

Smarthome security system based on Internet of Things (IoT) using ESP32

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ABSTRACT

The development of Internet of Things (IoT) technology has enabled the creation of a smarter, more efficient, and integrated home security system. This research was conducted to design and build an IoT-based smarthome security system using an ESP32 microcontroller, with the aim of improving home security through automatic access control and fire detection. The benefit of this research is to provide a home security solution that can be monitored and controlled in real-time through the Blynk application, while increasing the response to potential hazards. The research method includes hardware design consisting of RFID module for door authentication, flame sensor for fire detection, DHT22 sensor for temperature measurement, and actuators such as solenoid door lock, servo motor, fan, motor pump, buzzer, and LED indicator. The system was tested in various ways, including RFID tag reading, flame detection, temperature response, and remote control using Blynk. The test results show that the system is able to read RFID tags with a distance of ± 5 cm and a response time of < 1 second, detect flames up to a distance of ± 80 cm, and display sensor data in real-time on Blynk with an overall success rate of more than 95%. The system built can function properly as designed and is able to provide effective home security, both locally and remotely. Users can access information on home conditions and control devices directly anytime and anywhere. With stable performance and high success rate in various tests, this system can be an effective and practical solution to improve home security based on IoT technology.

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1. INTRODUCTION

The development of modern technology has brought significant changes in various fields of life, including automation. One of the things that automation technology can rely on is a smart home or smarthome[1]. Through a smartphone and internet connection, homeowners can remotely manage various electronic devices at home[2]. Smarthome also allows homeowners to remotely monitor the state of the house without fear of break-ins or theft and other crimes that will occur at home. Break-ins often occur due to the use of conventional locks. Because it requires carrying too many keys, the conventional door lock system is considered inefficient for homes with many doors. Therefore, a more efficient and practical lock is needed.[3]

According to West Sumatra Police Chief Inspector General Suharyono, the crime rate in West Sumatra province in 2024 increased by 1.95 per cent compared to last year. He further explained that of the 12,795 cases in 2024, the dominating ones were conventional cases such as theft, motorbike theft, and others as stated in the Criminal Code with a total of 11,399 cases[4]. Therefore, the use of conventional locks is considered impractical and vulnerable to theft.[5].

RFID is one of the most widely used automatic door lock systems. RFID (Radio Frequency Identification) is an identification system that uses radio waves to read data from microchips that can be implanted or placed in products [6]. Using RFID-based automatic door locks enhances higher security than conventional locks. The system allows users to open all doors in the house with just a few cards, thus eliminating the need for conventional keys. RFID technology is extremely difficult to hack or replicate [7]. In addition to the automatic door system, to improve home security there is a system that can provide warnings in the event of a fire. According to the Head of Operations and Infrastructure, Padang City Fire Department, the Padang City Fire Department recorded an upward trend in the number of fire cases throughout 2024. It was recorded that 245 fire incidents had been handled, the majority of which were caused by short-circuiting with a total of 145 incidents. In addition to the increase in fire cases caused by short-circuiting, the number of casualties has also increased [8]. Therefore, to facilitate and assist the community in informing the potential for fire early on, it is necessary to develop a tool that can detect and provide early warning of the occurrence of fire, so that people can monitor the situation in their residence [9].

In addition to automatic doors and fire detection, this system also functions to regulate room temperature. Decree of the Minister of Health of the Republic of Indonesia Number 1405/Menkes/SK/XI/2002 regarding good room air requirements has a temperature range between 18°C to 28°C. If the air temperature is above 28°C then an air conditioning device is needed such as a fan [10]. With these problems, along with the development of technology, the creation of a smarthome security system equipped with an automatic door system that can be monitored and controlled remotely so that it is more secure and efficient so that it can replace conventional door locks. In addition, there is also a fire detection system that is connected directly to the user's smartphone so that it allows residents of the house to continue to monitor home security remotely in the event of a fire or a detected spark. In addition to the two systems above, there is also a DHT22 sensor that helps maintain the temperature in the smarthome by using a fan actuator.

2. METHOD

This research was conducted using the experimental method. With this method, the author took some temperature test data and then compared it with the actual temperature. The author also takes some component voltage and current measurement data and compares it with the component's datasheet to determine the condition and feasibility of the component. The research instruments used are multimeters and infrared thermometers. In this study, the first circuit design was carried out on the smarthome, flowchart tool design, and testing. Hardware design is the process of designing, planning and developing the physical form of a system, including architectural design, component selection and technical specifications of the device to be made. Figure 1. Shows the hardware design of the proposed system.

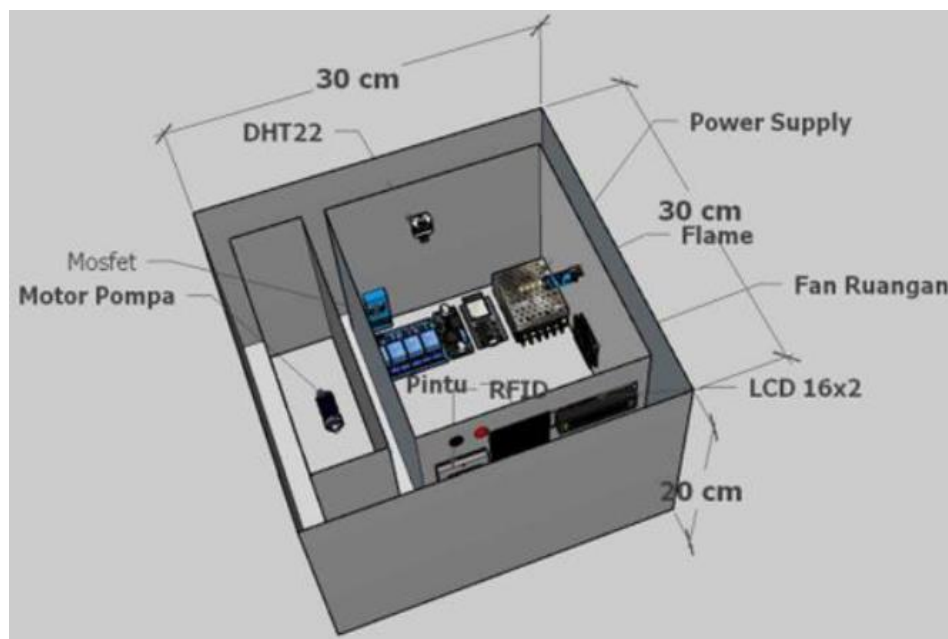


Figure 1. Tool Design Picture

Flowchart is symbolized by special symbols that have their own meaning in each symbol so that the entire system of work of the tool can be easily understood. The program flow chart is a chart that describes in detail the steps of the program process [11]. Flowcharts also describe the logical sequence of a problem-solving procedure, so that flowcharts can be understood as problem-solving steps written in certain symbols. And this flowchart will represent the flow in the program logically [12]-[15].

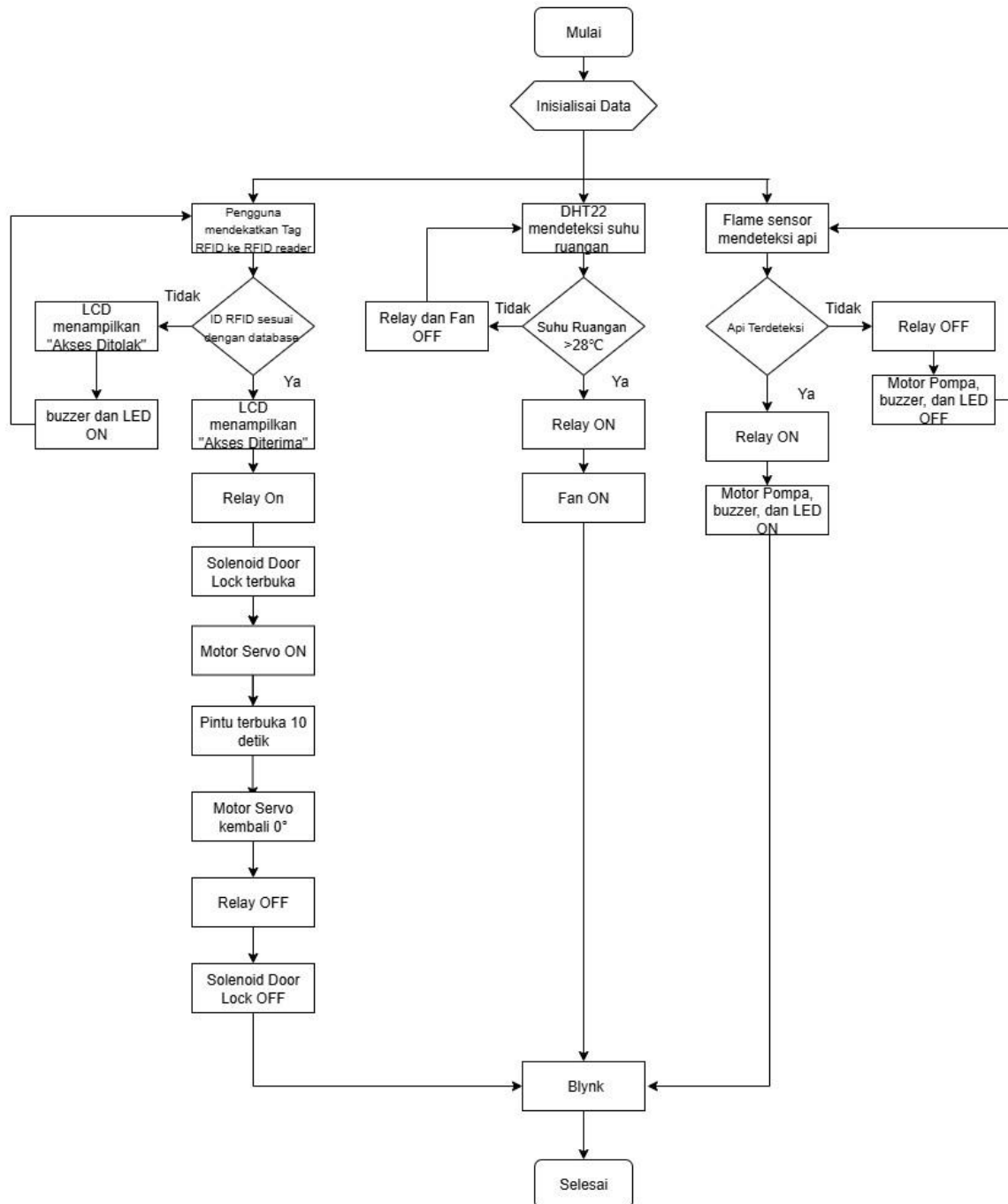


Figure 2. Flowchart

3. RESULTS AND DISCUSSION

The purpose of this test is to ensure that the system can detect the RFID tag ID inputted in the program can be read accurately and activate the solenoid and servo motor responsively. This test includes an evaluation of how far the RFID reader can detect RFID tags, as well as the speed of the solenoid and servo motor in responding to signals from the RFID.

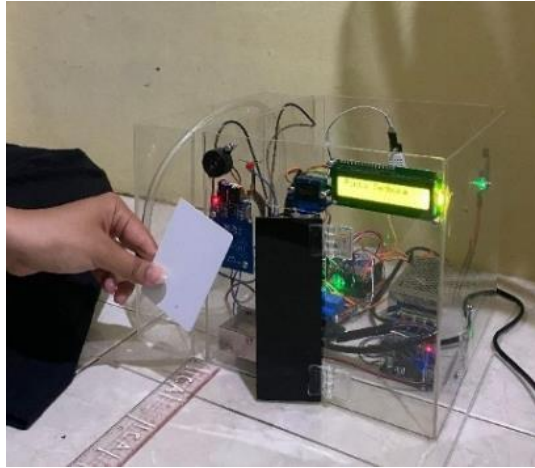


Figure 3. RFID Module Testing

In Figure 3, it can be seen that this test was carried out by bringing the RFID tag closer to the RFID reader with several test distances and the test results can be seen in the table below.

Table 1. RFID Module accuracy test results

No.	Distance Testing (cm)	Door	Solenoid Door Lock	Servo Motor
1	1	HIGH	On	On
2	2	HIGH	On	On
3	3	HIGH	On	On
4	4	HIGH	On	On
5	5	HIGH	On	On

In the Table 1, we can see that the RFID reader can read RFID tags with a distance of 5cm. This is in accordance with the RFID datasheet so that this RFID module is very accurate and can function properly. It can be seen in the table above that the solenoid and servo motor functions also run well according to the desired working principle.



Figure 4. RFID Tag ID Reading Test

In addition, RFID testing is also tested by making 3 ID tags that are inputted in the program and 2 IDs that are not inputted in the program. This test aims to ascertain whether RFID can find out which tag IDs are inputted and not inputted in this security system. For the results can be seen in Table 2.

Table 2. RFID tag ID reading test results

No.	RFID Tag	Door	Solenoid Door Lock	Servo Motor
1	97576E05	Open	On	On
2	BA8F6F1A	Open	On	On
3	C7C78E4A	Open	On	On
4	F71A9C4B	Closed	Off	Off
5	77618D4A	Closed	Off	Off

From the Table 2, it can be seen that tags 1, 2, and 3 are tags that have been inputted in the program, while tags 4 and 5 have not been inputted in the program. So in this test tags that have been inputted in the program can be used to access the door so that the solenoid and servo motor are on, while for tags that are not inputted cannot be accessed so that the solenoid and servo motor remain off.

In testing the flame sensor, the sensor reading distance is tested with varying distances to determine whether it can detect flames with the working principle of using infrared rays in the wavelength range of 760 nm - 1100 nm. This test uses a lighter with a flame diameter between 2.5 cm and 3 cm. The results of this flame sensor test can be seen in the Table 3.



Figure 5. Flame sensor accuracy testing

Table 3. Flame sensor accuracy test results using a match

No.	Distance Testing (cm)	Sensor Output	Buzzer	LED	Motor Pump	Status	
						LCD	Blynk
1	5	HIGH	On	On	On	Fire	Fire
2	10	HIGH	On	On	On	Fire	Fire
3	20	HIGH	On	On	On	Fire	Fire
4	30	HIGH	On	On	On	Fire	Fire
5	40	HIGH	On	On	On	Fire	Fire
6	50	HIGH	On	On	On	Fire	Fire
7	60	HIGH	On	On	On	Fire	Fire
8	70	HIGH	On	On	On	Fire	Fire
9	80	HIGH	On	On	On	Fire	Fire
10	90	LOW	Off	Off	Off	Safe	Safe

Based on the data in Table 3, the flame sensor can still detect fire with a maximum distance of 80 cm and depends on the size of the flame, if the flame is large then with a distance of 90 it can still detect it. From the test results, the sensor is in good condition for use. DHT22 sensor test is carried out by comparing the measurement results of the sensor parameters and the infrared thermometer and the experimental results can be seen in the Table 4.

Table 4. DHT22 sensor accuracy test results

Testing	DHT sensor reading (°C)	IR Thermometer Reading (°C)	Error %	Fan
1	32.0	32.0	0%	On
2	32.3	32.4	0.3%	On
3	33.8	33.8	0%	On
4	31.9	31.9	0%	On
5	31.6	31.3	0.9%	On
Average	32.38	32.28	0.2%	



Figure 6. DHT22 Sensor Testing

The data from the testing of several parameters above shows an error in the DHT22 sensor reading. The smallest error rate is 0.2% and the largest error rate is 0.9% with an overall average error of 0.2%. Based on the DHT22 sensor datasheet, the accuracy of the sensor is $\pm 0.5^{\circ}\text{C}$, while in the table of test results there is a difference of 0.2°C . So it can be concluded that the DHT22 sensor is not accurate. So it can be concluded that the DHT22 sensor in this study functions properly and can be used.

4. CONCLUSION

Based on the results of the design and testing that has been done, it can be concluded that the Internet of Things (IoT)-based Smarthome security system using ESP32 designed in this study is able to carry out the function of automatic door access control using RFID well, where the RFID tag authentication process takes place quickly with a response time of less than 1 second at an optimal reading distance of ± 5 cm, and can distinguish between registered and unregistered tags on the system. The integration of the flame sensor in this system is also able to detect flames up to ± 80 cm away with a response time of less than 1 second, and automatically activate the buzzer, LED indicator, and motor pump to perform initial extinguishing. In addition, the Blynk application proved effective as a remote monitoring and control media because it can display the ID of the affixed RFID tag, temperature, and fire conditions in real-time, as well as provide the option to open the door manually if the RFID tag is not available. Based on the test results, all system components work in accordance with the design and achieve a work success rate of more than 95% according to predetermined success indicators, so this system can be a practical, efficient, and reliable solution to improve home security. However, the weakness of the system lies in the dependence on electricity resources and internet connection, so that when there is a power outage or network disruption, some system functions cannot be used without a backup power source.

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