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Design of Door Security System using Rfid Based on IoT at Stmik Kaputama

M. Wahyu Salfian[1*], Husnul Khair[2], Milli Alfhi Syari[3]

[1,2,3]*STMIK Kaputama*

mwahyusalfian@gmail.com[1*], husnul.khair@gmail.com[2], milli.fhisya@gmail.com[3]

Abstract

The development of information technology has driven innovation in security systems, one of which is the development of door security systems based on the Internet of Things (IoT) and Radio Frequency Identification (RFID). This research aims to design and implement a Smart Door Lock system that allows real-time and remote access control through the integration of IoT and RFID technology. The system is designed using the ESP32 microcontroller connected to the MFRC522 RFID module, a relay for controlling the door lock, and indicators in the form of a buzzer and LED. Access data is stored locally and can be sent to a Telegram application via the Telegram Bot API to provide notifications of door activity. This research uses a Research and Development (R&D) method to produce a reliable, user-friendly, and efficient security system prototype. The test results show that the system successfully restricts access only to users who have registered RFID cards, and is able to automatically send access notifications to Telegram. Thus, this system can enhance security and convenience in door access management.

Keywords: *Smart Door Lock, Internet of Things, Radio Frequency Identification (RFID), Telegram*

1. Introduction

The development of information technology has opened up significant opportunities for the enhancement of digital security systems. The door security systems designed must meet several criteria, such as ease of use, reliability, and the ability to operate under various conditions. Additionally, it is important to ensure that the system can only be accessed by authorized users, thus preventing unauthorized access.

The Internet of Things (IoT) allows door security systems to be integrated with the internet network. When an object can send or receive data over a network without the help of computer devices or humans, it is called IoT [1]. Meanwhile, according to Wasista et al, the IoT refers to the interaction between people and objects or between devices that use the internet network as a medium for data and information exchange while also considering security [2].

By integrating IoT technology into the door security system, users can monitor and control door access remotely. This provides greater flexibility in managing security systems.

In addition to IoT, technology that can enhance door access security is Radio Frequency Identification (RFID). RFID is a technology that uses auto-ID or Automatic Identification methods [3]. This technology allows only people with access to open the door, making the access process easier without the need for physical keys. The use of RFID can enhance user convenience. By using radio waves, RFID will read the data sent by a unique card or tag. In the system created, the RFID card or tag serves as the user's identity [4].

This security system can be monitored remotely via mobile or web devices, such as Telegram. Telegram, being one of the popular messaging applications, provides a Telegram Bot that enables real-time message sending and receiving. A Telegram Bot is a feature of Telegram that has specific functions and operates automatically according to user commands or requests [5]. By utilizing Telegram, the door security system can notify users when access occurs and automatically record the access time. This is very useful for monitoring and auditing purposes.

The implementation of an RFID and IoT-based door security system is expected to provide a better solution compared to conventional systems. This system will not only enhance security levels but also offer comfort and efficiency in access management.

2. Research Methods

This research uses a Research and Development (R&D) approach, which aims to create a new product or solution to improve quality or effectiveness in a specific field. In this context, the R&D method is applied to develop innovations that support the achievement of research objectives.

The product developed in this research is a Smart Door Lock, focusing on the integration of modern sensors and their implementation in security systems for homes or rooms.
Data collection in this research was conducted through literature study methods, by reviewing various references relevant to the research topic. The data sources come from scientific journals, books, and academic publications related to smart door locks based on RFID technology. Through this information gathering, the researcher gained a comprehensive understanding of the utilization of RFID in the security systems of smart door lock. System needs analysis:

2.1. NodeMCU ESP32

The ESP32 is a microcontroller developed by Espressif Systems as the successor to the ESP8266. This microcontroller is equipped with a built-in WiFi module, which greatly supports the design of systems that can be controlled remotely via the internet, also known as IoT [6].

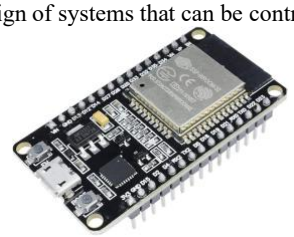

Fig. 1: NodeMCU ESP32

2.2. Base Plate ESP32

The ESP32 base plate is a support board for the NodeMCU module designed to facilitate cable connections in the system design process. This board provides expansion pins with a distance of about 28 mm between GPIO pins, which is compatible with the NodeMCU ESP32 configuration. The dimensions of this base plate are 60 × 60 × 11.6 mm. The use of a base plate is very helpful in the prototyping and development process of ESP32-based projects [7].

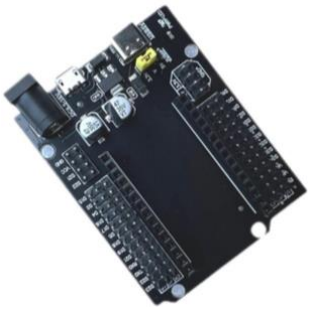

Fig. 2: Baseplate ESP32

2.3. RFID

RFID is a sensor that uses electronic activity to actively identify, track, and store the UID data previously stored in RFID tags or cards using radio waves. The data can be detected or captured by this sensor. RFID technology is an automatic wireless data collection system consisting of two parts: the tag (transponder) and the reader. The RFID reader can detect silicon chips that respond to radio wave signals, where the chips generally contain unique identifiers [9].

Fig. 3: Radio Frequency Identification (RFID)

2.4. Selenoid Door Lock

Selenoid Door Lock is an electronic door security device that utilizes a solenoid as the main mechanism to automatically open and lock the door. The solenoid itself is an electromagnetic coil designed to operate at a voltage of 12V DC. When electric current flows through the wires in the solenoid, a magnetic field is generated and used to automatically operate the locking system [10].

Fig. 4: Selenoid Doorlock

2.5. Buzzer

An electronic device that converts electrical vibrations into sound vibrations is called a buzzer. Because the way a buzzer works is basically the same as a loudspeaker, a buzzer also uses a coil that is connected to a diaphragm and powered by a current to function as an electromagnet. Depending on the polarity of the magnet and the direction of the current, the coil will be pulled in or out [11]. This audio device is commonly found in door bells, alarm clocks, reverse alerts in vehicles, anti-theft circuits, and other danger warning systems [12].

Fig. 5: Buzzer

2.6. Lampu LED RGB

One of the various types of semiconductor devices that produces light when an electric current flows through it is the LED (Light Emitting Diode). The type of semiconductor material used determines the color of the light emitted by the LED [13]. Red, green, and blue light can be emitted by RGB LEDs. RGB stands for the three colors in English: R for red, G for green, and B for blue, and it is a type of light source that can emit three different colors in one unit [14].

Fig. 6: Lampu LED RGB

2.7. Relay

A relay is an electrically controlled electronic component that has the same function as an electronic switch. Devices such as water pumps, lights, and other electronic equipment use relays to control the flow of electricity. Relays allow microcontrollers like the Arduino Uno and NodeMCU to control electrical devices [15]. Razor defines a relay as a device that drives its contacts using the principle of electromagnetism. The electric current flowing through the relay coil creates a magnetic field that causes the contacts to open or close [16].

Fig. 7: Relay

2.8. Cable Jumper

Jumper cable, or also known as a connecting cable, is an electrical cable used to connect components in an electronic circuit, especially on a breadboard, without the need for soldering. This cable is equipped with connectors at both ends, consisting of a male connector (sharp end to be inserted) and a female connector (hollow end to be connected). Based on the type of connector, jumper cables are divided into three types: Male to Male, Male to Female, and Female to Female [17].

Fig. 8: Cable Jumper

2.9. Smartphone

A smartphone, or as it is still called in Indonesian, 'smartphone', is a portable electronic device designed with special capabilities. The main advantage of this device compared to other electronics is its ability to continuously evolve through various cutting-edge technological innovations, making it a very helpful tool in daily life [18].
In general, smartphones are used as communication tools. However, with the various advanced features they possess, their usage has become increasingly diverse. Many people utilize them to browse the internet, access social media, enjoy entertainment, and support learning and working activities [19].

2.10. Arduino IDE

Arduino IDE itself is software specifically designed to assist the programming process on Arduino microcontrollers. This software combines various essential features such as code management, compilation, and uploading programs to Arduino boards in one interface. Because it uses a simpler programming language, such as a derivative of C++, Arduino IDE is very suitable for beginners who are not yet familiar with the world of programming. In addition, Arduino IDE also integrates elements from C++ and Java, making it flexible yet easy to understand in developing various microcontroller-based projects [20].

2.11. Telegram

Telegram Messenger is one of the instant messaging applications that has various interesting features, one of which is the bot feature. Because Telegram is open source, users and developers can modify and manage the application according to their needs. Telegram Bot allows developers to efficiently collect sensor data, process that data into useful information, and send it to the Cloud via an internet connection using the Telegram Bot API [21].

3. Results And Discussion

After all the components of the circuit have been designed in the 'Design of Door Security System Using IoT-Based RFID at STMIK KAPUTAMA', the next step is to integrate all these components.

Fig. 9: The overall Hardware

3.1. Device Testing

After all the physical components are installed and the software program is completed, the next step is to conduct gradual testing of the device. This testing is done by testing each circuit separately and then gradually integrating their functions to ensure that the entire system operates well and according to plan.

3.2. Downloader Programmer Testing

The testing of this downloader circuit can be done by transferring a program from a computer to the NodeMCU ESP32 microcontroller. Ensure that the downloader is connected to the PC via a USB port. Write the program using the Arduino IDE software in C language, then compile and upload it to the microcontroller. If there are no errors during the upload process, then the downloader and microcontroller are in good condition.

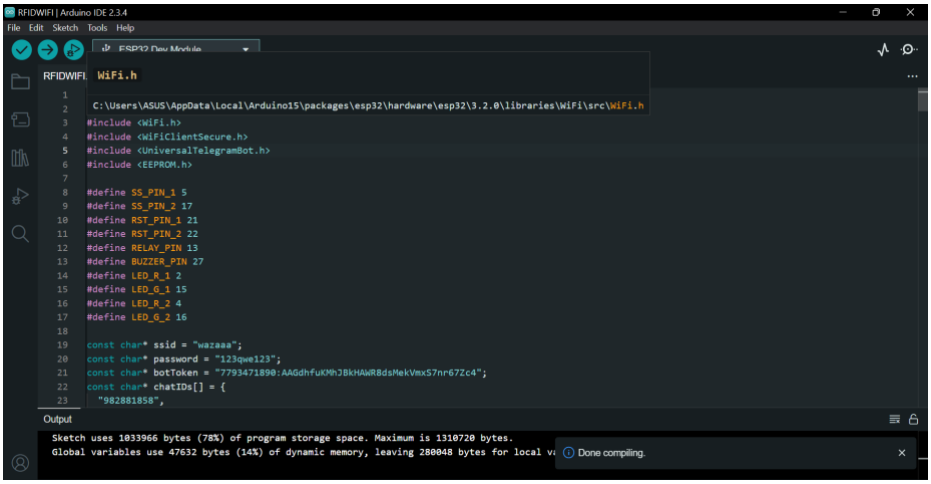

Fig. 10: Results of the Downloader Test

3.3. Hardware Testing Results

After the hardware is programmed and executed using the downloader, the program will automatically be uploaded to the microcontroller. This process ensures that all instructions and functions that have been designed for the hardware are correctly embedded within the microcontroller.

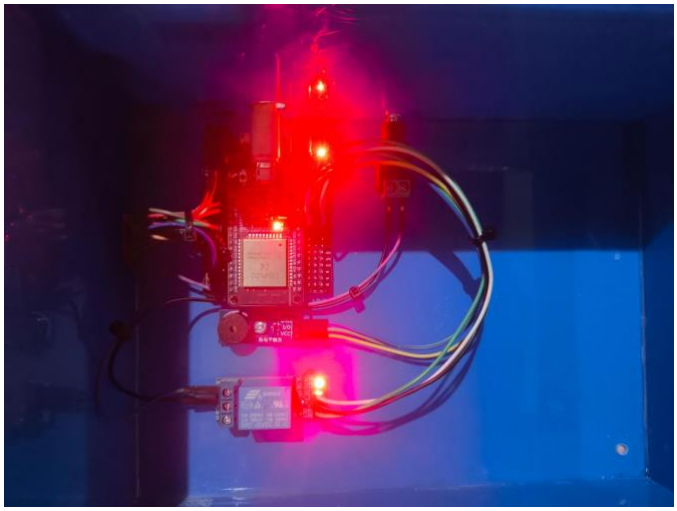

Fig. 11: Hardware Test Results

3.4. Results of Telegram Application Testing

The testing of the Telegram application was conducted to ensure that the system can respond correctly to user commands sent via the Telegram bot and according to the programmed functions. The Telegram application serves as a remote user interface to control the door opening system and to send notifications in real-time.

The commands that can be executed by the user include:

1. Open door, which opens the door automatically.
2. Open 10, which keeps the door open for 10 seconds automatically.
3. List cards, which displays the cards that have been registered.

Fig. 12: Results of the Telegram Application Testing

4. Conclusion

After completing the design and development stage of the system, the process continues with testing and analysis. Based on the results from all these stages, the conclusion that can be drawn is that the design of a door security device using IoT-based RFID can be implemented by utilizing a microcontroller such as the ESP32 connected to an RFID module (like MFRC522), a relay for door lock control, and supporting components such as a buzzer and LED as indicators. This system is designed so that only registered RFID cards can open the door. Card data can be stored locally (for example, using EEPROM), and the system can be developed to support remote access management via the internet. The way the door security device works in sending data to the Telegram application is done by connecting the ESP32 to a WiFi network and using the Telegram Bot API. Every time an activity occurs, such as an RFID card successfully or unsuccessfully opening a door, the ESP32 will send an automatic message to the designated Telegram bot. This allows the owner or manager of the system to monitor the door access status in real-time through the Telegram app on their mobile device.

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