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Safe Lock Security Prototype Using Fingerprint and PIN

Abdul Zain[1], Muh. Ikhsan Amar[2] , Aprizal Resky[3] , Andi Ika Putriani[4], Nur Imansyah[5]
[1,2,3,4] Institut Teknologi Bacharuddin Jusuf Habibie, Jl. Balaikota no.1, 91125 Parepare, Indonesia
[5,] Sekolah Tinggi Teknologi Bontang, Indonesia
[1]abd_zain@ith.ac.id , (Corresponding Author), [2]ikhsan.amar93@ith.ac.id, [3] aprizalresky@ith.ac.id,
[4]andiikaputriani497@ith.ac.id , [5]n_imansyah@yahoo.com

***Abstract*— In general, security safe box is currently still using key combination that has some drawbacks. One of the weaknesses is the risk of lossing of the keys and forgetting the lock codes that impact at users of not being able to operate the safe box. Therefore, the researcher is designing a tool that is more practical and safe that can replace the key of security safe box. In the research, the researcher uses the method of fingerprint and a PIN by designing a circuit input tool using the output fingerprint sensor and keypad. For the series of processor,the researcher applies the Arduino microcontroller Uno R3 while for series output the researcher applies three output circuit such as LCD, Buzzer, and Selenoids. Security tool safe box can only be operated by entering PIN and fingerprint which have been registered. Hence, the users do not need to save an object to operate the safe box. Based on the results of testing, this tool is able to open the safe box by inputting 5 registered ID interchangeably as much as 25 times. The Solenoids then are able to operate when they are given voltage > 9, 5V 350 mA to 12V 800 mA.**

Keywords*— *Arduino, Key, Fingerprint, Selenoids, Safety box.

I. Introduction

Theft is a crime that is very detrimental and prone to occurring, there are various types, one of which is theft of valuables such as money and jewelry. In an effort to overcome the risk of theft of valuables, the creation of a device called a safe has been encouraged [1]. A safe is a place to store valuables that is considered practical and reliable. In general, safe security systems use a combination lock security method [2]. However, the combination lock security method does not fully help in the security of the safe, because if a potential crime occurs when the owner is not there, thieves can easily penetrate the security of the safe by listening to the "click" sound of each disc that is rotated to release the peg mechanism [3].

Technological advances, especially in the field of security systems on safe doors, will provide enormous benefits for the security of valuables in the safe itself. The fingerprint security method is an identification security method by means of a fingerprint sensor (fingerprint) that reads human fingerprints as identity data, this security method is more practical in its use because it only needs to enter the registered fingerprint data. This fingerprint method requires several electrical components, namely Arduino Uno R3 as an information processor from the Fingerprint and a relay to change the signal from the Arduino to move the solenoid [4], [5].

The FPM10A Fingerprint Sensor is a fingerprint sensor that can identify a person's fingerprint that has been registered on the sensor by means of an optical scanner. The core of the optical scanner is the Charge Coupled Device (CCD) [6],[7]. The scanning process starts when a person places a finger on a glass plate and a CCD camera takes a picture. The scanner has its own light source usually an LED to illuminate the fingerprint groove. Before comparing the newly captured image with the stored data, the scanner processor ensures that the CCD has captured a clear image by checking the average pixel darkness, and will reject the scan if the image is too dark or too bright. If the image is rejected, the scanner will then try to capture the image once again. If the darkness level is sufficient, the scanner system continues to check the image definition, which is how sharp the scanned fingerprint is. If the definition of the fingerprint image meets the requirements, the processor will then compare the image with the fingerprint image in the database. The result can be known in a very short time whether a person is registered or not.

Arduino Uno is a development board based on the ATmega 328P-20PU microcontroller. This board has 14 digital pins for communication (I/O pins) with 6 of them can modulate PWM output (pulse width modulation, simulating analog output), 6 analog inputs (digitized

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using an internal ADC / Analog-to-Digital Converter), a 16 MHz oscillator, a USB connector, a power supply plug, an ICSP header, and a reset button. This board has everything needed to support access to the microcontroller being used, to power it up simply connect the board to a computer via a USB cable (USB powered) or by plugging in an adapter/battery cable with a voltage between 7 and 12V. As a USB driver, the Uno R3 uses an Atmega 16U2 chip (the R2 still uses an Atmega8U2 chip) that is programmed to convert USB (Universal Serial Bus) signals to TTL serial signals [7]-[12]. The Arduino uno tool can be seen in Figure 1 and the tool description can be seen in Table 1.

Figure 1. Arduino Uno R3

Table 1. Description of Arduino Uno R3

Microcontroller	ATMega 328
Operating Voltage	5 V
Input Voltage (Recommendet)	7-12 V
Input Voltage (Limit)	6-20 V
Digital I/O Pin	14 (of which 6 provide PWM output0
Analog Input Pin	6
DC Current I/O Pin	40 mA
DC Current For 3,3 V Pin	50 mA
Flash Memory	32 KB
SRAM	2 KB
EPROM	1 KB
Clock Speed	16 MHz

Relay described in research [2]. Relay is an electrically operated switch that consists of 2 main parts, namely Electromagnet (Coil) and Mechanical (a set of Switch / Switch Contacts) Relay uses electromagnetic principles to move the Switch Contact so that with a small electric current (low power) can deliver higher voltage electricity. For example, with a Relay that uses 5V and 50 mA Electromagnets are able to move the Relay Armature (which functions as a switch) to deliver electricity up to 220VAC 2A or 24VDC 10A. The Relay tool can be seen in figure 2.

Figure 2. Low Active Relay

Explanation of Liquid Cristal Display (LCD) can be read in research [1] explained that LCD (Liquid Crystal Display) is a very effective and efficient data display media. LCD (Liquid Crystal Display) module measuring 16 characters x 2 lines with backlighting facilities has 16 pins consisting of 8 data lines, 3 control lines and power supply lines. LCD (Liquid Crystal Display) is often used to display the desired results of a particular project or tool as information provided. The LCD tool can be seen in Figure 3.

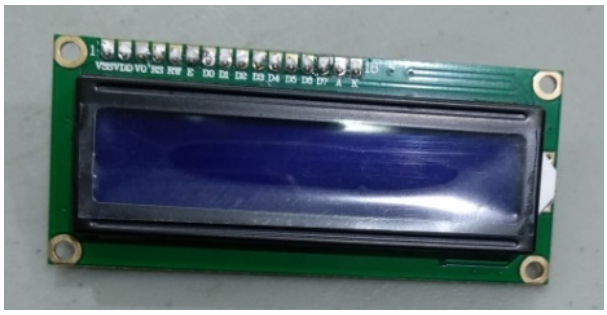

Figure 3. LCD 16 x 2

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The principle of the solenoid itself will work as a lock and will be active when given a voltage of 12V. Inside the solenoid there is a wire that is coiled on an iron core. When an electric current flows through this wire, a magnetic field occurs to produce energy that will pull the iron core into [5], [8], [12].

II. Research Methodology

To simplify system design, In the design of this tool using the fingerprint sensor input circuit and keypad then continued with the process circuit using the Arduino uno microcontroller and Relay as a switch. For the output circuit, namely LCD, buzzer, and Selenoid. The design block diagram can be seen in Figure 4 and the schematic circuit of the device can be seen in Figure 5 and the security circuit of the device can be seen in Figure 6.

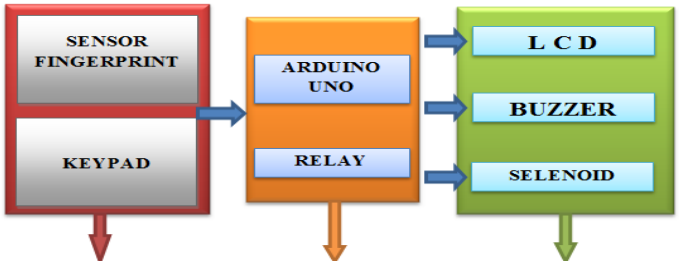

Figure 4: Block diagram of the circuit

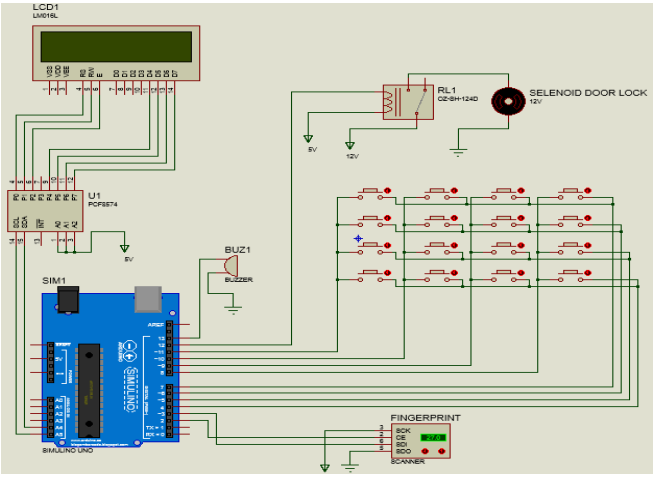

Figure 5. Schematic of the tool circuit

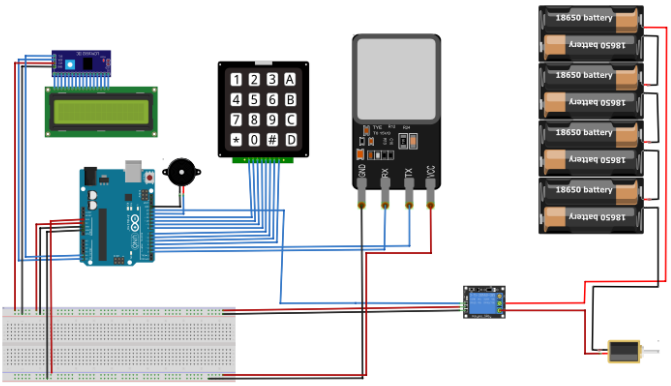

Figure 6. Security circuit

The description of the paths in Figure 6 shows:
1) Red path as positive path (+).
2) The black path as a negative path (-).
3) Blue line as data line.

In the use of the FPM10A fingerprint sensor, it has 4 pins, as seen in the Figure 6 circuit. red line for the VCC working voltage line connected to the 3.3V Arduino Uno R3 pin, black line for the GND line connected to the Arduino Uno R3 GND pin, blue line for the TX line connected to pin 2.

The use of a 4x4 Keypad to input digit numbers has 8 pins with the same function, the design can be seen in the circuit Figure 6. The 8 pins are connected to the Arduino on pins 4-11.

The use of a 16x2 LCD equipped with an I2C module has 4 pins, as seen in the circuit Figure 6. red line for the VCC working voltage line connected to the 5V Arduino pin, black line for the GND line connected to the Arduino Uno GND pin, blue line for the SCL line connected to pin A5 and yellow line for the SDA line connected to pin A4.

The buzzer on this security device has 2 pins, namely VCC and GND as seen in the circuit Figure 6. VCC is connected to pin 13 of the Arduino and GND is connected to the Arduino GND pin.

Relay and Selenoid on this security tool have different pins Relay has 3 input pins, namely: VCC, GND, and Data which are connected to Arduino and its 3 output pins are connected to 2 Selenoid pins and 2 interconnected 12Volt voltage source pins. More details can be seen in Figure 6.

Steps to start and run the Arduino IDE software In microcontroller programming by opening the Arduino IDE software. It should be noted for the port connection,

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because it is at this port addressing that the microcontroller can communicate with the computer via serial communication, in Figure 7. the port connection is set to port 3. Setting the port connection on Arduino 1.0 is done so that when the programme is uploaded no errors occur.

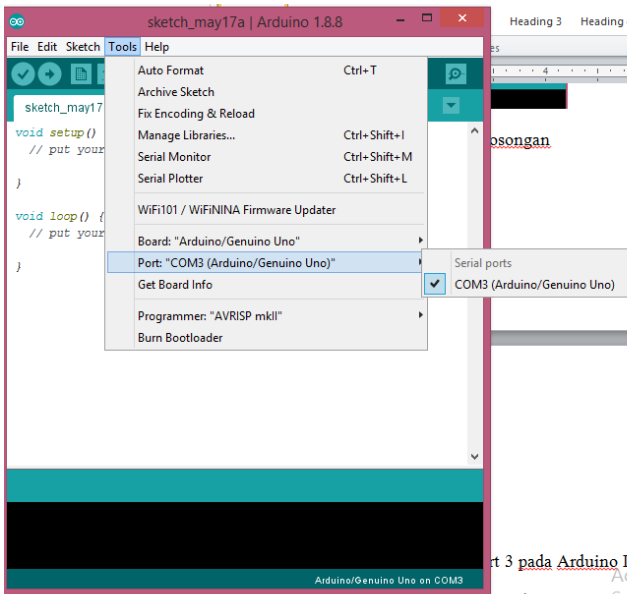

Figure 7. Specifying port 3 connection in the Arduino IDE

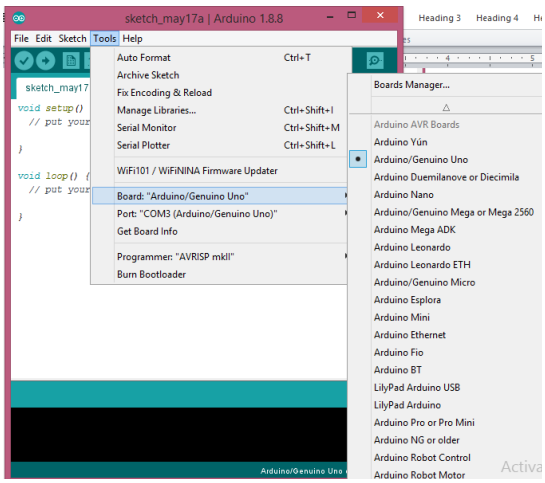

Figure 8. Selecting the microcontroller board type

Figure 8 shows the selection of the arduino board to be used, when you want to use the arduino board to be used, what needs to be considered is the type of arduino board, because arduino has many types that can be used in microcontroller projects. In making this project the author uses an arduino board with the type arduino uno / genuino uno.

After the arduino IDE opens, what also needs to be considered is how the results of the programme written in the arduino IDE can be saved with the .pde extension. In Figures 9 and 10, you can see the process of saving a project both to be created and already written which will be stored in a folder depending on where the desired drive is.

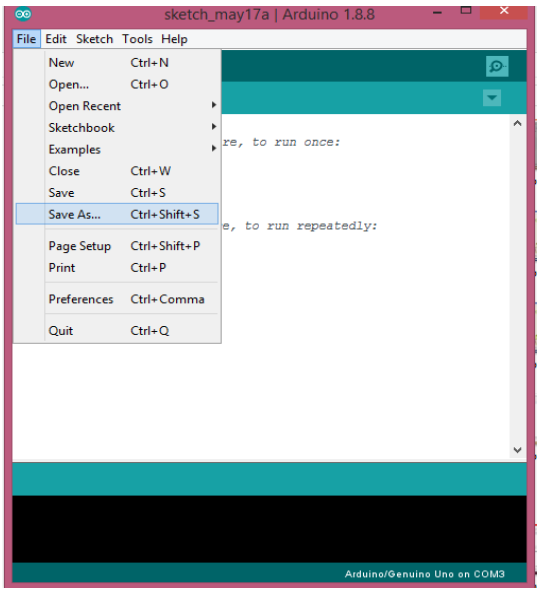

Figure 9. Performing a save

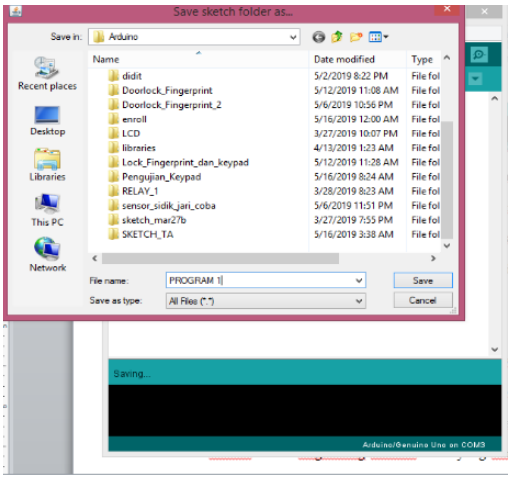

Figure 10. selecting the project save location

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III. Results and Discussion

A. Prototype Tool Results

Safe lock security tool is made by using the Arduino IDE programme by utilising the program compiler for Arduino uno R3 microcontroller, by listing the command programme on the tool. Layered security tool safe lock using PIN and Fingerprint. The input circuit in this tool is a series of Fingerprint sensors and PIN buttons, the prototype packaging made places the PIN numbers and fingerprint sensors in front of the door. The output circuit on this tool consists of an LCD circuit, a buzzer circuit and a solenoid circuit. The prototype made can be seen in Figure 11.

Figure 11. Prototype tool results.

B. Testing

In testing the safe lock security device, the first thing to do is test the sensor circuit. Testing is done by entering five registered fingerprint IDs 25 times continuously to find out how durable the sensor is in identifying as shown in Figure 12.

Figure 12. Fingerprint sensor testing process

Based on the results of testing the safe lock security tool both from testing the input circuit and the output circuit. The results of the sensor test were carried out by entering five IDs alternately 25 times with the result that the Fingerprint sensor can read five IDs that have been registered 25 times from each ID without experiencing problems. Output circuit testing is carried out on the output components of the tool to determine the amount of voltage in each component condition.

Table 2: Test results of the output circuit of the safe security device

Testing the safe lock security device			
Tool Condition	Buzzer (ON/OFF)	LCD (ON/OFF,V)	Selenoid (ON/OFF,V)
Safe Security Activated	OFF	ON,4.93V	OFF,0V
PIN Input	ON	ON,4.92V	OFF,0V
PIN Correct	ON	ON,4.78V	ON,11.36V
Fingerprint Input	ON	ON,4.91V	OFF,0V
Fingerprint Enrolled	OFF	ON,4.78V	ON,11.36V
Incorrect Fingerprint	ON	ON,4.91V	OFF,0V
Incorrect PIN	ON	ON,4.92V	ON,11.36V
Incorrect PIN Three times	ON	ON,4.91V	OFF,0V

Based on the data from Table 2, the test results of the safe key security tool can be stated that each component has operated properly.

Selenoid door lock testing is done to find out whether the Selenoid door lock can operate according to different input voltages. Testing is done by giving 4 different voltage values to the Selenoid door lock. The results obtained from the Selenoid test can be seen in Table 3 below.

Table 3. Solenoid test results

Selenoid Testing		
Voltage	Description	Active Duration
9V	X	0
10V	√	0,63
11V	√	0,55
12V	√	0,34

From the test results, the selenoid can operate with a source of 10-12V 350mA. The greater the voltage value given the faster the duration of solenoid operation. but the

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solenoid cannot operate when given a source of 9V 350mA.

IV. Conclusion

The results of the analysis and testing obtained, the authors draw the following conclusions:

1. This safe lock security tool can secure the safe by using fingerprints and PINs that have been registered as inputs to operate the tool with Arduino Uno as an information processor that can send signals to relays to operate the solenoid as a safe door lock.
2. In sending data to the device, it is programmed so that unregistered fingerprint and PIN data is limited to three or more times. So that if the fingerprint or PIN entered is not registered three or more times, Arduino will send a signal to the Buzzer to sound an alarm. And when the fingerprint and PIN data entered either using a fingerprint or PIN is correct or registered, the programme will recalculate the number of failures.

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