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Smart Home Remote Control System Prototype Using Internet of Things (IoT) Based ESP8266 Microcontroller

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Abstract- Technology is developing very rapidly in the current era, there will be several impacts that will result from the development of technology. Electronic equipment control can be done remotely in real time using the IoT system. The problem faced is the concern when leaving home. Because when leaving the house, homeowners sometimes often forget about electronic devices whether they are turned off or still on. IoT can be utilized at home as a smart home system by connecting an electronic device to an android application. This IoT-based smart home system uses an ESP8266 microcontroller which is used to connect between hardware and software that is controlled through the Blynk application. Blynk application is used as an interface that functions to provide input and produce output. This system consists of four sensors, namely the MQ2 sensor to detect gas leaks in the kitchen, the DHT11 sensor to determine the level of humidity and temperature in the bedroom, the PIR sensor to detect human movement at the front entrance, the ULTRASONIC sensor as a detector of the water level in the water reservoir and using three relays as a connector for lights and other electronic components. And using the Blynk application as a control system on the ESP8266 microcontroller. This prototype tool can help monitor and control the condition of the house in real time.

Keywords: NodeMCU ESP8266, Smart Home, IoT, Blynk.

I. INTRODUCTION (*HEADING 1*)

In the 4.0 era, everything humans do becomes easier and instant. Very rapid development can be seen in the technology sector which can be felt in the industrial world and among society. The internet is one example of technology that has been used by all of society. The internet is experiencing very rapid development, all groups can use the internet, from adults to teenagers and young people are also starting to use the internet.

With this development, an innovation was developed where household electronic devices can be controlled remotely using a smart home application. A smart house or better known as a smart home is a residence or residence that is connected to an Internet network that can control electrical equipment in real time which allows it to be monitored or accessed remotely. So that Smart home can increase efficiency, comfort and security by utilizing automatic technology [1]. The Smart Home application can control and control electronic equipment remotely.

The problem faced is worry when leaving the house. Because when leaving the house, homeowners sometimes often forget whether electronic devices are turned off or still on. Using a smart home application will make it easier for home owners to control and control household electronic devices. And using this smart home application can increase the level of efficiency, comfort and security in the house when it is left behind.

Several researchers have conducted research [2] on Web-Based Home Electronic Control Applications that use Raspeberry Pi as a web server as a link between hardware and software, but the price is quite expensive compared to using the ESP8266 Wifi module. Researcher [3] Implementation of Smart Home Applications Based on Android with Arduino Microcontroller which uses Bluetooth as a link between software and hardware. As for [4] Implementation of IoT (Internet of Things) Technology in Microcontroller-Based Smart Homes esp 8266 which uses IoT as home lighting.

From several previous studies, the author will carry out development using the title "Design and Build a Smart Home Remote Control System Using the ESP8266 Microcontroller Based on Internet of Things (IoT)".

II. METHODS

2.1 Product Design

In this research, researchers will design a Smart Home Remote Control System Prototype Using an Internet of Things (IoT) Based ESP8266 Microcontroller and use several processes to get the desired results. Apart from that, this research seeks to create tools to make it easier for users to control and monitor the condition of their homes in real time or online.

2.1.1 Block Diagrams

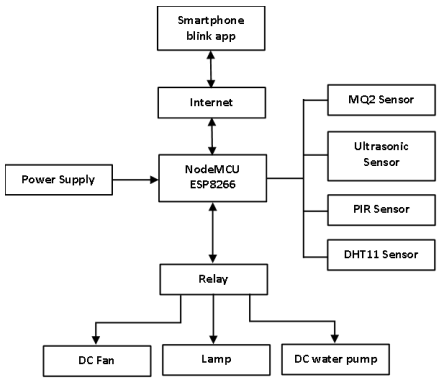

Figure 2.1.1 Block Diagrams

From the block diagram above, you can find out a little about the description of the object of this research and the following is an explanation of the function of each block:

1. Power Supply

   The power supply is used to provide 5V voltage to the ESP8266 and Relay, so that all equipment can work and function as it should.

2. NodeMCU ESP8266

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NodeMCU ESP8266 functions as the core of the system, which will receive input from Blynk and DHT11 Sensors as temperature and humidity detectors, MQ2 Sensors as gas leak detectors, Ultrasonic Sensors are used as Water levels, PIR Sensors as detectors of human movement.sss

3. MQ2 sensors

   The MQ2 sensor is used to detect the level of gas leaks, then sends the data to the NodeMCU ESP8266 and will be displayed in the Blynk application

4. Ultrasonic Sensor.

   Ultrasonic sensors are used as a water level meter or as a water level that will be displayed on the Blynk application.

5. PIR sensors

   The PIR sensor functions to detect human movement inside the house using infrared light technology.

6. DHT11 Sensors

   The DHT11 sensor functions as a temperature and humidity detector in a room which will be displayed on the Blynk application

7. Relays

   Relays are used to control lights, DC fans, DC 12V water pumps.

8. Blynk

   Blynk serves to display the results of the data generated by the sensors and as an interface between software and hardware.

2.1.2 Product Design

The product design in this design uses 4 sensors as input and 3 relays as output and also uses ESP8266 as a processor which functions to process the data generated by the input.

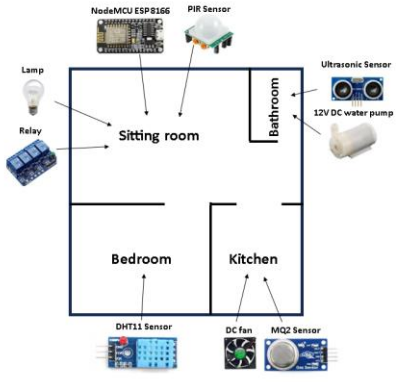

Figure 2.1.2 Product Design

2.1.3 Wiring Diagrams

In the installation section consists of several processes, namely input, data processing and output. In the input data section, several components are used, namely PIR sensors, ultrasonic sensors, MQ2 sensors, DHT11 sensors and the Blynk application. While in the data processing using ESP8266. And on the outside it generates data from data processing that is inputted by inputs which have Lights, DC Fans, 12V DC Water Pumps, Buzzers and Notifications on the Blynk application

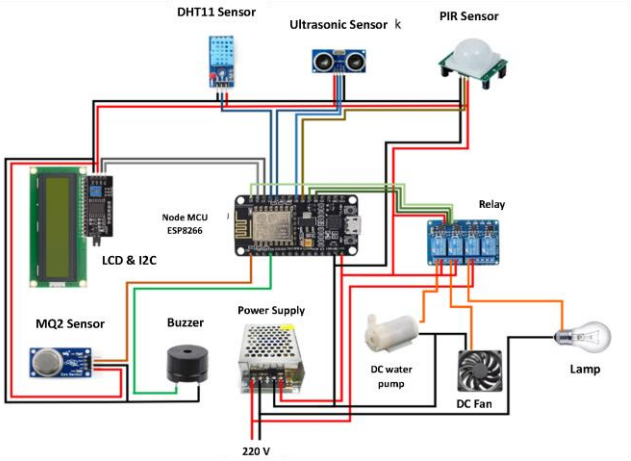

Figure 2.1.3 Wiring Diagram

2.1.4 Flowcharts

In figure 2.1.4 is how the Smart Home control system works using ESP8266 as a microcontroller and using 4 sensors.

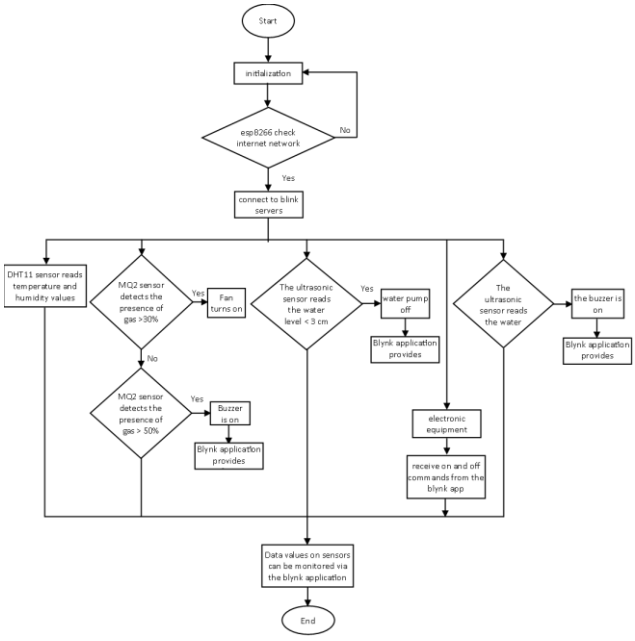

Figure 2.1.4 Flowchart

2.2 Product Test

Testing is a process so that the systems and tools created can work properly. By using several existing theories, there are several tests that will be carried out, including:

2.2.1 DHT11 Sensor Testing

DHT11 sensor testing is carried out to determine the temperature and humidity of a room. The test was carried out for 60 minutes with data collection every 10 minutes. Then

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the test results will be compared with the temperature clock humidity measurement.

2.2.2 MQ2 Sensor Testing

Testing of the MQ2 sensor is carried out in order to find out the level of accuracy of the sensor where at a certain value the sensor will turn on the DC fan. The test is carried out by giving gas from a lighter. The gas will be given a time of 0-25 seconds and given a distance of 5 cm.

2.2.3 Testing

Ultrasonic Sensor testing is carried out in order to determine the level of accuracy of the sensor where at a certain value the sensor will turn on the 12V DC water pump. the test is carried out by filling the tub with water so that the sensor value reading results will appear on the Blynk application. Kemudain will be compared with a ruler.

2.2.4 PIR Sensor Testing

PIR Sensor testing is carried out in order to determine the distance range for detecting human movement so that it can be received by the sensor. Testing is carried out by giving movement to the front of the sensor. This movement is given a range of 0-100cm.

2.2.5 Relay Testing

Relay testing is carried out by pressing the On button in the Blynk application, where this button is used on lights, DC fans, DC water pumps. So that the relay contact will move from NC to NO and vice versa if the Off button is pressed, the relay contact will move from NO to NC.

2.3 Variables and Variable Operational Definitions

A variable is something that can vary or change values. Values can be different at different times for the same object or values can be different at the same time for different objects. In this research there are several variables aimed at obtaining the results achieved, including:

1. DH11 Sensor, MQ2 Sensor, Ultrasonic Sensor, PIR Sensor are independent variables
2. NodeMCU ESP8266 functions as the dependent variable in this research.

2.4 Data Analysis Methods

In this study, the descriptive analysis method was used, namely describing the data according to the test results and analyzing the level of accuracy of the tool through the right components after the trials were carried out as follows:

1. The first stage, create a smart home prototype
2. The second stage, testing the DHT11 sensor to determine the temperature and humidity in a room
3. The third stage, testing the MQ2 sensor to determine the accuracy of the sensor when a gas leak occurs
4. The fourth stage, testing the Ultrasonic sensor to determine the water level
5. Fifth stage, testing the PIR sensor to determine the accuracy of the sensor when detecting human movement
6. Sixth stage, Relay testing to determine the level of responsiveness when pressing the On/OFF button on the Blynk application
7. Seventh stage, testing all components
8. Final Stage, Conclusion about success in creating a samrt home system

III. RESULTS AND DISCUSSION

3.1 Product Results and Evaluation

When designing systems and creating tools that can be used and applied among the community. As a remote monitoring and control tool. By using an internet connection, monitoring and control can be done anytime and anywhere.

There are several circuits of this tool, namely ESP8266, 4 Chanel Relay, DHT11 Sensor, MQ2 Sensor, Ultrasonic Sensor, PIR Sensor and 5V Power Supply as the circuit power source. By using the BLYNK application as a display interface for sensors connected to the internet.

3.2 Data Presentation

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

1. DHT11 Sensor Testing

   The DH11 sensor test was carried out to determine the temperature and humidity of a room. Testing was carried out for 60 minutes with data collection every 10 minutes. Then the test results are compared with a temperature clock humidity measuring instrument.

Table 3.2.1 DHT11 Sensor Test

No	Temperature (°C)		Error (°C)	Humidity (%)		Error (%)
	Thermometer	DHT11		Thermometer	DHT11	
1	29,4	29,2	0,2	55	52	3
2	29,6	29,4	0,2	54	51	3
3	29,3	29,1	0,2	54	53	1
4	28,7	28,6	0,1	51	50	1
5	29,3	29,2	0,1	52	51	1
6	29,4	29,5	0,1	51	49	2
Average Error			0,15	Average Error		1,8

2. MQ2 Sensor Testing

   Testing the MQ2 sensor starts by applying gas to the lighter. The gas will be given a time of 0 – 25 seconds and given a distance of 5 cm to the MQ2 sensor to determine the level of accuracy of the sensor.

Table 3.2.2 MQ2 Sensor Test

No	Time (Seconds)	MQ2 Sensor	Information
1	5	24	Fan off
2	10	29	Fan off
3	15	31	Fan on
4	20	34	Fan on
5	25	37	Fan on

3. Ultrasonic Sensor Testing

   Ultrasonic sensor testing starts from filling the tub with water so that the data values will appear in the Blynk application on the smartphone. Then the test results will be compared with a ruler. So you can know the level of accuracy of the Ultrasonic sensor.

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Table 3.2.3 Ultrasonic Sensor Test

No	Distance (Cm)		Error (Cm)
	Ultrasonic	Ruler	
1	25	25,2	0,2
2	20	20,5	0,5
3	15	15,8	0,8
4	10	11,3	1,3
5	5	6,5	1,5
Average Error			0,86

4. PIR Sensor Testing

Testing the PIR Sensor starts by providing movement in front of the sensor. This movement is given a distance range of 0–100 cm, to determine the distance range of the sensor in detecting movement

Table 3.2.4 PIR Test

No	Distance (Cm)	Circumstances	BLYNK notifications
1	1	There are people	There is a notification
2	20	There are people	There is a notification
3	40	There are people	There is a notification
4	60	There are people	There is a notification
5	80	There are people	There is a notification
6	100	There are people	There is a notification

5. Relay Testing

Relay testing is carried out by pressing the On button in the blynk application on a smartphone which is used to control lights, DC fans, DC Water Pumps. So that the relay contact will move from Normally Close to Normally Open and vice versa if the Off button is pressed, the relay contact will move from Normally Open to Normally Close

Table 3.2.5 Relay Test

No	Units	Condition	Initial relay condition	Relay Current Condition
1	R1	Button pressed	Off	On
2	R2	Button pressed	Off	On
3	R3	Button pressed	Off	On

3.3 Data Analysis

3.3.1 Temperature and Humidity Test on the DHT11 Sensor

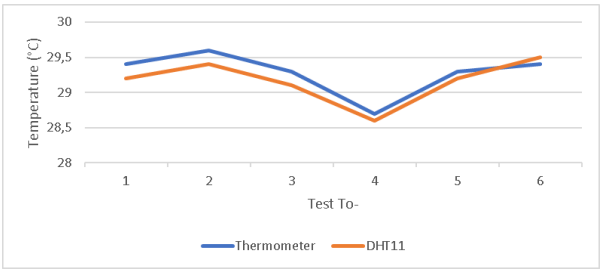

Figure 3.3.1 Comparison graph of thermometer temperature with DHT11 sensor

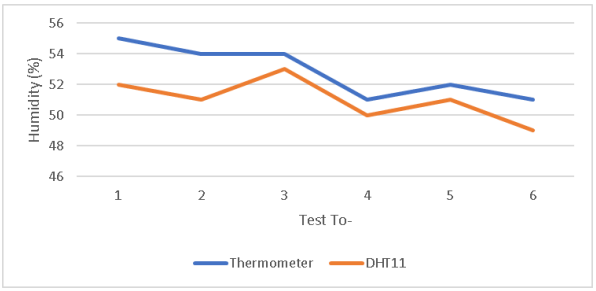

Figure 3.3.2 Comparison graph of humidity thermometer and DHT11 sensor

3.3.2 Test MQ2 Sensor

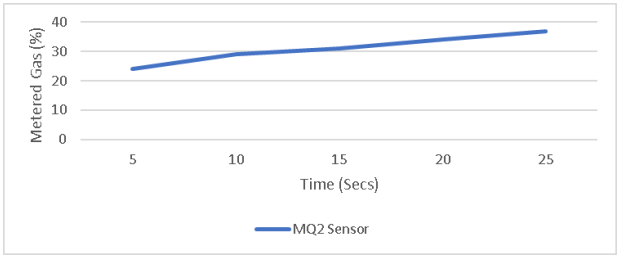

Figure 4.3.3 MQ2 Sensor Graph

3.3.3 Ultrasonic Sensor Test

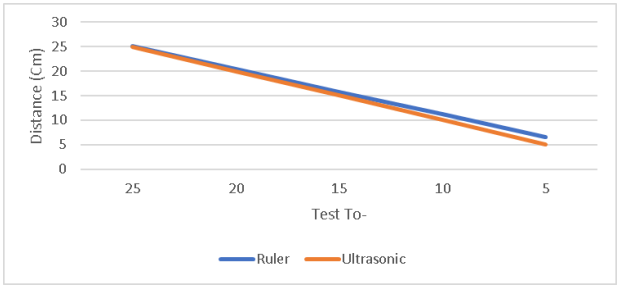

Figure 4.3.4 Comparison Graph of Ultrasonic Sensor Distance with a Ruler

3.4. Discussion

Based on the testing stages that have been carried out, it can be concluded that the designed system can work properly, although there are some errors that can still be tolerated. From the test results, compare the temperature and humidity values on the DHT11 sensor with a temperature clock humidity measuring instrument. Based on the test results in table 3.2.1, the temperature and humidity test results on the DHT11 sensor in a room have an average error value of 0.15 °C in temperature and 1.8% in humidity.

In table 3.2.2 the results of the MQ2 sensor test show that within 5-25 seconds the gas leak value that can be captured by the MQ2 sensor is 24-37% which then turns on the fan automatically from a value of 31%. In table 3.2.3 the Ultrasonic Sensor test will be compared with a ruler. Based on the results of testing the accuracy of the Ultrasonic Sensor, it gets an average error value of 0.86cm. In table 3.2.4 the PIR sensor tester is based on the results of the maximum

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distance test specified by the author, which is 100cm and the sensor can still read movement.

From the test results of the relays in table 3.2.5 which are used to control lights, DC fans, DC water pumps in the initial conditions the relay is Off, then pressing the button on the display of the BLYNK application then the relay which was originally Off turns On. Conversely, if the relay is On when pressed, the relay will turn Off.

IV. CONCLUSION

4.1 Conclusion

From a series of research, testing and analysis of the design of the Smart Home Remote Control System Prototype Using the ESP8266 Microcontroller, it can be concluded as follows:

1. The results of the Smart Home prototype design help monitor and control the condition of the house in real time.
2. The DHT11 sensor obtained an average error value of 0.15 °C in temperature and 1.8% in humidity.
3. The MQ2 sensor can detect gas leaks above 20% which can be seen on the BLYNK application display. And it can turn on the DC fan automatically when the sensor detects a gas leak above 31%.
4. The Ultrasonic Sensor obtained an average error value of 0.86 cm.
5. The results of the design for detecting human movement in a Smart Home system that uses a PIR Sensor can respond and work well.
6. The results of the Relay design to control lights, DC fans, DC water pumps remotely can work well.

4.2 Suggestion

The suggestions that can be given for further research are as follows:

1. It is expected to add a camera that is useful for additional security systems besides the PIR sensor and is very useful for monitoring the condition of the house when it is abandoned.
2. It is expected to use ESP32 because it has dual connections, namely Wifi and Bluetooth and also has more Pins.

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