

Automatic Stove Control System Based on the NodeMCU ESP8266 Microcontroller

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Abstract – *A stove is a handy tool for humans. The use of stoves in everyday life brings beneficial and detrimental impacts. A stove is a tool used to help human activities, but the impact of its weakness can cause household accidents caused by the negligence of the community itself. The NodeMCU-based automatic hob was built to address this problem. This stove can set the cooking time and automatically stop working at the specified time. This stove can also turn off automatically if the sensor does not detect the presence of people around to minimize the occurrence of household accidents. This automatic stove is expected to be a technological reformer in household appliances and a solution to reduce the number of accidents caused by stoves.*

Keywords: *NodeMCU, ESP8266, Automatic Stove, IoT, Blynk*

I. Introduction

Technology is something that cannot be avoided in the progress of life because technological advances will go hand in hand with advances in science [1]. Every innovation brings positive benefits to human life [2]. Technology also provides many conveniences and new ways of carrying out human activities [3]. Humanity has also enjoyed many benefits brought by the technological innovations generated in the last decades [4]. The number of cutting-edge technology products shows this [5].

Cooking is an activity that processes a portion of food that can change raw food ingredients into cooked food by heating the raw food ingredients so that they can be consumed and give a distinctive taste to the food ingredients. To cook a meal, a stove is needed as a medium for cooking food [6]. The use of stoves in everyday life brings beneficial and detrimental impacts [7]. The stove is a tool used to assist human activities but has an impact on the side of its weakness, namely, it can cause several cases of household accidents caused by negligence on the part of the community [8]. According to several surveys that can be found, there are still many accidents that occur due to people forgetting to turn off the stove [9].

Electric stove technology is now also developing

from manual to automatic [10]. As technology develops, by incorporating technology into its components, stoves become safer and more efficient [11]-[12]. The stove developed in this paper is called NodeMCU ESP8266-based electric stove. To reduce the possibility of household accidents, this stove allows users to choose the cooking duration, and it will automatically stop working at that time. There is also a temperature sensor to monitor the temperature of the food being cooked. This NodeMCU ESP8266-based automatic stove is projected to be a technological reformer in household appliances and a way to reduce the number of stove-related mishaps.

I.1. NodeMCU ESP8266

NodeMCU ESP8266 is a microcontroller module that contains ESP8266 inside. NodeMCU ESP8266 can connect to WiFi networks. NodeMCU ESP8266 can be programmed using the Arduino IDE programming language [13]-[14].



Fig 1. NodeMCU ESP8266 [15]

1.2. Stove

The stove is one of the main tools used in the household. This tool is used to cook foods/drinks and used to re-warm a cooked food [16].

1.3. Thermocouple

A thermocouple is a temperature sensor that converts the temperature difference into a voltage change. This is due to the difference in density possessed by each metal which depends on the density of the metal [17]-[18].



Fig 2. Thermocouple sensor [19]

1.4. Relay

A relay is a switch that is operated electrically and is an electromechanical component consisting of two main parts, namely electromagnets and mechanics. The function of the relay on the tool is to turn on and off the heating element [20].

1.5. LCD 16x2

The LCD is a tool that serves to display size or number so that it can be seen and known through the crystal screen display [21]. The function of the LCD is to provide information in the form of a screen display according to the value of the work of electronic components such as sensors for detection. in the form of text display and menus on the microcontroller application in accordance with the commands that have been written on the microcontroller [22].

1.6. IR Sensor

Infrared sensors have the task of detecting a device by requiring the reflection of light that is beamed from the infrared. The beam of infrared to an entity in a certain area will be drawn by the

photodiode. Photodiodes are used to capture infrared light because they are 100 times faster than phototransistors [22]-[23].

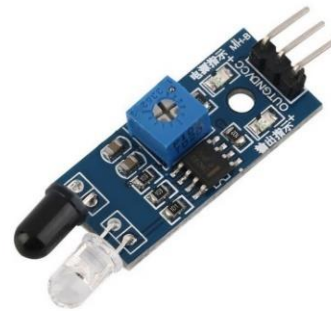


Fig 3. IR sensor [24]

II. Research Method

II.1. Block Diagram System

There are three parts in this box, namely: input, process, and output. In the input section, there are two sensors as input to detect the temperature and the presence of a person. In the process section, there is the NodeMCU ESP8266 as the brain of this automatic stove system. At the output, there is a 16x2 LCD to display the commands and conditions of the tool, the relay as a switch to turn the stove on and off, and Blynk as a liaison application between the stove and the smartphone. Fig. 4 shows the block diagram system in this research.

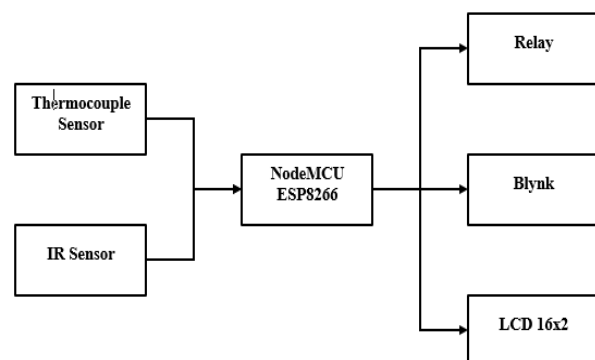


Fig 4. The block diagram tool

II.2. Program Flowchart

The program starts by connecting to WiFi. If WiFi is connected, then the Blynk app can be used. In the Blynk app, there are two buttons available. When button one is pressed, the thermocouple sensor reads the temperature of the food, and then the stove

turns on. The working principle of button two is almost the same as button one, except that on button two, there is an infrared sensor on the stove that functions to detect the presence of a person. Finally, the LCD will display temperature readings from the thermocouple sensor and stove status.

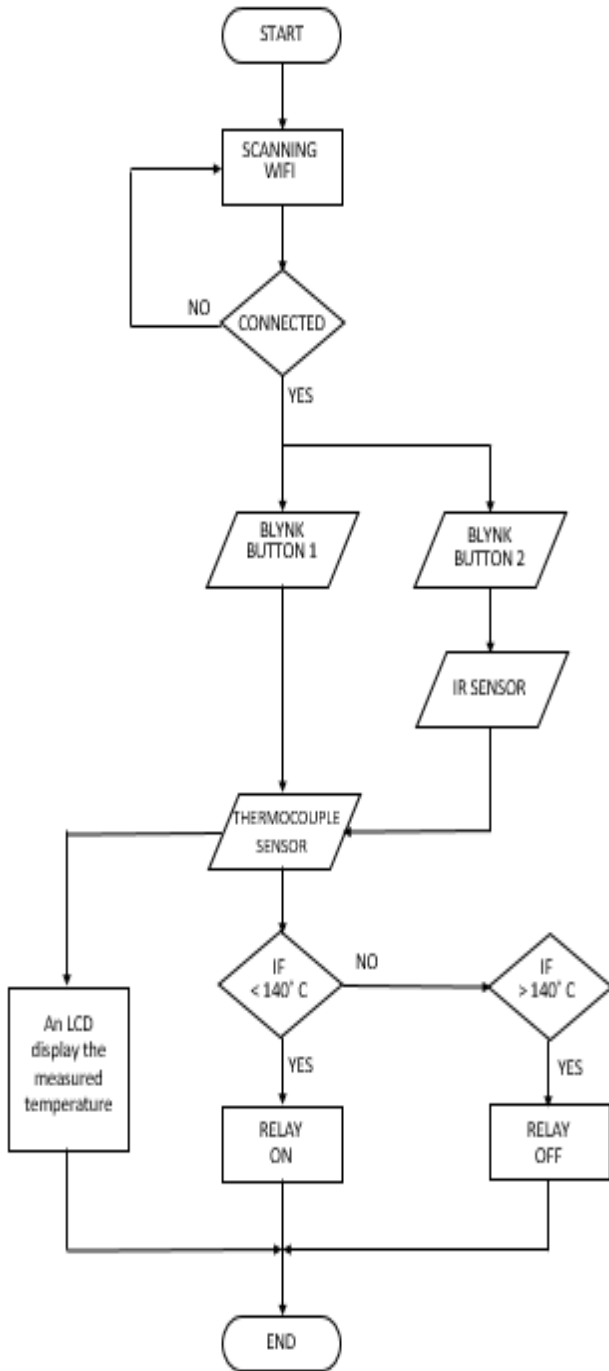


Fig 5. Flowchart program

Fig. 6 is a picture of the NodeMCU ESP8266 Microcontroller-Based Automatic Stove and Cook Temperature Control System tool circuit.

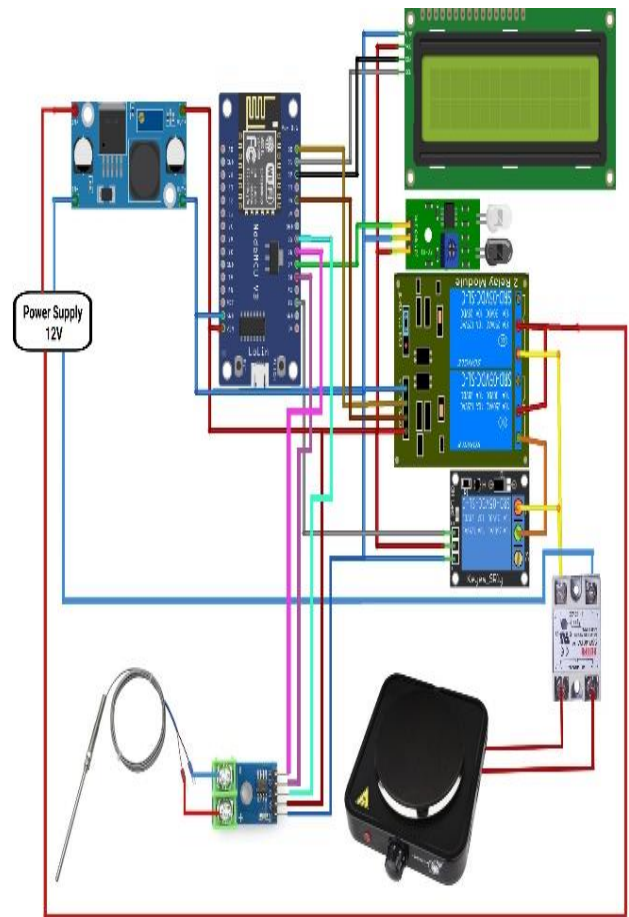


Fig 6. Wiring design

There is a NodeMCU ESP8266 module as a microcontroller. There are also several components used in this tool, including a 12V power supply, step-down converter, 16x2 I2C LCD, relay, SSR, infrared sensor, thermocouple sensor, and electric stove.

TABLE I
NODEMCU ESP8266 PORT USAGE

| No. | NodeMCU port | Usage |
|-----|--------------|---------------------|
| 1 | Vin | 5V |
| 2 | Gnd | Gnd |
| 3 | D0 | In 1 Relay 2 Module |
| 4 | D1 | Pin SCL LCD |
| 5 | D2 | Pin SDA LCD |
| 6 | D4 | In 2 Relay 2 Module |
| 7 | D5 | SCK Max6675 |
| 8 | D6 | SO Max6675 |
| 9 | D7 | IR Sensor |
| 10 | D8 | CS Max6675 |
| 11 | TX | In Relay Module |

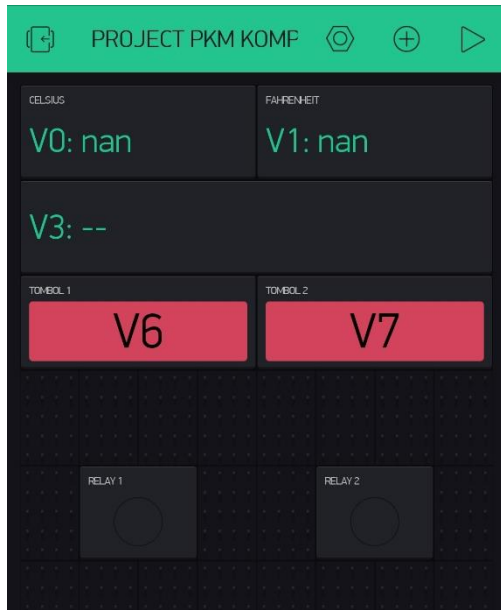


Fig 7. Blynk display

In Fig. 7, there is a display of the Blynk application that has been designed for a smartphone.

III. Result and Discussion

III.1. Result of Tool Realization

The design that has been made in this automatic stove system research uses acrylic with a thickness of 5 mm. On the front, a trapezoidal shape is formed to resemble the design of the stove in general and make it easy to read the LCD on the front. There are hinges on the top and back that open and close, making it simple to repair if there is an error in the circuit or programming.

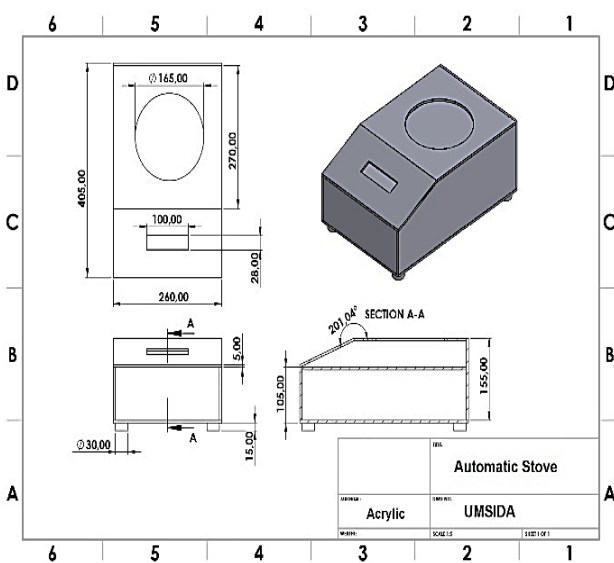


Fig 8. Design of an automatic stove

The following is the result of the realization of the tool. Fig. 9 is the result of the realization of the tool. The components of the tool will be described by numbering as follows; 1. 12V power supply, 2. Step Down, 3. NodeMCU ESP8266, 4. Max6675 Type-K Thermocouple, 5. Relay, 6. SSR, 7. An electric stove socket, 8. Infrared Sensor, 9. LCD.

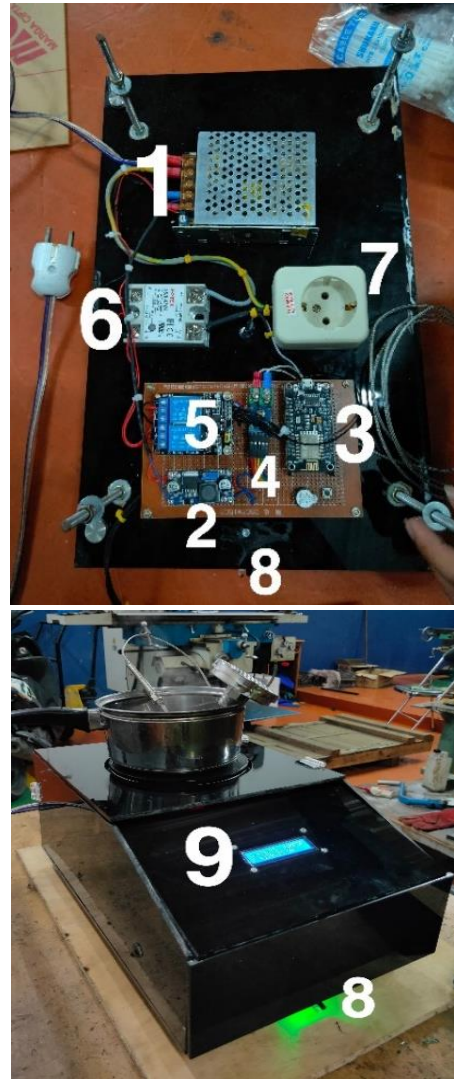


Fig 9. Result of tool realization

The mechanics of this tool are pretty simple. In the blynk application, there are 2 buttons to turn on the program (button 1 for automatic, button 2 for manual).

Here is how the button 1 works:

1. Press button 1 on the Blynk app.
2. The thermocouple sensor reads the temperature of the food.
3. When the temperature is below 140° C, the stove is on. The stove turns off when the temperature is above or equal to 140° C.

And for button 2, it is a button to turn on and off the stove manually, by using a smartphone. On button 2, there is an infrared sensor when the stove is on and no one is detected around the stove, the stove automatically turns off in a few minutes.

III.2. Program Results

First, make a program on the Arduino IDE to program the NodeMCU ESP8266; the program on the Arduino IDE is shown in Fig. 10.

```
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include "max6675.h"
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27,16,2);

char ssid[] = "Free";
char pass[] = "gratis";
char auth[] = "mYk8z30f12qy3Mj7xA01007saf8VqsPH";

int DO = 12; //D6
int CS = 15; // D8
int CLK = 14; //D5
int relay1 = D0;
int relay2 = D3;
int buzzer = D4;
int infrared = D7;
int relay3 = 1;
MAX6675 thermocouple(CLK, CS, DO);
float c, f;
WidgetLED led1(V4); //led relay kompor
WidgetLED led2(V5); //led relay IR untuk safety
int deteksi;
```

Fig 10. Programming on NodeMCU ESP8266 using Arduino IDE

```
BLYNK_WRITE(V6){
  int P1 = param.asInt();
  //jika virtual button 1 bernilai 1
  if (P1 == 1){
    //jika suhu 90°
    if (c < 140){
      digitalWrite(relay1,LOW); //kompor on
      led1.on();
      lcd.clear();
      lcd.setCursor(10, 0);
      lcd.print("KOMPOR");
      lcd.setCursor(10, 1);
      lcd.print("ON");
      Blynk.virtualWrite(V3, "KOMPOR ON");
    }
    //jika suhu 100°
    if (c > 140){ //kompor off
      digitalWrite(relay1,HIGH);
      digitalWrite(buzzer,LOW);
      lcd.clear();
      lcd.setCursor(10, 0);
      lcd.print("KOMPOR");
      lcd.setCursor(10, 1);
      lcd.print("OFF");
      led1.off();
      Blynk.virtualWrite(V3, "KOMPOR OFF");
    }
  } else { //jika P1 bernilai 0
    digitalWrite(relay1,HIGH);
    digitalWrite(relay2,HIGH);
  }
}
```

Fig 11. Programming how button 1 on Blynk works

The next programming for how button one works on Blynk is when the thermocouple sensor detects a food temperature below 140, the stove turns on, and vice versa. In this programming, it is also explained that when the stove is on, the LCD will display the text "Stove ON" and when the stove is off, the LCD will display the text "Stove OFF." This program is shown in Fig. 11.

Next, the program for how button two works on Blynk is described in Fig. 12. In this programming, it is also explained that when this system is activated, the LCD will display the words "Manual Stove," and when the stove is off, the LCD will display the words "Stove OFF".

```
BLYNK_WRITE(V7){
  int P2 = param.asInt();
  //jika virtual button 2 bernilai 1
  if (P2 == 1){
    //thermo();
    digitalWrite(relay2,LOW); //kompor on
    led2.on();
    lcd.setCursor(10, 0);
    lcd.print("KOMPOR");
    lcd.setCursor(10, 1);
    lcd.print("Manual");
    Blynk.virtualWrite(V3, "KOMPOR Manual");
  } else {
    digitalWrite(relay2,HIGH);
    lcd.clear();
    led2.off();
    Blynk.virtualWrite(V3, "KOMPOR OFF");
  }
}
```

Fig 12. Programming how button 2 on Blynk works

```
void IR(){
  deteksi = digitalRead(infrared);

  if (deteksi == HIGH) {
    // led2.on();
    digitalWrite (relay3, HIGH);
  } else{
    // led2.off();
    delay(5000);
    digitalWrite (relay3, LOW);
    //delay(5000);
  }
}

void thermo(){
  c = thermocouple.readCelsius();
  f = thermocouple.readFahrenheit();
  //
  Serial.print("C =");
  Serial.println(c);
  Blynk.virtualWrite(V0, c); //celcius
  Serial.print("F =");
  Serial.println(f);
  Blynk.virtualWrite(V1, f); //farad
  //celcius
  lcd.setCursor(0, 0);
  lcd.print("C =");
  lcd.print(c);
  //farad
  lcd.setCursor(0, 1);
  lcd.print("F =");
}
```

Fig 13. Programming for thermocouple and infrared sensors

Next, the programming for the sensors used in this research, namely the thermocouple sensor and infrared sensor, is shown in Fig. 13. In this infrared sensor programming, when the sensor detects the presence of a person, the stove turns on, and vice versa. In this thermocouple sensor programming, the thermocouple sensor can read two kinds of temperatures, namely celsius and Fahrenheit.

III.3. 12 V Power Supply Testing

Table II displays the outcomes of ten multitester tests conducted on the 12 V power supply. It can be inferred that the 12 V voltage utilized in this tool is accurate given the test result of 100% accuracy. The electric stove will be turned on using this 12 V voltage, which will also function as a step-down source to deliver power to the control circuit.

TABLE II
12V POWER SUPPLY TESTING

| Testing Number | Voltage needed (V) | Multimeter (V) | Accuracy (%) |
|----------------|--------------------|----------------|--------------|
| 1 | 12 | 12 | 100 |
| 2 | 12 | 12 | 100 |
| 3 | 12 | 12 | 100 |
| 4 | 12 | 12 | 100 |
| 5 | 12 | 12 | 100 |
| 6 | 12 | 12 | 100 |
| 7 | 12 | 12 | 100 |
| 8 | 12 | 12 | 100 |
| 9 | 12 | 12 | 100 |
| 10 | 12 | 12 | 100 |
| Average | 12 | 12 | 100 |

TABLE III
STEP DOWN TESTING

| Testing Number | Voltage Needed (V) | Measured Voltage (V) | Accuracy (%) |
|----------------|--------------------|----------------------|--------------|
| 1 | 5 | 5 | 100 |
| 2 | 5 | 5 | 100 |
| 3 | 5 | 5 | 100 |
| 4 | 5 | 5 | 100 |
| 5 | 5 | 5 | 100 |
| 6 | 5 | 5 | 100 |
| 7 | 5 | 5 | 100 |
| 8 | 5 | 5 | 100 |
| 9 | 5 | 5 | 100 |
| 10 | 5 | 5 | 100 |
| Average | 5 | 5 | 100 |

III.4. Step Down Testing

Table III shows a 5-volt step-down test using a multi-tester with ten times of testing and 100% accuracy obtained. It can be concluded that the 5-volt voltage used in this tool is accurate.

III.5. Testing of WiFi Connection to NodeMCU ESP8266

Ten WiFi connections to a NodeMCU ESP8266 were tested with waiting times of 4 and 5 seconds, and the test results are shown in table IV. The results of the tests show that the NodeMCU ESP8266 can establish a medium-speed WiFi connection.

TABLE IV
TESTING OF WIFI CONNECTION TO NODEMCU ESP8266

| Testing Number | WiFi ESP8266 | | Accuracy (%) |
|----------------|--------------|------------------|--------------|
| | Condition | Waiting Time (s) | |
| 1 | Connected | 5 | Medium |
| 2 | Connected | 4 | Medium |
| 3 | Connected | 5 | Medium |
| 4 | Connected | 5 | Medium |
| 5 | Connected | 4 | Medium |
| 6 | Connected | 5 | Medium |
| 7 | Connected | 5 | Medium |
| 8 | Connected | 4 | Medium |
| 9 | Connected | 5 | Medium |
| 10 | Connected | 4 | Medium |

III.6. Thermocouple Sensor Testing

Table V shows the results of testing the thermocouple sensor ten times using a thermometer. Temperature readings using a thermocouple sensor and a Celsius thermometer are about 1–10 degrees Celsius. This test obtained an average accuracy of 93.83%.

III.7. IR Sensor Testing

In Table VI, the IR sensor experiment has been tested ten times with the appropriate test results between the command and the realization of the IR sensor. The results of testing the equipment are shown in Table VI. There is good consistency of results. The IR sensor test commands and realizations are all detected as they should be. This indicates that the equipment has been working properly.

TABLE V
THERMOCOUPLE SENSOR TESTING

| Testing Number | Thermocouple (°C) | Thermometer (°C) | Accuracy (%) |
|----------------|-------------------|------------------|--------------|
| 1 | 35.50 | 35.00 | 98.60 |
| 2 | 37.00 | 36.00 | 97.30 |
| 3 | 42.00 | 41.00 | 97.70 |
| 4 | 46.50 | 45.00 | 96.80 |
| 5 | 67.00 | 61.00 | 91.10 |
| 6 | 84.50 | 78.00 | 92.30 |
| 7 | 94.00 | 87.00 | 92.60 |
| 8 | 98.50 | 89.00 | 90.40 |
| 9 | 99.50 | 90.00 | 90.50 |
| 10 | 100.00 | 91.00 | 91.00 |

TABLE VI
IR SENSOR TESTING

| Testing Number | IR Sensor | | Description |
|----------------|------------|-------------|-------------|
| | Command | Realization | |
| 1 | Barrier | HIGH | Appropriate |
| 2 | No Barrier | LOW | Appropriate |
| 3 | Barrier | HIGH | Appropriate |
| 4 | No Barrier | LOW | Appropriate |
| 5 | Barrier | HIGH | Appropriate |
| 6 | No Barrier | LOW | Appropriate |
| 7 | Barrier | HIGH | Appropriate |
| 8 | No Barrier | LOW | Appropriate |
| 9 | Barrier | HIGH | Appropriate |
| 10 | No Barrier | LOW | Appropriate |

TABLE VII
RELAY TESTING

| Testing Number | IR Sensor | | Description |
|----------------|-----------|-------------|-------------|
| | Command | Realization | |
| 1 | HIGH | HIGH | Appropriate |
| 2 | LOW | LOW | Appropriate |
| 3 | HIGH | HIGH | Appropriate |
| 4 | LOW | LOW | Appropriate |
| 5 | HIGH | HIGH | Appropriate |
| 6 | LOW | LOW | Appropriate |
| 7 | HIGH | HIGH | Appropriate |
| 8 | LOW | LOW | Appropriate |
| 9 | HIGH | HIGH | Appropriate |
| 10 | LOW | LOW | Appropriate |

III.8. Relay Testing

The relay experiment has been tried 10 times with suitable test results between the command and the

relay implementation. The results are shown in Table VII. In Table VII, the equipment's test results are displayed. The outcomes are consistently good. All the relay test commands and realizations were correctly identified. This suggests that everything has been operating as it should.

IV. Conclusion

Based on the test results that have been conducted, it can be concluded that:

1. Normal power supply testing and no voltage decrease while the device is active or in standby mode. The step-down voltage of 5 volts is 100% accurate on average and the average voltage accuracy of 12 volts is 100%.
2. Based on the test results from the thermocouple sensor, the temperature reading using a thermocouple sensor and a Celsius thermometer is about a 1–10 degree Celsius difference. So it can be said that the accuracy of the thermocouple sensor reaches 93.83%.
3. Based on the test results of the infrared sensor, there is good consistency in the results. IR sensor test commands and realizations are all detected as they should be.
4. The internet connection test runs optimally, and the tool can be connected so that commands from Blynk can be sent to NodeMCU with an average delay of 4.5 seconds needed to connect.

Some of the benefits obtained in the research of automatic stove systems are:

1. It is safer when used because there are several sensors that can turn off and turn on the stove automatically.
2. It can prevent scorching in cooked dishes.
3. can prevent fires or electrical short circuits caused by stoves that are still turned on because someone forgot to turn them off.
4. Make it easy for users to warm food without having to go to the kitchen.

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