  pinMode(pinBuz, OUTPUT);
  pinMode(pinFan, OUTPUT);
  pinMode(pinLamp, OUTPUT);
  digitalWrite(pinFan,HIGH);
  digitalWrite(pinLamp,HIGH);
  ledLamp.off();
  ledFan.off();
  delay(1000);
}
```

Fig. 6: Blynk Connection As Well As The Working Process Of The Fan And Lamp

4. Then, create a program for the Buzzer alarm, this process explains that if the temperature and humidity are within the set limits, the Buzzer will sound for 5 seconds:

```
void loop() {
  if(millis() - last > 1000){
    cekSensor();
    Blynk.virtualWrite(V0,temp);
    Blynk.virtualWrite(V1,humid);
    if(ftemp || flembab){
      if(!fbuz){
        cnt++;
        if(cnt < 5){
          digitalWrite(pinBuz, HIGH);
        }else{
          digitalWrite(pinBuz, LOW);
```

Fig.7: Program For Buzzer Alarm

5. Next, enter the program for the temperature limit set to turn on the fan, and the humidity limit to turn on the lights, as well as the notification set for Blynk:

```
if(temp > 35){
  if(!ftemp){
    Blynk.logEvent("notif_suhu","Suhu 33, Aktifkan Kipas");
    ftemp = true;
    cnt = 0;
  }
 }else if(temp < 35){
  ftemp = false;
  digitalWrite(pinFan,HIGH);
  ledFan.off();
 }

 if(humid > 65){
  if(!flembab){
    Blynk.logEvent("notif_kelembapan","Kelembapan 66,  Aktifkan Lampu");
    flembab = true;
    cnt = 0;
  }
 }else if(humid < 65){
  flembab = false;
  digitalWrite(pinLamp,HIGH);
  ledLamp.off();
 }
```

Fig. 8: Program For The Temperature Limit

4.3. Hardware Testing

Once all the programs are created, design the hardware by connecting the
Relay, Buzzer, DHT22 Sensor to ESP8266 by using BreadBoard. This design was made to test the Relay and also the Buzzer, as shown in Figure 9:

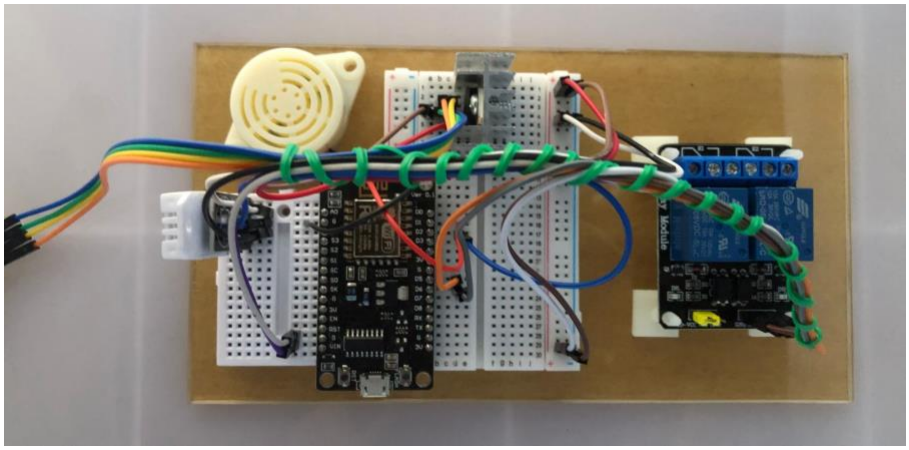

Fig. 9: Design for Test Relay and Buzzer

Next, if the test done earlier is successful, then do the Finishing by combining it with the Box and the design of the fan and lamp, as well as the switch for the power on the lamp as a Prototype:

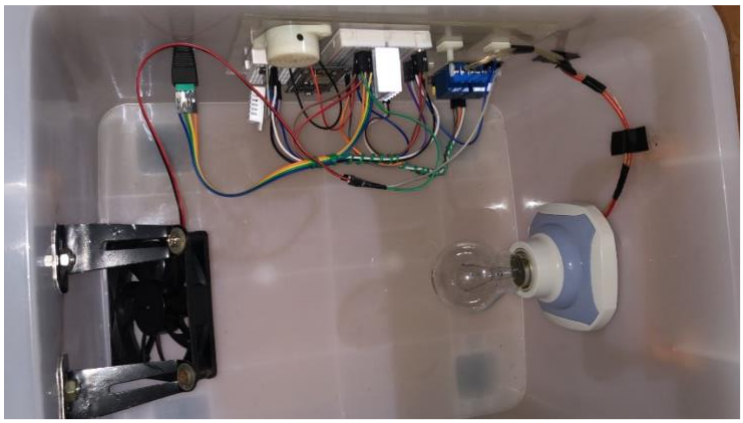

Fig. 10: Completed Design

4.4 Blynk Testing

In this Blynk test, we created a new template with a widget like the image below:

Fig. 11: Blynk Display

After the program has been created, the next step is to input the program code into the circuit by clicking the Bar menu on the Arduino IDE then click upload with the note that the Board and Port on the Arduino IDE Bar menu are complete. Next, wait a few moments for the upload process to complete, then the program that has been uploaded will be automatically saved to the microcontroller.

4.5 Overall Testing Implementation

The implementation of this test is carried out to determine the performance of the components that will be used in this thesis with the output in the form of Blynk which will get a notification as shown in Figure 12 if the temperature is >35 the command is to turn on the Fan:

Fig. 12: Notification To Turn On The Fan

Meanwhile, if the humidity is >65 then Blynk will give a notification output like Figure 13 with a command to turn on the lights:

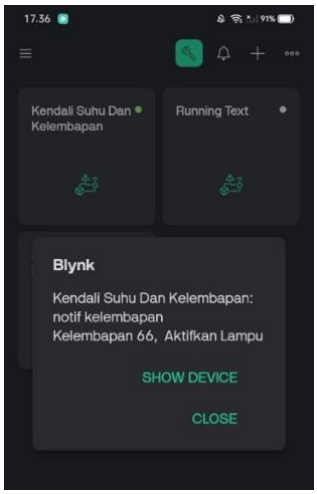

Fig. 13: Notification To Turn On The Lights

To control the Fan and Lights of Blynk, when the lights are active, the lights on the relay are on as shown in Figure 14:

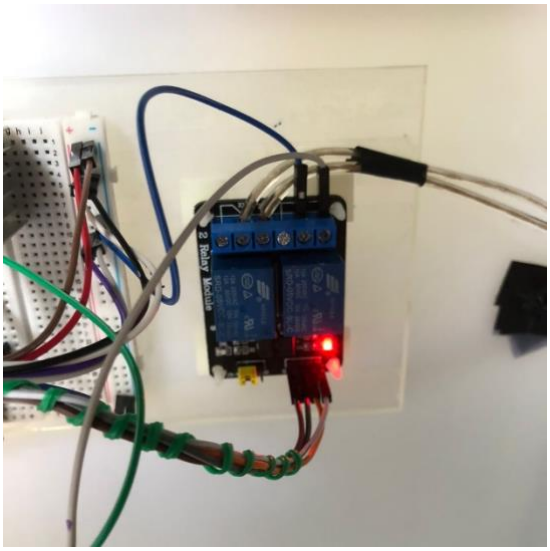

Fig. 14: Relay Light Turns On When The Fan Is On

This experiment was carried out by making the DHT22 sensor read the temperature and humidity and ensure that the Buzzer alarm was on at the same time as the Blynk notification. Then the Fan and Light experiment was successfully controlled through Blynk. After all series have been completed in the "Design and Build Temperature and Humidity Control Device in IoT-Based Rice Storage", here is a picture of the successful testing of the IoT Temperature and Humidity Control Device in Figure 15 below:

Fig. 15: Fan and Light Simultaneously

5. Conclusion

After carrying out the design and manufacturing stage of the system, which is then followed by the testing and analysis stage, the following conclusions can be drawn: By using a monitoring system designed with a Fan and The lamp is able to effectively control temperature and humidity and efficient, and Internet of Things (IoT)-based systems enable monitoring and control of rice storage conditions in real-time, so that the quality of rice is maintained.

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