

Design & Build of Home Automation Trainer Using MCU ESP8266 Node Modul Based on Internet of Things (IoT)

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Abstract— The development of knowledge and technology in the world of education is currently advancing rapidly, providing many new ideas, methods and innovations in the field of technology development, especially trainers. Home automation is the introduction of technology in a home environment to provide convenience and protection for residents by remote monitoring. The smart home modeling device based on the ESP8266 Node MCU and the Internet of Things (IoT) uses Blynk as a monitoring controller that is stored on a Virtual Private Server (VPS). This system uses relays to connect lights, sockets, and fans, the DHT11 Sensor detects humidity and temperature, the Flame Sensor detects fire, and the MQ-2 Sensor detects gas leaks. The results obtained that the average lag time for turning on the relay is about 0.12 seconds and the average turning off the relay is about 0.12 seconds, the average error of the DHT11 Sensor when detecting heat is 3.30 Celsius and when detecting cold is -28.20 Celsius, the limit for detecting fire on the Flame Sensor is a maximum of 20 cm, the limit for gas leakage is set above 200 ppm. (*Abstract*)

Keywords— *IoT, Smart Home, Node MCU ESP8266, Device automation.* (*key words*)

I. INTRODUCTION

The development of knowledge and technology in the world of education requires teachers to be more creative and innovative in the process of learning activities in order to achieve learning objectives. The development of mobile technology is currently so rapid, one of which is mobile devices which are now commonly used by smartphones [1][2]. Learning media (Personal, 2017; Arsyad, 2014; Sadiman, et. Al. 2014) is the process of delivering or intermediary messages and information between the sender and the recipient that can take place effectively which cannot be separated from the learning objectives in schools. According to Buchori & Setyawati [4],[5] the media is a determinant of the success or failure of learning. Creative and innovative learning media can stimulate students to be curious so they are motivated to learn.

The development of IoT is currently massively used by internet users and the world of education to improve the ability of Information and Communication

Technology and Innovation in Education, students should be equipped with insights about IoT technology, as well as other appropriate technologies [6],[7].

The lack of teaching aids to facilitate simulation is certainly an obstacle when learning, especially in programming subjects, microprocessors, and microcontrollers [8], [9]. From these shortcomings, researchers will try to do experiments in the form of Home Automation using a Virtual Private Server (VPS) on the Blynk application which can monitor easily, and cheaply and aims to be able to perform more complex simulations, because electronics cannot be reasoned from abstract explanations without practice [10],[11]. In this study, the researcher proposes a research title regarding “DESIGN AND BUILD OF TRAINER HOME AUTOMATION USING MCU ESP8266 NODE MODULE

II. METHOD

A. Product Design

Researchers strive to create tools to facilitate monitoring and can perform more complex simulations, where simulation serves as a learning medium in the field of experimental circuit analysis. Product designs include Block Diagrams, Product Designs, Application Designs, Wiring Diagrams, System Flowcharts, Research Procedures.

Block Diagrams are used to assist in understanding how the tool works. Made by researchers. The following is an illustration of the block diagram of the tool that will be made in this study in Figure 1.

The following is a description of the function of each block diagram:

1. The power supply is used to energize the system through relays and the NodeMCU ESP826 module, so that all components are able to work and function properly.
2. The relay is used for testing the control of lights, sockets, and fans, testing is done by pressing the on/off button on the blynk smart

phone application.

3. Flame Sensor is used to detect ultraviolet radiation generated by the flame of a match.
4. The DHT11 sensor is used to measure temperature, which is to detect temperature and humidity.
5. The MQ-2 sensor is used to detect match gas from the butane group and then sends the data to the ESP8266.
6. The ESP8266 MCU node will calculate the fire rays through the flame sensor, measure temperature and humidity with the DHT11 sensor, while calculating the value of gas leaks with the support of the MQ-2 sensor, and will transfer the data to the Blynk Server in TCP/IP format. NodeMCU ESP8266 will continue to detect instructions that have been sent by the Blynk Server in TCP/IP format which will of course be changed via logic "HIGHT" or "LOW" on certain pins by relays to control on/off lights, sockets, and fans.

B. Product Design

The product design was designed by researchers to facilitate the simulation of learning activities

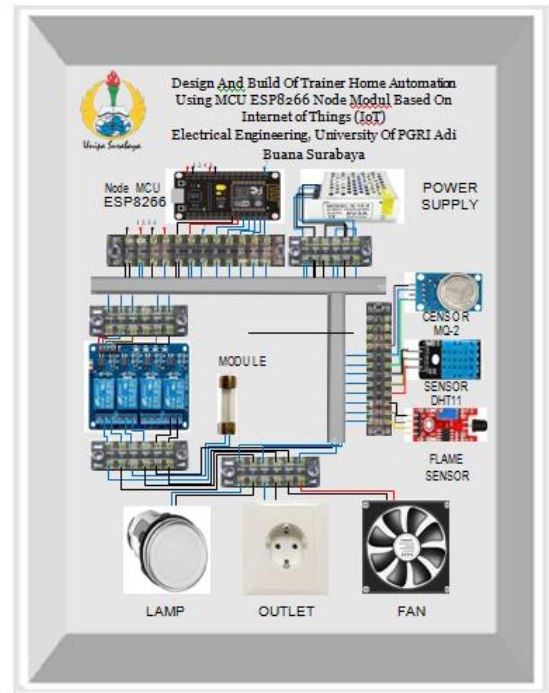


Figure 2. Product Design

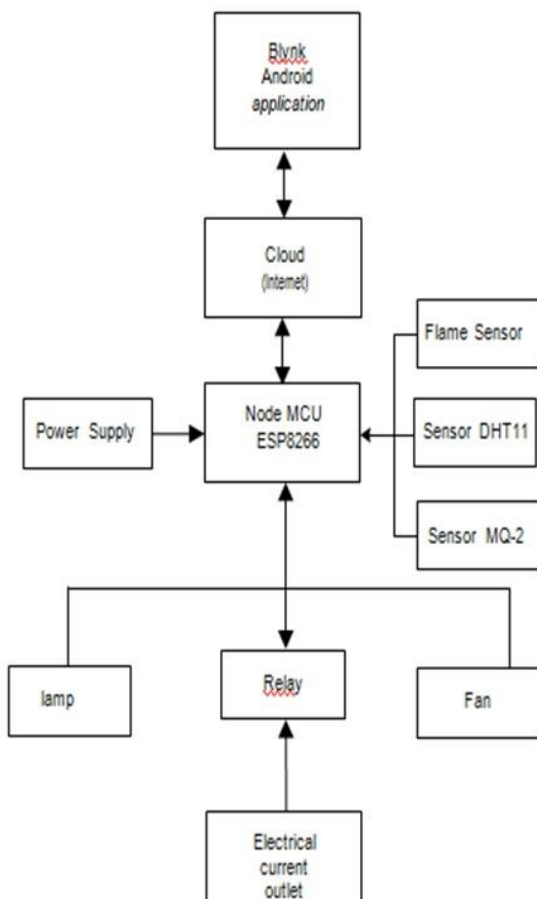


Figure 1. Block diagram of the designed system

C. App Design

How the application works in Figure 2.1.3 When pressing the switch button on the lamp, socket, and fan, the relay will automatically turn on, while for the dht11 sensor, MQ-2 sensor, and Flame sensor, we need to stimulate the sensor, so that the value obtained can appear on the display blynk application.



Figure 3. App Design

D. Wiring Diagram

The Wiring Diagram below is a reference for researchers in connecting the microcontroller with the Arduino program. The pins on the wiring have been determined by the researcher to avoid troubleshooting

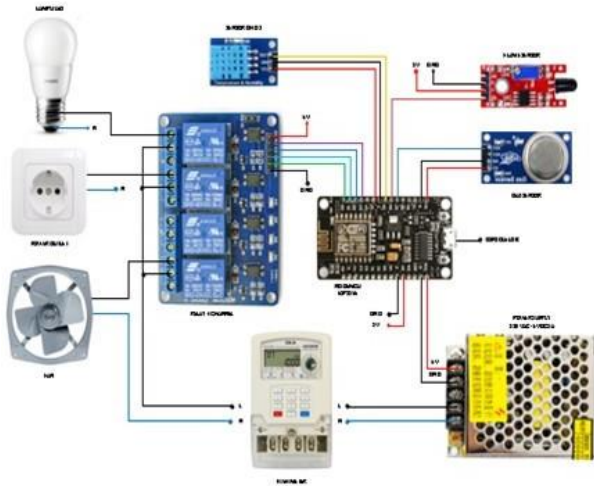


Figure 4. Wiring Diagram

E. Flowchart System

Flowchart of how it works the design of the home automation trainer using the esp8266 mcu node module based on the internet of things (IoT) is described in the image below.

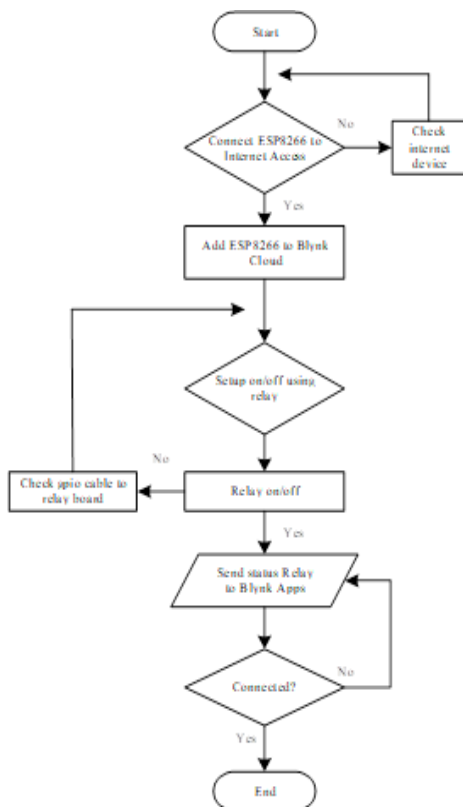


Figure 5. Flowchart Setup Relay

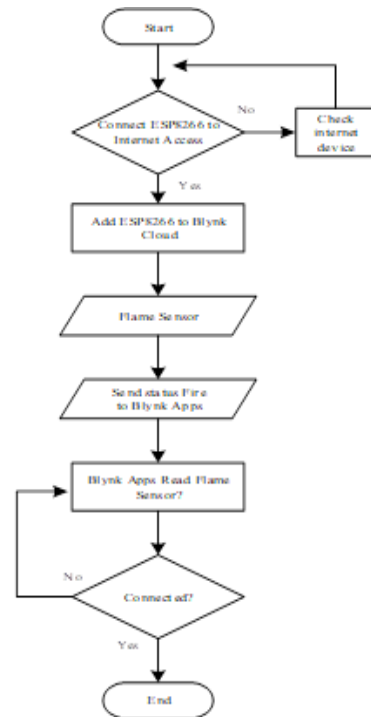


Figure 6. Flowchart setup Flame Sensor

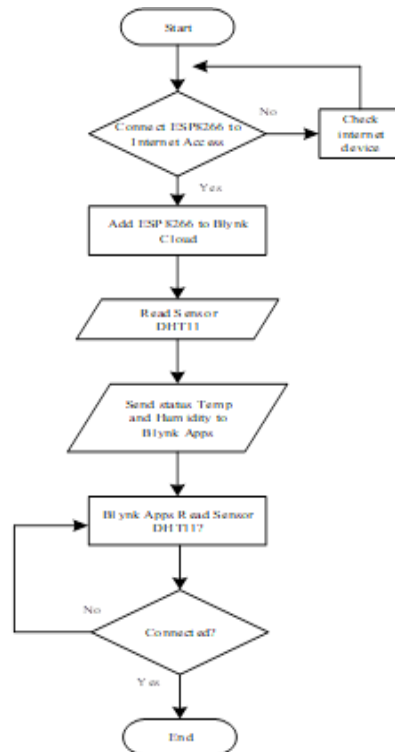


Figure 7. Flowchart Setup Sensor DHT11

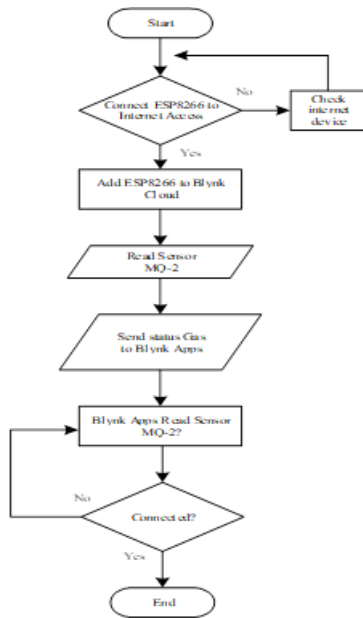


Figure 8. Flowchart Setup Sensor MQ-2

F. Research Procedure

Researchers make research procedures with the aim of providing an overview from the beginning of the process of tools made by researchers to testing tools and can be simulated easily. The flowchart can be seen in the following figure.

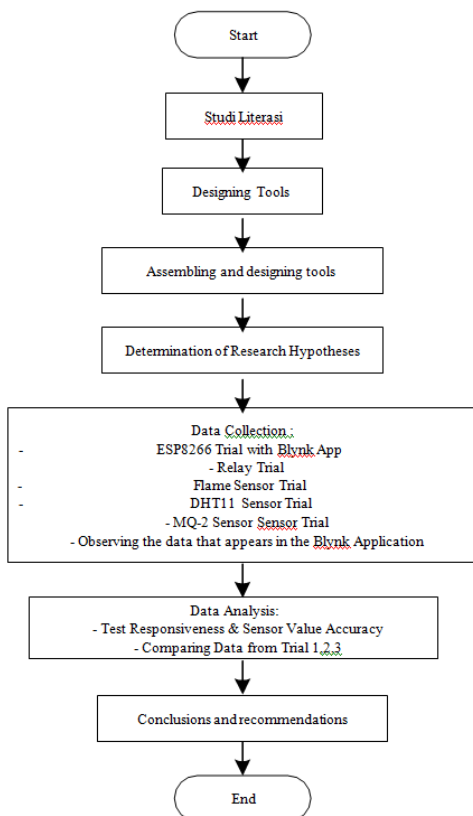


Figure 9. Research Procedure

• Product Test

Product Test is a process so that the tool to be worked on can be successful, and in line with the following theory:

1.) ESP8266 Test In the design of this Trainer Design and Build device, each component will be connected to the Esp8266 via the pins found on the Esp8266 board. This test aims to ensure the pins on the Esp3266 board run according to research.

2.) Relay Control Test Ok

Experiments can be done by pressing the on/off button on the blynk smart phone application, starting from lights, sockets and fans. Experimental data retrieval was carried out three times to determine the responsiveness of the relay work. The condition is carried out after the system works and is connected to an internet connection (WiFi). If at any time the internet connection stops or the signal is not in good condition, then this condition can also affect system capacity.

Table 1. ESP8266 Microcontroller Connection with Relay

| Microcontroller | DHT11 Sensor |
|-----------------|--------------|
| D4 | Data |
| 3V | VCC |
| GND | GND |

3.) Test Flame Sensor

Experiments can be done by providing a stimulus in the form of matches. The fire is given a distance of 5 cm to 20 cm, to determine the range of the sensor in detecting the presence of fire

Table 2. ESP8266 Microcontroller Connection with Flame Sensor

| Microcontroller | Flame Sensor |
|-----------------|--------------|
| D1 | D0 |
| 3V | VCC |
| GND | GND |

4.) Test DHT11 Sensor

Experiments on taking measurement data were carried out in two conditions, namely cold and hot. Cold stimuli come from ice cubes, while hot stimuli come from matches. The DHT11 temperature sensor is tested by being given a cold and hot response so that it can calculate the temperature value on the Blynk application display display when conditions are normal, given a cold response, and given a hot response which then the test results are compared with the thermometer test.

Table 3. ESP8266 Microcontroller Connection with DHT11 .
Sensor

| Microcontroller | DHT11 Sensor |
|-----------------|--------------|
| D4 | Data |
| 3V | VCC |
| GND | GND |

5.) Test MQ-2 Sensor

Experiments using MQ-2 were carried out by providing a stimulus in the form of gas from a match. Where the gas is given a time of 5 seconds to 25 seconds on the MQ-2 sensor, according to the data sheet about the MQ-2 sensor, it detects the quantity value of gas leakage which is between 200 - 500 ppm.

Table 4. ESP8266 Microcontroller Connection with MQ-2 . Sensor

| Microcontroller | MQ-2 Sensor |
|-----------------|-------------|
| A0 | A0 |
| 3V | VCC |
| GND | GND |

G. Variables and operational definitions of variables

In this study obtained several variables that have a goal to get the results achieved. These variables are

- Flame sensor notification
- DHT11 . Temperature and Humidity Sensor Value
- MQ-2 . Sensor gas quantity value
- Relay work responsiveness

H. Method Analysis Data

The data analysis methods used in this study include:

- 1) The first stage, create 1 trainer
- 2) The second stage, testing the relay to operate based on electromagnetic rules to move the contactor to change the ON status to OFF or vice versa
- 3) The third stage, testing the Flame Sensor to find out how quickly the sensor detects fire.
- 4) The fourth stage, testing the DHT11 Sensor to measure temperature and humidity.

- 5) The fifth stage, testing the MQ-2 Sensor to measure gas.
- 6) The sixth stage, testing the responsiveness of the Relay, Flame Sensor, DHT11 Sensor, and MQ-2 . Sensor
- 7) The seventh stage is to test all components

III. RESULT AND DISCUSSION

A. Product Results and Evaluation

When designing and making tools that can be used by vocational high schools and universities as a simulation in a more complex learning process, the control of monitoring trainers can be monitored via the blynk application display on a smartphone. By using an internet connection, monitoring can be done anywhere as long as the smartphone and the device have an internet connection.

The series of this tool consist of: Esp32, 4 Channel Relay, Flame Sensor, DHT11 Sensor, Mq-2 Sensor and 5V Adapter as the power source. With the blynk application as a display of monitoring sensors sent via an internet connection.

B. Data Presentation

Based on the experiments carried out, the analysis of the data obtained resulted in the following data:

- Relay Work Responsiveness Test

At this stage the data taken is the responsiveness of the relay work when pressing the on or off button on the blynk application, where when the condition of the relay turns off and on, a time lapse (delay) is found caused by data transfer to the Internet Of Things (IoT) cloud server.

With the results of the data obtained as follows:

Table 5. Relay Work Responsiveness Test

| Condition | Test Response Time 1 (second) | | Test Response Time 1 (second) | | Test Response Time 1 (second) | |
|--|-------------------------------|------|-------------------------------|------|-------------------------------|------|
| | On | Off | On | Off | On | Off |
| The light button on the application is pressed | 0.12 | 0.13 | 0.12 | 0.13 | 0.12 | 0.11 |
| The stop button on the application is pressed | 0.12 | 0.12 | 0.13 | 0.13 | 0.12 | 0.12 |
| The fan button on the application is pressed | 0.13 | 0.13 | 0.12 | 0.13 | 0.13 | 0.13 |

- Test the Flame Distance Range on the Flame Sensor

At this stage the data taken is a test of the distance range on a match that is measured using a ruler where the sensor will send data to the blynk application, with 3 repetitions.

With the results of the data obtained as follows:

Table 6. Test Range of Flame Distance on Flame Sensor

| Condition | Blynk App Time Notification Results (Second) | | | |
|-------------|--|-----------|-----------|-----------|
| | Distance (Centimeter) | Testing 1 | Testing 2 | Testing 3 |
| Fire Detect | 5 cm | 0.73 | 0.79 | 0.85 |
| | 10 cm | 0.75 | 0.54 | 0.73 |
| | 15 cm | 0.88 | 0.91 | 1.23 |
| | 20 cm | 0.6 | 0.76 | 1.24 |

- Temperature Responsive Test on DHT11 Sensor

At this stage the data taken is to compare the DHT11 temperature sensor tested by detecting heat and cold where the temperature value results can be seen on the display display blynk when conditions are normal, detecting heat, and detecting cold, then the test results are compared with the temperature value on the thermometer.

With the results of the data obtained as follows:

Table 7. Temperature Responsive Test on the DHT1

| Duration Time (Second) | Display Blynk Display (celcius) | | Display Blynk Display (celcius) | | Error (celcius) | |
|------------------------|---------------------------------|------|---------------------------------|------|-----------------|------|
| | Dete ct | | Dete ct | | Dete ct | |
| | Hot | Cool | Hot | Cool | Hot | Cool |
| 1 Sec | 30.6 | 30.1 | 29.3 | 26.8 | -1.3 | -3.3 |
| 2 Sec | 30.8 | 29.4 | 30.8 | 24.5 | 0 | -4.9 |
| 3 Sec | 31 | 28.4 | 31.3 | 23.1 | 0.3 | -5.3 |
| 4 Sec | 31.2 | 28 | 32 | 21.3 | 0.8 | -6.7 |
| 5 Sec | 31.5 | 27.3 | 35 | 19.3 | 3.5 | -8 |

- Gas Sensor Responsive Test

At this stage the data taken is the sensor quantity value when detecting a butane gas leak, which is between 200-500 ppm. Testing the MQ-2 sensor will send a quantity value that will appear in the blynk application when the amount of gas is above 200 ppm.

With the results of the data obtained as follows:

Table 8. Gas Quantity Responsive Test (PPM)

| Condition | Gas Quantity (ppm) | | | |
|------------|--------------------|-----------|-----------|-----------|
| | Time | Testing 1 | Testing 2 | Testing 3 |
| Normal | Normal | 336 | 289 | 297 |
| Gas Detect | 5 sec | 489 | 480 | 449 |
| | 10 sec | 489 | 486 | 483 |
| | 15 sec | 485 | 513 | 490 |
| | 20 sec | 480 | 475 | 533 |
| | 25 sec | 480 | 447 | 508 |

B. Analysis Data

From the table of sensor readings can be illustrated with the following diagram:

- Test Relay Responsiveness In Blynk App



Figure 10. Relay Responsive Test in the Blynk Application

- Fire Distance Range in the Blynk Application Test(Distance)



Figure 11. Test of Fire Distance Range in the Blynk Application (Distance)

- DHT11 Sensor Responsiveness Test (Celsius)

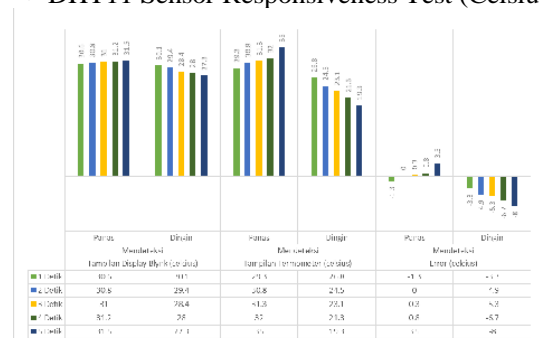


Figure 12. DHT11 Sensor Responsive Test (Celsius)

- Gas Quantity Responsive Test (PPM)

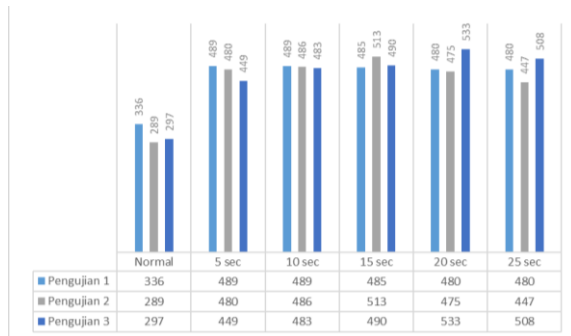


Figure 13. Gas Quantity Responsive Test (PPM)

C. Discussion

From the results of experiments that have been carried out on controlling the blynk application, it is known that the condition of the lights being pressed causes the screen on the display of the blynk application to turn green, which indicates that the relay is ON, so the lights, sockets and fans will turn on. While the output voltage obtained by the relay is 220 Volt AC. Or vice versa, when the light, socket, and fan buttons are pressed, the display blinks white so that the lights on the relay are OFF or off, the outlet is cut off through AC power, or the fan will stop rotating. When measured, the output voltage obtained by the relay is 0 Volt AC.

In the measurement there is a time lag when the on relay button on the blynk application is pressed, the fastest time for the relay to turn on is about 0.12 seconds and the longest time is 0.13 seconds. After several experiments, the average value obtained was found to be around 0.12 seconds for the relay to turn on through the flash. When measuring the time lapse when the off relay button on the blynk application is pressed, it is found that the fastest time interval for the relay to turn off (Off) is approximately 0.11 seconds and the longest time interval is approximately 0.13 seconds. When several experimental tests were carried out, it was found that the average time interval for the relay to turn off on the blynk required about 0.12 seconds.

Based on the test results, the distance range of the fire source on the flame sensor is able to detect fire at a maximum distance of 20 cm as measured by a ruler. In table 4.2.3 the test results for the accuracy of the DHT11 sensor when detecting heat store an average error of 3.30 Celsius, and for detecting cold the average error is -28.20 Celsius. The value obtained is done by adding up all the error values from the test results then divided by the number of tests. And the test results for the gas leak sensor detector (MQ-2) can be monitored by looking at the quantity value of 5 seconds for gas leakage, after reaching the concentration limit that enters the MQ-2 sensor, which is above 200 ppm, then esp8266 will send the MQ sensor quantity

value -2 in the blynk application so that the output value will appear on the blynk application display.

IV. CONCLUSION

From a series of research, testing and analysis of Monitoring Trainer Home Automation Using the ESP8266 Node MCU Based on the Internet of Things (IoT) it can be concluded as follows:

- Home Automation Trainers assist learning and practical activities in Vocational High Schools and Universities, in conducting simulations.
- The average response time when the relay on condition uses Blynk is about 0.12 seconds, while the response time for the relay off condition is about 0.12 seconds.
- Maximum range of 20 cm to detect fire on the Flame Sensor.
- The DHT11 sensor obtained error data when detecting heat with an average of 3.30 Celsius while when detecting cold the average obtained was -28.20 Celsius.
- The MQ-2 sensor can detect gas leaks above 200 ppm which can be seen on the blynk application display.

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