



Design of a Prototype of ABK Door Security on a Ship with Fingerprint and IOT Sensors

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Abstract

The aim of this research is to design and build a security system for crew room doors based on a fingerprint sensor integrated with a microcontroller. This system is designed to ensure that only verified people can open and enter the crew's room. The main components of the system include Arduino Nano, LCD, Buzzer, Solenoid Door Lock, and ESP8266 Wemos D1 Mini module, with additional features in the form of notifications via Telegram when access is carried out or an unauthorized access attempt occurs. Users must register their fingerprints with the system in order to unlock the door. An automatic notification will be sent to Telegram every time the lock is accessed, and the system supports up to 100 registered fingerprints. Testing shows that the system is effective in improving security, with the highest success rates in users aged ≥ 25 years and male users. The age group ≥ 50 years and women had a lower success rate and a higher error percentage, which shows that system performance is influenced by the physical condition of the user's fingerprint. These findings provide important insights for the further development of fingerprint-based security systems in the future.

Keywords: Door Security, Fingerprint Sensor, Buzzer, Arduino Nano, LCD, Solenoid Door lock and ESP2866 Wemos D1 Mini.

1. INTRODUCTION

With population growth continuing to increase and rapid technological advances, security systems are one of the most important technological needs. The security system cannot be ignored because of the high crime rate, especially theft. Security systems are usually used in places or rooms where valuables or important documents are stored. There have been many innovations and developments in security devices that use technology to prevent criminal acts. Doors are the first layer of protection for personal spaces that store important items or documents. Although traditional locks are still used on many doors, criminals often find ways to tamper with them.

Various innovations and development of security devices that use security technology to prevent crime. Doors are the first layer of protection for personal spaces that store important items or documents. Although traditional locks are still used on many doors, criminals often find ways to tamper with them. The use of electronic technology, such as microcontrollers, produces more sophisticated security systems, and offers creative solutions. Fingerprint sensors, electronic devices that use fingerprint scanning to verify identity, are an example. The fingerprint sensor increases system security by ensuring that only registered people can access it. This allows people to improve security systems without relying on traditional locks. The way to use this tool is by placing your finger on the fingerprint sensor. This will open the electronic lock and door. Based on related problems, the author made research with the title "Prototype Building Design for Crew Door Security on Ships with Fingerprint Sensors and IoT".

2. LITERATURE REVIEW

Security Technology/Biometrics

Biometric technology is a system that utilizes parts of the human body to enable identification, using unique body features such as fingerprints, irises and the face. This technology is almost always used in various places to protect people's valuables. The fingerprint sensor stores data in the system. This security technology relies on body parts as identity, because the medical world recognizes that each person has unique body features (Ikhsan et al., 2022).

Sensor Fingerprint

The fingerprint sensor is a scanning device that performs two main tasks. The first is to take a picture of the user's fingerprint and then analyze the fingerprint flow pattern based on the registered data. Each finger has a fingerprint consisting of a ridge pattern and a groove at the tip. For centuries, fingerprints have been used to identify people. It has been shown to have a very high degree of accuracy (Maio, Maltoni, Cappelli, Wayman, & Jain, 2002). Fingerprints were chosen in this study because of their wide popularity in various applications, such as attendance systems, immigration, and building access. According to a report available in the Wall Street Journal, it is estimated that fingerprint recognition will remain the main option in the biometric market going forward. (Siswanto et al., 2018)

Arduino Nano

Arduino functions as the data processing center for the door security system, managing all input and output from connected components. Arduino Nano can be operated with a voltage between 6 to 20 Volts. There is pin 30 or Vin for external power supply, as well as pin 27 or 5V for regulated voltage of 5 volts. The system will automatically select a power source with a higher voltage. The FTDI FT232L chip on the Arduino Nano is active when getting power via USB, and the TX and RX LEDs on the digital pin and pin 1 show HIGH status (Tambusai & Widodo Education, 2021).

LCD (Liquid Crystal Display) A16x2

An electronic component whose function is to display characters such as text and numbers. This LCD is used to display information according to what has been programmed, the LCD module is formed from 8 rows and 5 columns of pixels, and the last row is the cursor.

Buzzers

This tool converts electrical energy into sound vibrations. The buzzer, as seen in figure 1, consists of a coil mounted on a diaphragm. When current is passed through the coil, the coil functions as an electromagnet. The movement of the coil causes the diaphragm to move back and forth, which in turn makes the air vibrate and produce sound. The sound produced is in accordance with the data entered (Kurniawan, 2024).

Door Lock Solenoids

A solenoid door lock is an electric door lock that uses electrical voltage to lock or open the door. The door lock solenoid operates with a voltage of 12V.

Push Button

The electronic component used to interact with the system is a push button. The opening or closing system is the mechanism that allows this push button to connect or disconnect electricity. The circuit remains in its normal position when the button is not pressed. By pressing it, this button can be used to connect to the operator. It is very important, especially for deactivating or activating circuits (Khalid et al., 2020).

Adapter

The working principle of an adapter is similar to a replacement battery or battery which functions as a power source. By using an adapter, all electronic devices that require a power source can utilize it. The adapter functions as a medium that changes a high voltage electric current to a lower one, so that the electric current produced is in accordance with the needs of the device used (Education Tambusai & Widodo, 2021).

White Connector

White Connector is a tool/connector for connecting one device to another device. White Connectors can have different pin configurations, such as 3 pins or 8 pins and are usually made of durable materials.

DC Socket Connector

Connectors in electronics engineering are electro-mechanical components that function to connect electronic circuits or devices to one another. There are two main types of connectors, namely plug connectors (male) and socket connectors (female). DC Socket or DC Connector is a connector used for cables that carry direct electric current (DC). DC connectors are usually cylindrical and have positive and negative polarity. Connector. This DC current is often used in adapters such as laptop adapters and telephone adapters

IC LM2596

LM2596 is a monolithic IC that functions as the main component in a DC step-down power supply circuit. This component provides all the active functions required for a step-down (buck) switching regulator, with the ability to handle up to 3A of current. As seen in Figure 1, the LM2596 can operate at a maximum switching frequency of 150 kHz, resulting in smaller filter components and lower switching frequency specifications.

Battery

Batteries store electrical energy in the form of chemical energy and then convert it back into electrical energy to produce the required current, so that it can be used to operate various devices. The current produced by the battery comes from a chemical reaction between the active material on the battery plates and the sulfuric acid in the electrolyte solution. Batteries can be recharged with direct current flowing in the opposite direction to the current used when operating. Under normal conditions, the battery is always charged by the alternator (Nasution, 2021).

Esp8266 Wemos D1

Wemos D1 is an advanced microcontroller based on the ESP8266 module, which is known for its ability to support the combination of various electronic components as well as the development of the Internet of Things (IoT). This microcontroller not only has the ability to interact with other devices via traditional electronic connections, but is also equipped with a Wi-Fi feature that allows these devices to connect to internet networks wirelessly.

3. RESEARCH METHODOLOGY

A. System Block Diagram

The system created in this research uses a Fingerprint sensor as a detection tool and controller for opening and closing locks on doors, Arduino Nano as a microcontroller, 16x2 LCD as a monitoring tool and Esp8266 to send and receive data. In figure 1, it uses a 12V power supply and a 12V battery as backup power. Push buttons are used to input data and delete data and also change the mode of the tool. When the Fingerprint sensor reads a fingerprint that has been registered, the LCD screen will display "Scan Successfully, Lock opened." When entering a fingerprint that has not been registered, the LCD

screen will display "Fingerprint Not Registered", then the Esp8266 will send a notification to Telegram according to the output issued. and also from telegram can command to unlock. If you make a mistake once, the buzzer will sound, then if you make a mistake three times, the buzzer will sound for one minute.

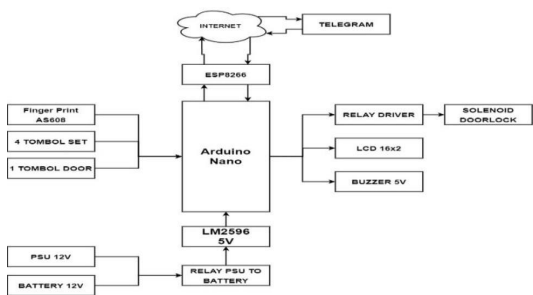


Figure 1 Blok Diagram

B. Tools Circuit Design

This component uses a 12V power supply and a battery as a 12V backup power, the Arduino Nano microcontroller which is integrated using a Fingerprint sensor functions as a tool to automatically detect fingerprints according to existing data, then the LCD will display text when the data entered is correct or incorrect, solenoid The door lock will move when the data is correct and the buzzer will sound when the data is entered incorrectly, once the data is entered incorrectly it will sound once and if it is incorrect three times in a row it will sound for 1 minute (Purnama et al., 2022).

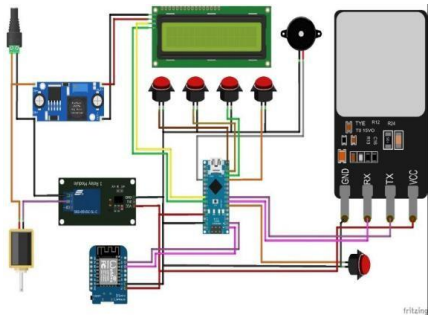


Figure 2. Tool circuit design

4. RESULTS AND RESEARCH

Product Trial

1. Component Tensting

a. Sensor fingerprint

The Fingerprint sensor is used to store fingerprint data that has been uploaded to this tool. The Fingerprint sensor has its own memory, storing a maximum of 100 fingerprints. The following is a Figure of 3 Fingerprint Sensor tests.

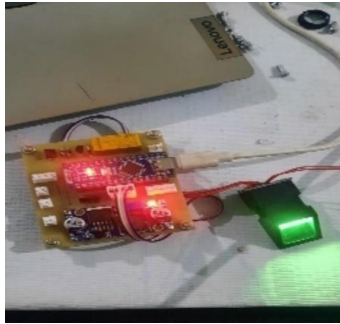


Figure 5 sensor fingerprint

b. LCD (Liquid Crystal Display) 16x2

The LCD in this tool functions to display notifications and information directly, the LCD makes it easier to see notifications, operating status and the mode used. The LCD in Figure 5 is the output of the tool programming.

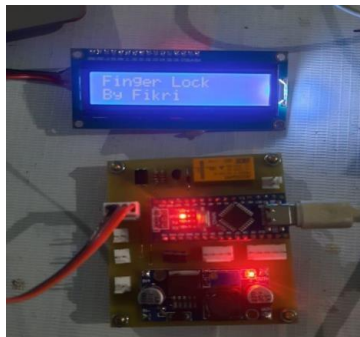


Figure 6. Testing LCD

c. Buzzer

Test the Buzzer component in Figure 6 by providing 3.3V DC power. The buzzer will be active when given input to find out whether the buzzer is functioning properly, first you have to check it first to make sure there are no problems with the buzzer.

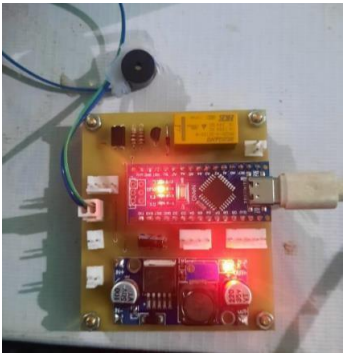


Figure 7 Testing buzzer

d. Solenoid Door Lock

Testing and checking the door lock solenoid aims to ensure that the solenoid functions correctly and well, there is nothing that could allow failure to occur. This solenoid functions as a lock in the crew's room on the ship

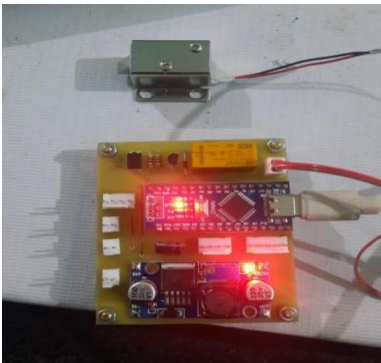


Figure 8. Testing solenoid door lock

e. Push Button

The push button in this tool has several important functions, such as manually deactivating the electrical circuit, as well as changing the mode so that you can input or register fingerprints and delete fingerprints that have been registered in the device's memory.

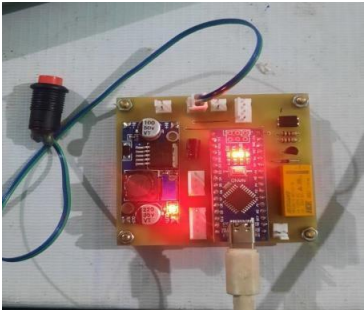


Figure 9. Testing Push Button

f. Battery

With this battery, the system can automatically switch from the main power source to the battery, ensuring that the power flow remains stable and uninterrupted. This is very important to prevent operational disruptions that can occur due to loss of power from the main source, so this battery is a crucial component in ensuring continuous power availability.



Figure 10. Testing Battery

g. Esp8266 Wemos D1

Esp8266 connected to the internet can be used to receive notifications online, for this tool notifications are connected to Telegram and can also command the tool to unlock Telegram.



Figure 11. Testing Esp8266 Wemos D1

2. Product Design

The process of assembling all components into one complete unit. Each component will be carefully installed on this acrylic miniature, ensuring that all elements are installed firmly and according to the specified design. This process not only aims to combine these components, but also to ensure that the system being built functions optimally in a form that is close to actual conditions.



Figure 12. Front view door

Figure 10 is the front of the device, there are several items such as the LCD which is used to display visual information, Fingerprint is used to detect fingerprints, there are four push buttons which function to change modes and upload data.



Figure 13. Side view of the door

Figure 13 is the right side of the device which contains two items, namely, a DC socket which functions to distribute power to the microcontroller and a switch which functions to cut off the power when it is no longer needed.

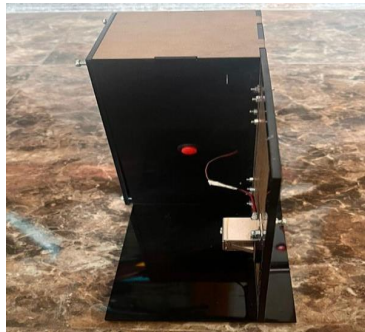


Figure 14. Left side view of the door

Figure 14 is the left side of the device which has a push button which functions to open the lock manually when in the room.



Figure 15. Rear view the door

Figure 15 is the back of the device which contains a door lock solenoid which functions as a lock on the door. The door lock solenoid will automatically open when Fingerprint reads the registered fingerprint and the solenoid will automatically lock when the door is closed again.



Figure 16. Top view of the door

Figure 16 is a security door prototype circuit that uses Arduino Nano and Esp2866 with a 12V power supply and a battery as a backup power supply

Test Results

Test results are a presentation of data obtained from experiments carried out to determine the effectiveness of performance

a. Aged male hand ≥ 25 years

Drawing finger	Appearance LCD	Buzzer	Telegram
 Right thumb		Doesn't sound	Scan Finger Berhasil, Pintu terbuka

 Left thumb		Sounds	Scan Finger Berhasil, Finger Belum Terdaftar
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Table 1 Present Data Male Hand ≥ 25 Years

b. Aged Female Hand >25 Years

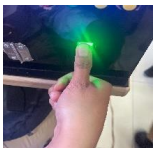
Drawing Finger	Appearance LCD	Buzzer	Telegram
 Right thumb		Doesn't sound	Scan Finger Berhasil, Pintu terbuka
 Left Thumb		Sounds	Scan Finger Berhasil, Finger Belum Terdaftar 14:54

Table 2 Present Data Female Hand ≥ 25 Years

c. Aged Male Hand ≥ 50 Yeras

Drawing Finger	Apperance LCD	Buzzer	Telegram
 Right thumb		Doesn't sound	Scan Finger Berhasil, Pintu terbuka
 Left thumb		Sounds	Scan Finger Berhasil, Finger Belum Terdaftar 14:54

Table 3 Present Data Male Hand ≥ 50 Years

d. Aged Female Hand ≥ 50 Years

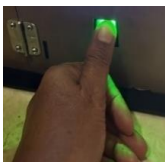
Drawing thumb	Apperance LCD	Buzzer	Telegram
 Right thumb		Doesn't sounds	Scan Finger Berhasil, Pintu terbuka
 Left thumb		Sounds	Scan Finger Berhasil, Finger Belum Terdaftar ₁

Table 4 Present Data Female Hand ≥ 50 Years**e. Table of Trial by Age**

Age Group	Number of Trials	Succes	Fail	Succes Rate %	Persentase Error %
≥ 25 years	10	10	0	100%	0%
≥ 50 years	10	9	1	90%	10%

Table 5 trial by age

The data above is the success rate and error percentage for each age group. The age group ≥ 25 years has the highest success rate of 100% and the lowest error percentage of 0%. Meanwhile, those over ≥ 50 years old have the lowest success rate at 90% and the highest error percentage at 10%. These results show that the performance of the Fingerprint system on this prototype can be influenced by age, possibly due to wet finger conditions or when the finger is injured.

a. Testing Table by Gender

Gender	Number of Trials	Succes	Fail	Succes Rate %	Persentase Error %
Male	10	10	0	100%	0%
Female	10	9	1	90%	10%

Table 6. Trial by Gender

From this data, the percentage of successes and errors between men and women is that women have the largest errors compared to men. Most of the errors experienced by women are due to the condition of their hands and fingers being wet or the shape of their fingerprints being irregular which results in injuries.

b. Trial ApplicationTelegram



Figure 17. Trial application telegram

This test is carried out when the tool and Telegram are connected online via an internet connection. This Telegram function is to receive notifications and at the same time to command the unlocking of Telegram. By carrying out this test, it is hoped that it will make it easier to control the tool from a distance.

Tools Performance

Make sure that the 12V power supply is always available and fulfilled to ensure the system can function properly. The first step in operating this system is to register fingerprints. The registration process is carried out through settings or modes that will be displayed on the LCD screen. In this system, there are four push buttons located above the fingerprint sensor, each of which has a different color to make navigation easier. The green button is used to change modes, while the two yellow buttons are used to choose between the option of registering or deleting fingerprints. The green button is also used to confirm the mode selection that has been selected, and the red button functions to return to the initial mode.

When you want to register a fingerprint, select the appropriate mode from the menu displayed on the LCD, namely "Add Finger Setting Menu". Once this mode is selected, the user will be asked to scan the finger twice on the fingerprint sensor until the LCD displays the message "Successfully Saved Finger". If the registration process is successful, the fingerprint will be stored in the system. On the other hand, if the user wants to delete a registered fingerprint, select the appropriate mode on the LCD, namely "Successful Erase Finger Deleted", then scan the finger twice. If the deletion process is successful, the fingerprint will be removed from the system.

To unlock the door, simply paste the registered fingerprint on the fingerprint sensor. If the fingerprint is recognized, the LCD will display the message "Scan Successfully Lock Unlock", and the door lock will unlock. However, if the attached fingerprint is not registered in the system, the LCD will display the message "Fingerprint Not Registered", and a buzzer will sound as a warning. If the error occurs three times in a row, the buzzer will sound for one minute as an additional warning sign.

In addition, all notifications or activities that occur during the operation of this tool will be sent automatically to the Telegram application, so that users can monitor and receive real-time information. Users can also give commands to unlock the door directly via Telegram, which provides flexibility in controlling door access remotely. Inside the room, there is a push button that can be used to open the lock from the inside, providing convenience for residents.

This system is also equipped with a backup power supply in the form of a battery which will activate automatically when the main power supply is no longer able to provide power. This ensures that the system remains operational even if there is a disruption to the main power source. The system's data storage capacity allows up to 100 fingerprints to be stored, providing flexibility for users in managing access to the door.

5. CONCLUSIONS AND SUGGESTIONS

Based on the discussion of this research, it can be concluded that the crew door security system on ships using fingerprint and IoT sensors can improve security and make access management more efficient. This design uses a PCB design, the power supply required is 12V. This tool will store fingerprints according to the input data and a maximum of 100 fingerprints of input data, the LCD will display the results of the data processed by the Arduino nano microcontroller, the Esp8266 will send notifications to Telegram, and Telegram can order to open the lock on the door. There is a push button inside to open the lock when inside and there is a power reserve that comes from a battery that has 12V power according to component requirements.

Bibliography

- Aldoni, F., & Mukhaiyar, R. (2022). Arduino Based Automatic Fish Seed Counter Tool. *Research Domain: Journal of Multidisciplinary Research and Development*, 4(2), 123–130. <https://doi.org/10.38035/rj.v4i2.443> accessed January 3, 2024
- Dita, P. E. S., Fahrezi, A. Al, Prasetyawan, P., & Amarudin, A. (2021). Door Security System Using a Fingerprint Sensor Based on the Arduino UNO R3 Microcontroller. *Journal of Computer Engineering and Systems*, 2(1), 121–135. <https://doi.org/10.33365/jtikom.v2i1.111> accessed January 4, 2024
- Ikhsan, M. N., Ibrahim, I., & Rahmadewi, R. (2022). Motorcycle Security System with Fingerprint Biometric Technology Using the R305 Fingerprint Sensor. *STRING (Technology Research and Innovation Writing Unit)*, 7(2), 144. <https://doi.org/10.30998/string.v7i2.13797> accessed on January 8, 2024
- Kurniawan, E. (2024). Design of a Fresh Water Generator Performance Monitoring System Using Arduino Mega 2560 Romanda Annas Amrullah component parts which can cause a decrease in the amount of fresh water production. *Like*. 2(3). accessed on January 13, 2024
- Nasution, M. (2021). Specific Characteristics of Batteries as Electrical Energy Storage. *Print) Journal of Electrical Technology*, 6(1), 35–40. accessed on January 16, 2024
- Education Tambusai, J., & Widodo, B. (2021). Design an Automatic Parking Information System by Determining Parking Positions Based on Telegram Using Arduino Mega2560. *Tambusai Education Journal*, 5(3), 7055–7074. accessed on January 19, 2024
- Purnama, A., Fauziah, F., & Nathasia, N. D. (2022). Smart Counter on Transjakarta Bus Capacity Using Infrared Sensor Based on Arduino Uno Atmega328. *JIPi (Scientific Journal of Informatics Research and Learning)*, 7(1), 175–185. <https://doi.org/10.29100/jipi.v7i1.2623> accessed January 21, 2024
- Siswanto, A., Efendi, A., & Yulianti, A. (2018). Home Door Access Control Tool Using Fingerprint Technology in a Smart Home Environment with Encrypted Data. *Journal of Postal and Informatics Research*, 8(2), 97. <https://doi.org/10.17933/jppi.2018.080201> accessed 3 February 2024
- Yalandra, H., & Jaya, P. (2019). Personal Room Door Security Design Using Arduino Based Fingerprint Sensor. *Voteteknika (Vocational Electronics and Informatics Engineering)*, 7(2), 118. <https://doi.org/10.24036/voteteknika.v7i2.104347> accessed March 3, 2024
- Yudhana, A., Sunardi, & Priyatno. (2018). Design of Home Door Security Based on Fingerprints Using the UML Method. *Journal of Technology*, 10(2), 131–138. <https://dx.doi.org/10.24853/jurtek.10.2.131-138> accessed March 13, 2024

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