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Door Lock System Using Fingerprint

Muhammad Hazmie Naim Ahmat Kamil[1], Mohammad Nazmi Mohamad[1], Mohammad Aizat Razali[1], Mohd Sabani Mohd[1*]

[1]Department of Electrical Engineering, Center for Diploma Studies,
Universiti Tun Hussein Onn Malaysia, Pagoh Education Hub, 84600 Pagoh, Johor, MALAYSIA.

*Corresponding Author Designation

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Abstract: On this report, the significance of the proper security level is being highlighted due to the security concern on the crimes activities which are surprisingly increased over a year. The thief and robbery activities that kept happening among the citizens are the proof that the security level that is used nowadays are still weak and not entirely effective to restrain the problems or constrains that related to the security concern. It can even cause traumatized among the victims or worse causing death. So, this paper is intended solely to introduce the most secure modern device that is used widely on the premise or buildings to protect its nature, which is the fingerprint sensor. It is able to make verification by using fingertip which is the one of the biometric identification that is used to verify the user. So, the problems such as lost, theft or duplicate or anything else that are often heard when they were using the conventional key to open the door can be solved. Moreover, this paper will also include the main objective, which is to design the prototype of the door lock system using fingerprint. Methodology that is being used are based on the SDLC process where all the 7 process involved to ensure the established system are stable and easy to use. Several important parts are described in detail such as the material, the methods, the designing process and also the implementation process with the aid of flowcharts and block diagrams. Furthermore, this paper also included the several experiments that is conducted mainly to learn in-depth on the characteristics of the related topics such as the accuracy of the fingerprint scanner, the range of Bluetooth module and also the entire system.

Keywords: Fingerprint sensor, Door Lock, Arduino

1. Introduction

Today, the world has followed the currents of modernization where the most human activities have been enhanced and improved and even replaced by something called technology. Human Development and Research (RnD) in this field of technology has brought great changes in improving human abilities and feasibility in various fields such as economic, social as well as in other fields. It is common

**Corresponding author: sabani@uthm.edu.my*

knowledge that the threat of crime can occur anytime and anywhere and even it can happen to anyone such as burglary and robbery. This has proven that the safety aspect should be given priority in daily life. As such, we are honored to discuss in more detail about one of the security devices known as biometric scanning or fingerprint scanning which is also our choice in this year -end project.

In general, biometric scanning can be used by using certain devices or tools such as fingerprint sensors to read and scan the user's fingerprint. It is a digital input device capable of scanning human fingerprints and processing those scans into digital images. The processing mechanism of the fingerprint scanner is also very simple, i.e. it will scan the fingerprint and then will compare the processed image with the previously registered fingerprint. If the two matches are successful, then the device will allow such security controls and vice versa.

Term Wireless Communication is defined by the International Telecommunication Union (ITU) as the broadcasting, emission or reception of any signal, signal or message by electromagnetic waves. This advanced wireless digital technology and its practical use allows security problems such as radio bypass or interference in conventional analog virtual communication systems to be fixed and improved. In the opportunity of advances in technology, it also allows it to spread into various fields including the disaster prevention sector, criminal activities, security inspection, protection, health and wellness, transportation and logistics, and monitoring and control of buildings and facilities. Network services in the communications industry have moved fast in line with the demand of consumers who want faster speeds and levels of communication. The development from 1G to 4G and now to LTE and further to 5G has accelerated the rate of progress in most technologies.

In addition, Bluetooth is a wireless communication technology that allows devices such as smartphones, computers or peripherals to transmit data wirelessly over short distances. The use of Bluetooth is intended to replace the use of wires to connect between one device to another. Bluetooth is a technology capable of exchanging data between devices over short distances. Most Bluetooth technologies have a maximum range of 30 feet or about 10 meters. Bluetooth operates using various and variable frequency rates. Bluetooth technology uses low energy and cost and is also very stable and free from the interference of other mobile devices. Even so, the Bluetooth range and transmission speed are lower than WI-FI which is around 24Mbps. But, Bluetooth has also improved in terms of speed and range.

2. Materials and Methods

This section is intended to explain in detail about the project structure, the method, design and implementation that is used to construct the whole system of the project. This section begins with the project material, which is the equipment and tools needed in the project. Next, in the method section, the methods that are being used for the implementation of the project will be described wholly and lastly, design and implementation section where the process of the project implementation will be clarified in detail.

2.1 Materials

On this section, all the materials, equipment and other resources that are being used will be described and specified. In- depth study and research about the project have been done to ensure that the selected material and equipment are suitable and appropriate to use. The list of materials are Arduino Uno, Fingerprint sensor, Relay, Solenoid lock, HC-05, RTC, Power adapter 12V, LCD, Buzzer, and LED.

In addition, 2 push buttons, a breadboard, Jumper wires, resistors, and USB cable is also included on this project which the function of each material has been determined to be complied with the objective of the project. All the materials and equipment are in available in the market with the reasonable price.

2.2 Methods

This section purposely to clarify an appropriate process sequences throughout the course of this project. Then, the detail that is related to the development or methods is also included. The procedures taken on this project have been analyzed in critical and practical ways to give an assurance that the project can be developed and constructed. The details about the methods and process sequences can be shown as in Figure 1 below.

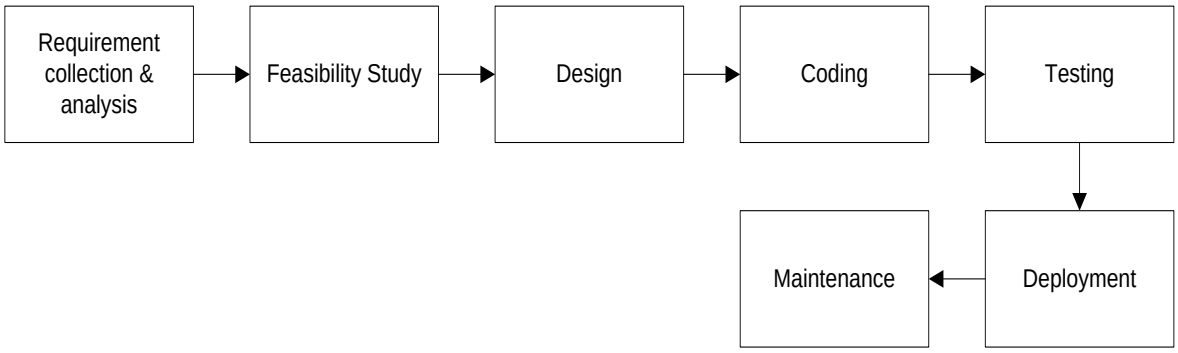

Figure 1: Block Diagram of SDLC

As in Figure 1, the methods and process that is used on this project is defined based on the SDLC (Software Development Life Cycle) with the coherent of 7 phases, which is the Requirement collection and analysis, which the scope of the project that is needed in this course will be analyzed in order to filter the possible and impossible project so that the most relevant topic will be chosen, the feasibility study, which is the related research and paper work of past studies will be surveyed in more detail so, it could be adjusted and fitted in our project. Next, the design process, which the suitable paper work and a schematic circuit will be constructed for the project purpose. Furthermore, the coding process where the instructions and process of the components used will be programmed so, it could work exactly as an expected output. Next is testing part where the output produced by the components and equipment will be analyzed whether the output produced adhered to the scope of the project or not. Next, is the deployment process, some pilot test to the whole operating system will be conducted and lastly, the maintenance process, where the errors and problems occurred while running the entire system will be fixed and eliminated if needed to.

2.3 Design and Implementation

This section gives the entire details about the process involved during the implementation of the project. This section consists of 3 major parts denoted as hardware implementation where we describe in detail the manual operation of circuit connection from a scratch, software implementation where it clarifies the software used in order to manifest the system so, it could work as expected and lastly the system operation part where the process of the entire system will be described and clarified in detail.

2.3.1 Hardware Implementation

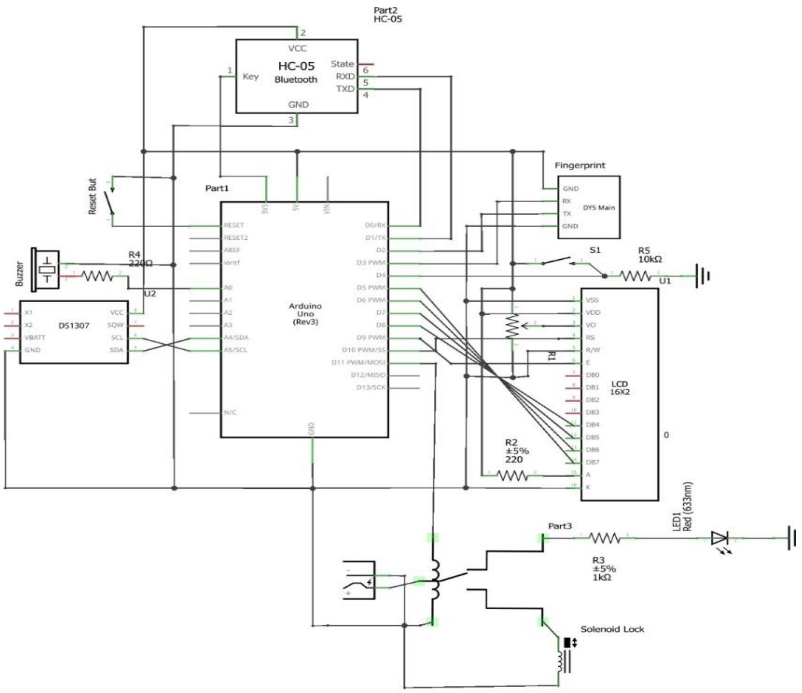

Figure 2: Schematic Circuit

As in Figure 2, one Arduino board is chosen, which is Arduino UNO because of its feasibility to do heavy work and the compatibility with the programming software apart to its simple and compact design. The fingerprint sensor for TX and RX pin are located in Arduino pin 2 and 3 respectively. Because of the Arduino UNO provide TX and RX pin only for pin 1 and 2, the library function namely as *SoftwareSerial.h* must be added in order to allow users to create their own TX and RX terminal on the unused pin on Arduino. Apart from that, the library function of *Adafruit_Fingerprint.h* that used solely to get the fingerprint sensor function is also needed so, the code can be created and edited based on our desired. Next, LCD 16X2 is also included, which is used to indicate and display the state and condition of the system and it uses *LiquidCrsytal.h* to function. The connection of pin EN, RS, D4, D5, D6 and D7 are located at pin 10,9,8,7,6,5 respectively on Arduino board. Next, for RTC or also called as Real Time Clock is also included where it has the ability to store the data of time, date and day in a long period of time due to its own backup power from a lithium battery. Moreover, it uses an i2c (inter-integrated circuit) protocol that uses 2 major pins, which is serial data wire (SDA) and serial clock wire (SCL) that mainly to establish communication between two or more IC's in a single system. Additionally, it uses *DS3231.h* library function to operate and pin SDA and SCL are located at the SDA and SCL pin on Arduino referring to the A4 and A5 on Arduino board. Moreover, the 1 channel relay is also included on this project. It is done to provide and establish the secondary circuit which it's included the power adapter 12V to be connected with the solenoid lock and triggered by relay coil and contact. Relay pin is connected on pin 11 on Arduino board. Apart from that, the component of HC-05 Bluetooth module that is used to receive the signal and control the Arduino board remotely by phone is also included. The connection of HC-05 is just like the fingerprint sensor where both needed TX and RX pin to operate. The original TX and RX pin on Arduino which is pin 0 and 1 is used to be connected to TX and RX pin on HC-05. In addition, the buzzer, push button and push button reset, and also LED is also connected with the basic connection on Arduino board.

2.3.2 Software Implementation

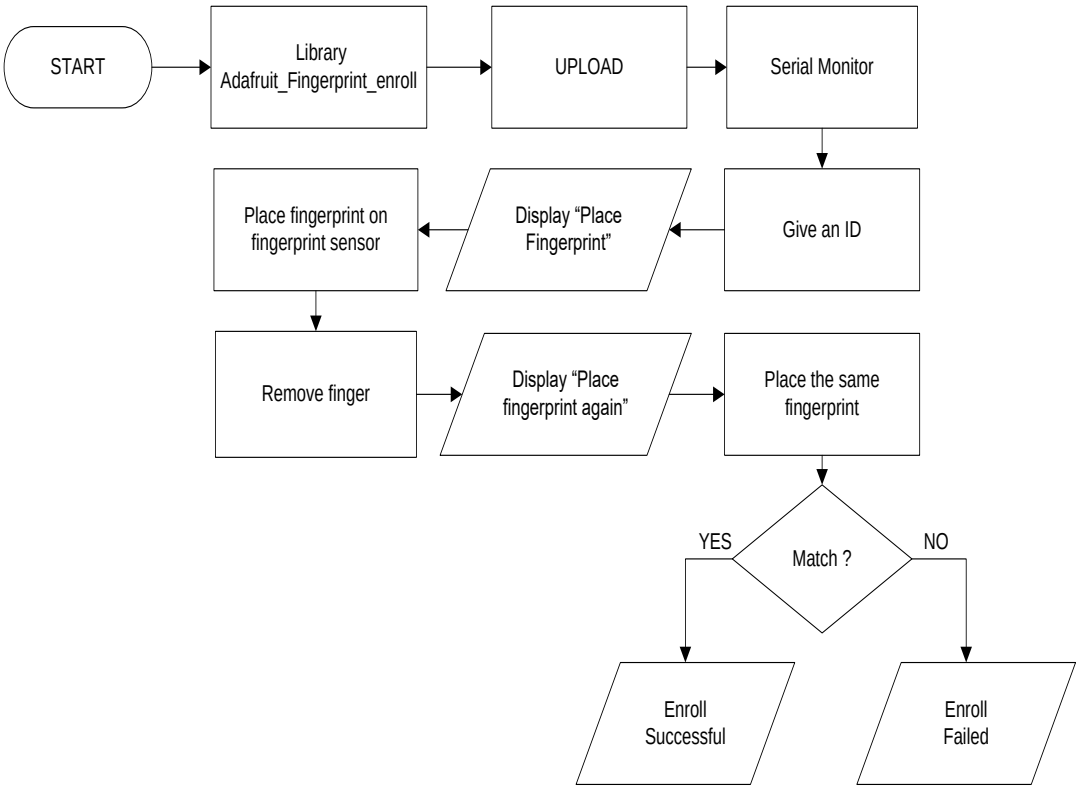

Figure 3: Flowchart of fingerprint verification

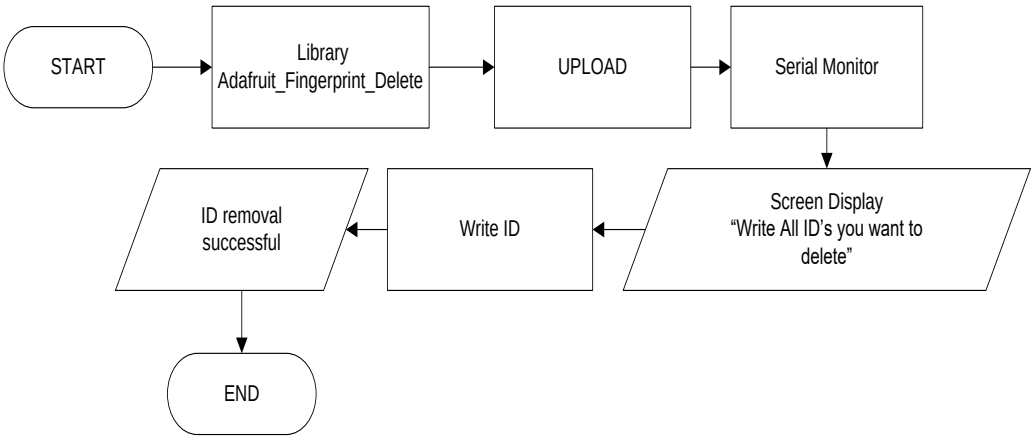

Figure 4: Flowchart of Fingerprint Deletion

Figure 3 shows the steps of the fingerprint verification process. For verifying an enrolled finger, the process is to place the finger and release it back and then place it again until the fingerprint verification process is success. Meanwhile**,** Figure 4 shows the steps of the fingerprint deletion process. It's simply type the desired IDs on the serial monitor and it will delete the fingerprint thoroughly.

Figure 5 shows the block diagram of the process sequence involved within the PLX-DAQ software system. PLX-DAQ is the abbreviation from Parallax Data Acquisition that is used to receive the data from serial monitor and send the data directly into spreadsheet in Microsoft Excel. It's user-friendly

and easy to navigate with vary of options. It is used in this project to record the data of people who got accessed on this system.

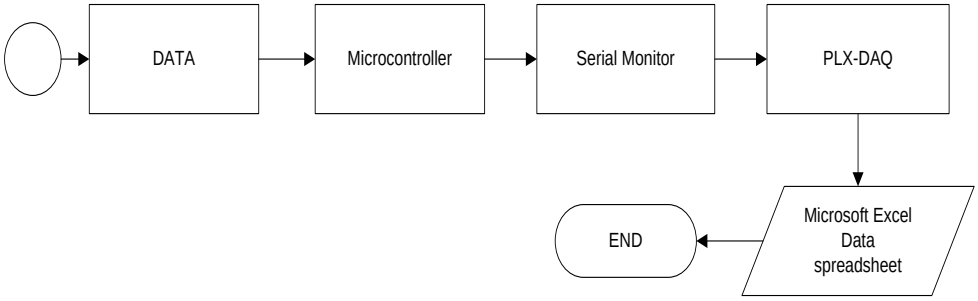

Figure 5: Block Diagram of PLX-DAQ Process

2.3.3 System Operation

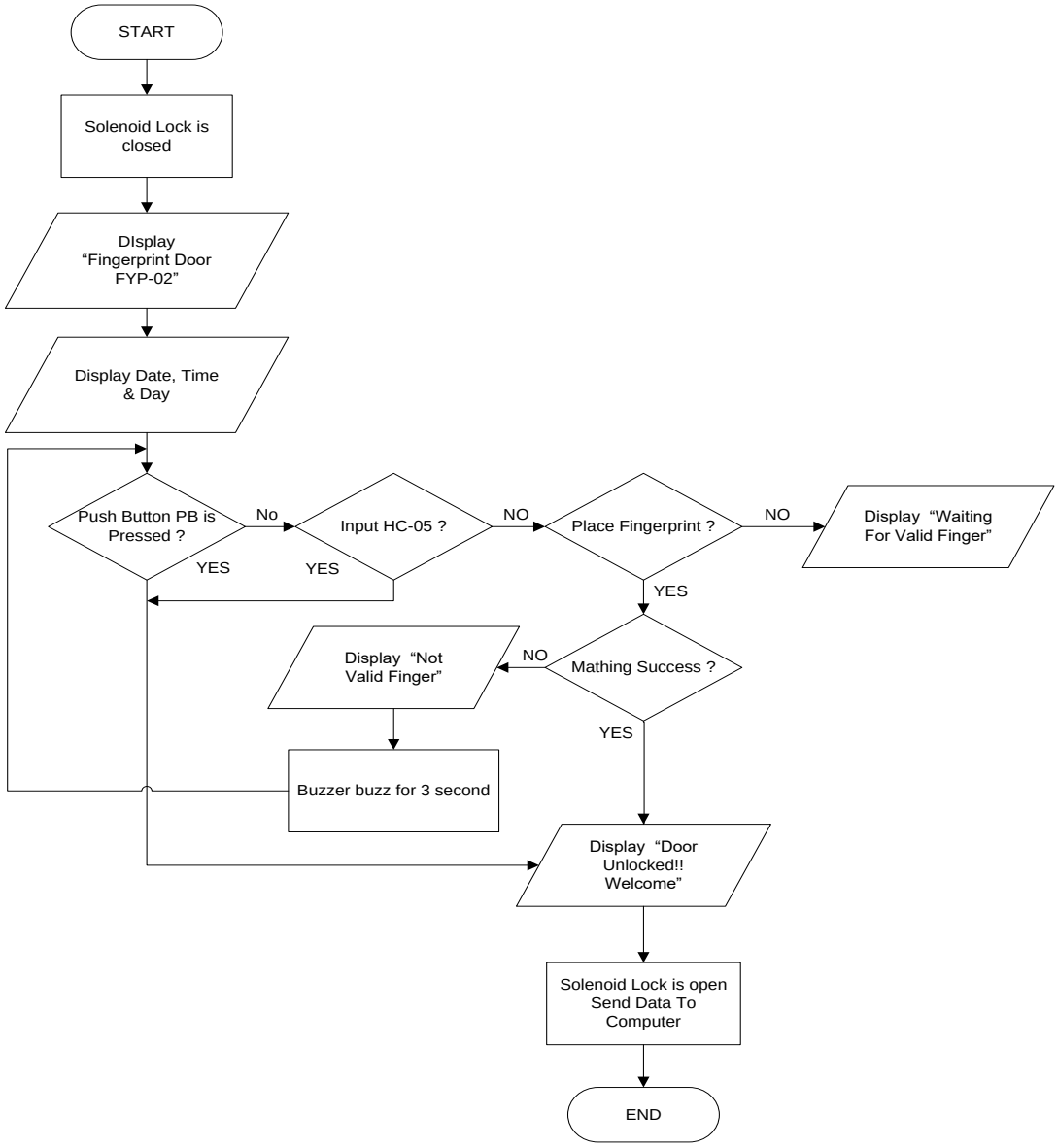

Figure 6: Flowchart of System Operation

The initial state of the project as shown in the Figure 6 shows that the solenoid lock is closed and the LCD will display the corresponding time, date and day. Next, there are three conditions that

may be able to open the solenoid lock. Firstly, is the push button where it is intended to open the door from inside the chamber so, generally it is for users to open the door from inside. Next, the project is also embedded with Bluetooth module HC-05 where it can receive the signal from phone. If there's any input signal from the phone obtained, it will go directly to the instruction that allows the solenoid to open and make the other instruction thereafter. And lastly, if there is no input received from the push button or HC-05, the system will make the fingerprint sensor in the standby mode. If someone who has access is trying to scan their fingertip, the relay will trigger and make solenoid lock to open. But, if someone who has no access trying to scan their fingertip, the relay won't trigger thus solenoid lock remains closed and the buzzer will buzz for 3 seconds.

3. Results and Discussion

In this section is a discussion about the result and analysis after a few experiments was conducted to see how the system behaved upon completion. These are the results to identify the functionalities of the individual components.

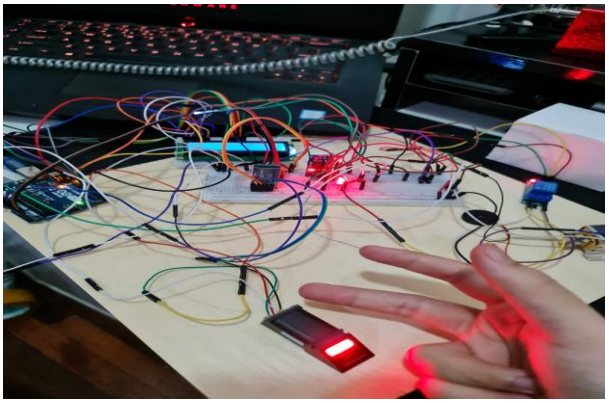

Figure 7: Fingerprint Accuracy Testing

Table 1: Result of Fingerprint Accuracy Testing

Print ID	Finger	Total Tests	Case I	Case II
#1	A	20	20	20
#2	B	20	20	20
#3	C	20	20	20

Table 1 shows an experiment was by using a thumb which is Finger A, an index finger which is Finger B and a middle finger which is finger C. After conducting this experiment shown in Figure 7, in case I where all three fingers are in a clean state, all three fingers' fingerprints can be detected 100% by the fingerprint sensor. In case II, the outcome was pretty much the same as in case I although in case II all three fingers were covered in cooking oil.

Table 2: Result of Range Between HC-05 With Phone Testing

Range(m)	Case I	Case II
1 m	✓	✓
4 m	✓	✓
5 m	✓	✓
6m	✓	✕

7m	✓	✕

In this experiment shown in Figure 8, test has been conducted on how far is the range between the Bluetooth module HC-05 and the phone that is connected to it can be detected by the Bluetooth module HC-05. After conducted the experiment, in case I the range between Bluetooth module and the phone that is connected to it has no barrier in between both components. As obtained from the result, from 1m to 7m range, the Bluetooth module HC-05 can detect the phone that is connected to it. Meanwhile in case II, barriers have been set in between the Bluetooth module HC-05 and the phone that is connected to is for instance a wall, a door or even a cupboard. From Table 2 the range between the Bluetooth module HC-05 and the phone that is connected to it is capped at 5m. The reason is that the Bluetooth module HC-05 is classed as Bluetooth class 2. In conclusion the total range between the Bluetooth module and the phone that is connected to it limits at 10m when there are no barriers in between the Bluetooth module and the phone but when there are barriers in between the Bluetooth module and the phone, the total range between the Bluetooth module and the phone decreases to 5m.

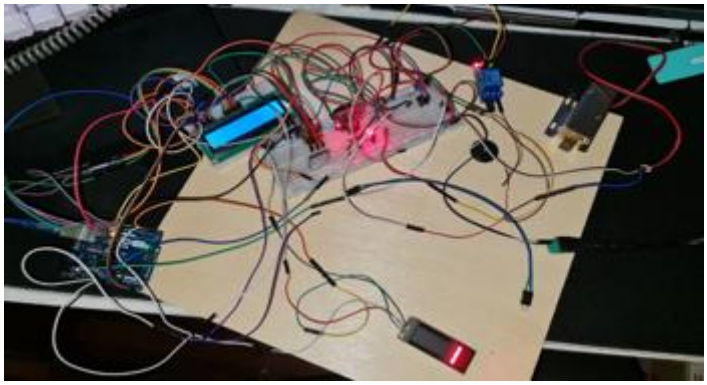

Figure 8: Pilot Test

Table 3: Result of Pilot Test

Finger Type	Result
Valid	Solenoid lock opens
Invalid	Solenoid lock closes

The purpose of this experiment was to see how the relationship between the fingerprint sensor and the solenoid lock works. In this experiment, a valid and an invalid finger was used to test the relationship between the fingerprint sensor and the solenoid lock. The valid finger is the thumb and the invalid finger is the index finger. A hypothesis shown in Table 3 was made which is when a valid finger is scanned on a finger sensor, will the solenoid lock open and when an invalid finger is scanned on a finger sensor, will the solenoid lock be closed. Based on these experiments, the hypothesis that was made is accepted. When a valid finger was scanned on the fingerprint sensor it will detect that valid finger and after scanning the valid finger, the solenoid lock will open. Besides that, when an invalid finger was scanned on the fingerprint sensor, we find that the solenoid lock will close after we scan the invalid finger.

4. Conclusion

In conclusion, the objective of this project was achieved successfully which is to create a circuit which can scan and read a fingerprint. By doing this project, creating a circuit which can open and close a door using a fingerprint sensor and also by using a smartphone and creating a circuit that can increase the safety of the people was made possible. Besides that, this project has its strength and its weaknesses

for instance this project can be done because the cost of this project is not that expensive. Other than that, one of the weaknesses in this project is that this fingerprint system cannot detect and track the faces of our users as this project does not include a camera. In addition, this project is a very flexible project. Last but not least, the hopes of igniting the spirit of the younger generation to improvise and use other implementations to further improvise our project is high so that it can be used by others with ease.

Acknowledgement

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