DOOR ACCESS SYSTEM – ARDUINO BASED

By

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FINAL PROJECT REPORT

Submitted to the Department of Electrical & Electronic Engineering
in Partial Fulfilment of the Requirements
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(Electrical & Electronic Engineering)

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Department of Electrical & Electronic Engineering
Universiti Teknologi PETRONAS
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_____

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September 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

_____

(Shuhada Natasha binti Mohd Zainor)

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ABSTRACT

The development of a door access system includes many different features from as simple as keypad to as complex as using smart cards and biometrics. The Door Access System – Arduino Based is developed to overcome the issue of upgrading and maintenance the system that occur in the existing system. This report discusses on the door access system using Arduino. Arduino is a type of microcontroller that uses its own programming language. It has its own electronic prototyping platform to be used during experiment. This project has two features as inputs, which are keypad and fingerprint scanner. While the outputs are magnetic switch, indicator, LCD display and a siren. Interfacing all inputs and outputs with Arduino produced accurate results in accessing the door based on the accuracy results obtained by performing a test on five individuals with four different fingerprints each person. The entered password using keypad and minutiae obtained by scanning fingerprint are clarified as inputs, while the output is the result displayed on LCD display. This project is reliable as it could increase the security level of door access system by implementing simple approach as Arduino.

LIST OF CONTENTS

CHAPTER 1: INTRODUCTION

1.1 Background Of Study

1.1.1 Door Access System……..…. 1

1.1.2 Arduino……..…... 2

1.1.3 Keypad…….. 4

1.1.3 Fingerprint scanner…… 4

1.1.4 LCD display……..... 6

1.1.5 Magnetic switch……. 7

1.1.6 Siren circuit…… 8

1.1.7 Indicator……. 8

1.2 Problem Statement……. 9

1.3 Objective…… 10

1.4 Scope Of Study……..... 10

1.5 Relevancy / Significant / Contribution Of The Project……..... 10

1.6 Feasibility Of The Project Within The Scope & Time Frame……..... 10

CHAPTER 2: LITERATURE REVIEW…… 11

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Project Process Flow……..…… 16

3.2 Project Activities……... 18

3.2.1 Identify features / hardwares to be used…… 19

3.2.2 Design circuit and identify I/O pins to Arduino board…. 20

3.2.3 Construct circuit for testing…….. 21

3.2.3.1 Keypad…….. 21

3.2.3.2 Fingerprint scanner…….. 22

*3.*2.3.3 *LCD display*…….. 22

3.2.3.4 Interface…….. 23

3.2.4 Understand the circuit diagram……. 24

3.2.4.1 Keypad circuit operations…….. 24

3.2.4.2 Fingerprint scanner circuit operations…… 24
3.2.5 Create coding of each feature…… 25
3.2.6 Testing by 'load and run' program of each feature into Arduino…… 25
3.2.7 Construct circuit on veroboard…… 26
3.2.8 Build prototype…… 26
3.3 Gantt chart…… 27
3.4 Tool Required
3.4.1 Hardware…….. 28
3.4.2 Software…….. 29
3.4.2.1 Arduino programming…… 29
3.4.2.2 Fritzing…… 29

CHAPTER 4: RESULT & DISCUSSION
4.1 Keypad
4.1.1 Password…….. 30
4.2 Fingerprint scanner
4.2.1 Enrolling…… 32
4.2.2 Finger test and matching…… 33
4.3 Safety Feature…… 34
4.4 Interfacing…… 34
4.5 Accuracy test…… 35

CHAPTER 5: CONCLUSION …… 36

REFERENCES…….. 38

LIST OF FIGURES

Figure 1: Door Access System – Arduino Based process flow…… 1
Figure 2: Arduino Mega 2560 Microcontroller Board……. 3
Figure 3: Block diagram of the system interfaced by Arduino…… 3
Figure 4: 4x4 keypad matrix……. 4
Figure 5: Rows and columns of a keypad……. 4
Figure 6: An 8-bit resolution image of minutiae …….. 5
Figure 7: Adafruit Fingerprint sensor …….. 5
Figure 8: Fingerprint scanner process flow …….. 5
Figure 9: 16x2 LCD display ……. 6
Figure 10: Magnetic switch ……. 7
Figure 11: Magnetic switch schematic ……..….. 7
Figure 12: ON condition of magnetic switch……..…….. 7
Figure 13: OFF condition of magnetic switch ……..….. 7
Figure 14: Siren circuit ……..…….. 8
Figure 15: LED ……...…….. 8
Figure 16: Flow chart of project process flow ……..17
Figure 17: Flow chart of the project activities……. 18
Figure 18: Hardware …….. 19
Figure 19: 4x4 keypad schematic …….……..…….... 21
Figure 20: 4x4 keypad layout ……..……..…….. 21
Figure 21: Constructed circuit of keypad ……..…….. 21
Figure 22: Constructed circuit of fingerprint scanner…..…….. 22
Figure 23: Constructed circuit of LCD player ……..22
Figure.24: Constructed interface circuit …….……. 23
Figure 25: Format used in transferring data of fingerprint scanner ……..24
Figure 26: Example of output from Arduino serial monitor ……..... 25
Figure 27: Constructed circuit on veroboard ..…..…….. 26
Figure 28: Door Access System – Arduino Based prototype …….. 26
Figure 29: Gantt chart ……..…..…….. 27
Figure 30: Arduino Mega 2560 board ……...…….. 28
Figure 31: USB cable…….…….. 28

Figure 32: Fingerprint scanner……..……. 28
Figure 33: 4x4 keypad……..... 28
Figure 34: 16 x2 LCD……. 28
Figure 35: Arduino IDE development cycle…….. 29
Figure 36: Keypad output (password) at LCD display…….. 30
Figure 37: Insert Password……. 31
Figure 38: Result for correct password entered…….……. 31
Figure 39: Wrong password entered……..……. 31
Figure 40: Result for wrong password entered…….. 31
Figure 41: Output of entering 3 times of wrong password……. 31
Figure 42: Fingerprint enrolling output at serial monitor…… 32
Figure 43: Finger test output at serial monitor……. 33
Figure 44: Finger test output at LCD display…….. 33
Figure 45: Found match of fingerprint……. 33
Figure 46: Process flow on detecting intruder…….. 34
Figure 47: Final product……...……. 34
Figure 48: Results of accuracy test……. 35

LIST OF TABLES

Table 1: LCD display pin description……6
Table 2: Different biometric recognition technologies…… 12
Table 3: Comparisons of existing door access system with Door Access System - Arduino Based……. 14
Table 4: Connections to Arduino pins…….. 20
Table 5: Functions of each hardware……. 28

LIST OF APPENDICES

APPENDIX A (DIAGRAMS)…… 40
APPENDIX B (DATASHEETS)…… 42
APPENDIX C (PROGRAMMING CODES)……..... 52

CHAPTER 1
INTRODUCTION

1.1 Background Of Study

1.1.1 Door Access System

Door access system is a type of control access system which control the opening and closing of the door. It is a system that is implemented on a building to keep the people and assets in the building to be safe from outsiders. The system is usually used during the activity of people entering and exiting the building. The door access system helps to differentiate unauthorized and authorized people as the system only allows the authorized person to enter the building. The door access system has two main features which are:-

a) Keypad
b) Fingerprint scanner

To operate the system, these two features are interfaced with Arduino programming and the outputs are:-

a) LCD display
b) Magnetic switch
c) Siren
d) Indicator

Figure 1 illustrates the three main processes in the operation of the Door Access System – Arduino Based:-

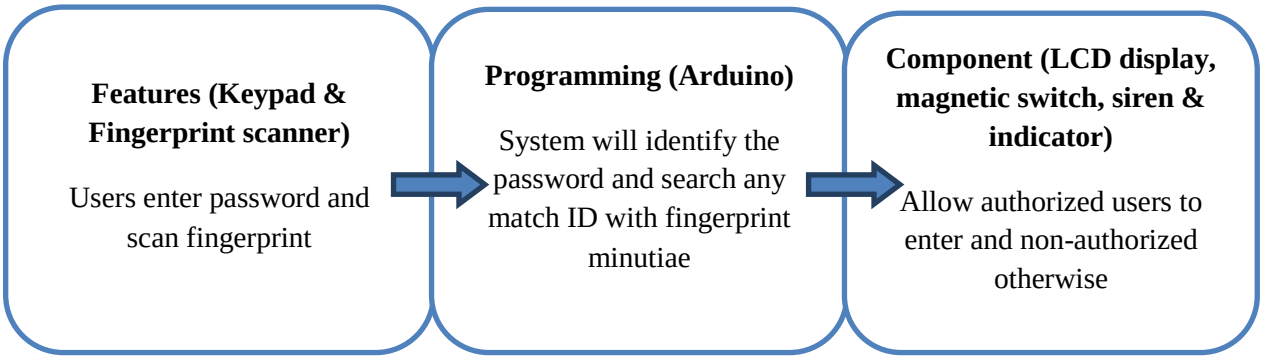

Figure 1: Door Access System – Arduino Based process flow

1.1.2 Arduino

Arduino is an open-source physical computing platform based on a single microcontroller board. Arduino is used when there are interactions between inputs and outputs. It is used to control the output according to the inputs command such as controlling the light or motor by using a switch. The Arduino programming language uses Wiring which is an integrated development environment (IDE), and a single board microcontroller. The language can be expanded through C libraries. The advantages of using Arduino are [1] :-

a) Inexpensive – Compared to other microcontroller boards, Arduino board is rather cheaper.
b) Cross platform – Arduino software can runs on Windows, Macintosh OSX and Linux operating system. While most microcontroller systems can only runs on Windows only.
c) Simple, clear programming environment – Arduino is easy to use by beginners and advanced users.

In this project, Arduino is implemented by using the Arduino Mega 2560 as the microcontroller board as in Figure 2. It comes with an ATMEGA2560 microcontroller whereby the program stored in ATMEGA2560 can be edited in the future for maintenance purposes. The inputs and outputs will be connected to the Arduino Mega 2560 I/O pins and interfacing is done by using Arduino software. Based on Figure 3, it shows the block diagram of the system interfaced by Arduino. Atmega 2560 is the microcontroller which controls the inputs (keypad and fingerprint scanner) and outputs (LCD display, magnetic switch, siren and indicator).

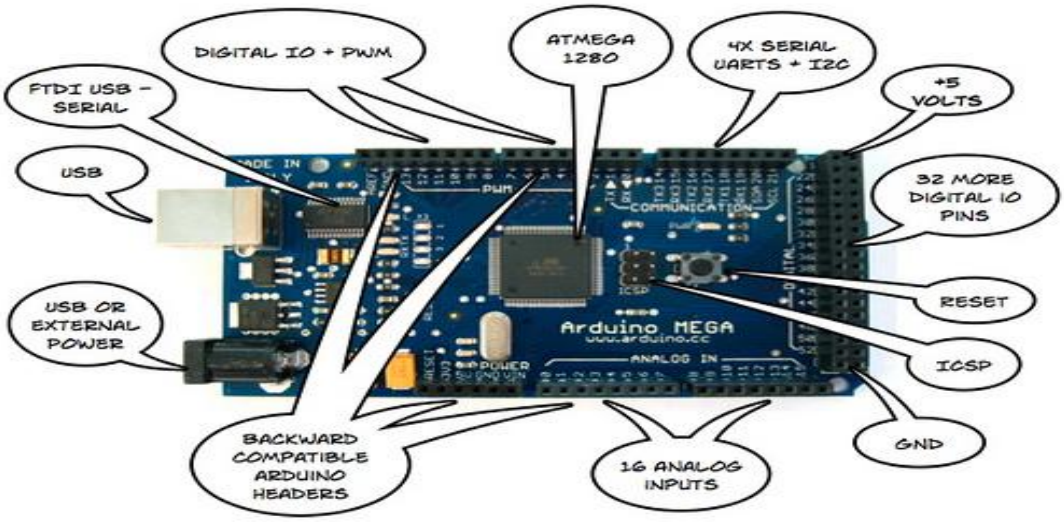

Figure 2: Arduino Mega 2560 Microcontroller Board [2]

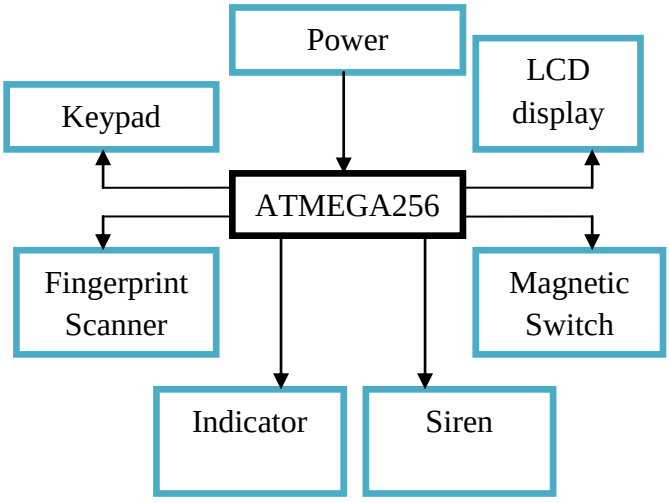

Figure 3: Block diagram of the system interfaced by Arduino

1.1.3 Keypad

A keypad is a device used to enter the desired output. In this project a keypad matrix with 16 push buttons is used as shown in Figure 4. This type of keypad has four rows and four columns whereby the overlapping rows and columns are the keys as shown in Figure 5.

Figure 4: 4x4 keypad matrix [3]

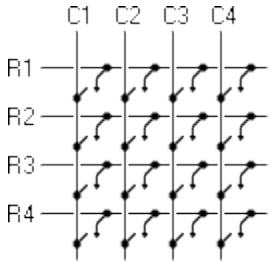

Figure 5: Rows and columns of a keypad [4]

1.1.4 Fingerprint scanner

A fingerprint scanner is a type of biometric scanner which scans the human fingerprint. Its function is to capture the human fingerprint as in Figure 6. There are two types of fingerprint scanner which are optical and capacitive fingerprint scanner. The differences between these two types of fingerprint is that the optical fingerprint and capacitive fingerprint scanner captures minutiae by light and current respectively. In this project, the optical scanner is used because it is less accessible to electrostatic discharge (ESD) compared to capacitive fingerprint scanner. The fingerprint scanner is frequently implemented in control access system. The reason being is because every human have different fingerprint minutiae which helps in identifying the true data of a person accurately. In the case of door access system, the person who wishes to enter the building needs to scan their fingerprint to be Based on Figure 7, in this project the Adafruit fingerprint scanner used can cater up to 162 fingerprints. The stored fingerprints are stored in the onboard Flash Memory which has the size of 512bytes. The fingerprint scanner process flow is shown in Figure 8.

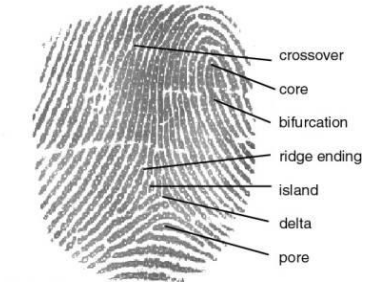

Figure 6: An 8-bit resolution image of minutiae [5]

Figure 7: Adafruit fingerprint scanner [6]

Scan & enrolment - User place finger onto the scanner

Sensing by sensor - Fingerprint sensor provide light to fingers surface and captures the minutiae by using a charge-coupled device (CCD) with an 8 bits per dot with a resolution of 500 dpi (dots per inch) in grey-scale

Storing by processor – The captured minutiae which has been converted to digital signal is stored in the local database.

Comparing by software – Every fingerprint scanning event will capture a new humans minutiae. This new minutiae will be compared to the ones stored in database to be identified whether the person is authorized or non-authorized.

Figure 8: Fingerprint scanner process flow

1.1.4 LCD display

A 16x2 LCD display which has 2 horizontal lines comprising a space of 16 displaying character is used in this project as shown in Figure 9. It has two types of registry inbuilt which are:-

a) **Command register** that is use to insert command
b) **Data register** that is use to insert data

In this project ,the function of the LCD display is to displays the desired output according to the program. Based on Table 1 ,each LCD pins has its own and it is connected to Arduino I/O digital pins.

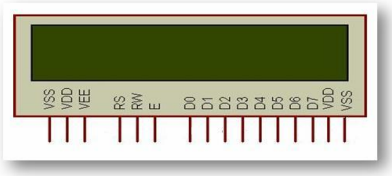

Figure 9: 16x2 LCD display [7]

Sr. No	Pin No.	Pin Description
1	Pin 1 (GND)	This is a ground pin to apply a ground to LCD.
2	Pin 2 (VCC)	This is the supply voltage pin to apply voltage to LCD.
3	Pin 3 (VEE)	This is the pin for adjusting a contrast of the LCD display by attaching a veriable resistor in between VCC and GND.
4	Pin 4 (RS)	RS stands for Register Select. This pin is used to select command/data register. If RS=0 then command register is selected. If RS=1 then data register is selected.
5	Pin 5 (R/W)	R/W stands for Read/Write. This pin is used to select the operation Read/Write. If R/W=0 then Write operation is performed. If R/W=1 then Read operation is performed.
6	Pin 6 (EN)	En stand for Enable signal. A positive going pulse on this pin will perform a read/write function to the LCD.
7	Pin 7-14 (DB0-DB7)	This 8 pin is used as a Data pin of LCD.
8	Pin 15 (LED+)	This pin is used with pin 16(LED-) to setting up the illumination of back light of LCD. This pin is connected with VCC.
9	Pin 16 (LEC-)	This pin is used with pin 15(LED+) to setting up the illumination of back light of LCD. This pin is connected with GND.

Table 1: LCD display pin description [7]

1.1.5 Magnetic switch

A magnetic switch is a normally-closed dry contact that depends on magnetic field to operate. It applies relay working principle and control electrical switches by another switch. In this project the magnetic switch act as a magnetic door lock, whereby it is activated to lock the doors and it will be deactivated for the authorized users. It is also used as an intruder alarm to acknowledge the security guards on the presence of intruder. Figure 10 shows the magnetic switch, while Figure 11 shows the schematic of magnetic switch.

Based on Figure 12, there are two circuits in magnetic switch, which are:-

a) Control circuit (in green)
b) Load circuit (in red)

During ON condition, the current flows through control circuit will produce magnetic field that would cause load circuit to be close (ON) as shown in Figure 13. Otherwise the load circuit will be open (OFF).

Figure 10: Magnetic switch [8]

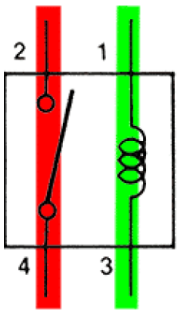

Figure 11: Magnetic switch schematic [9]

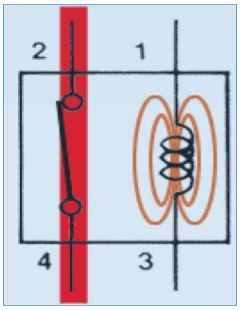

Figure 12: ON condition of magnetic switch [9]

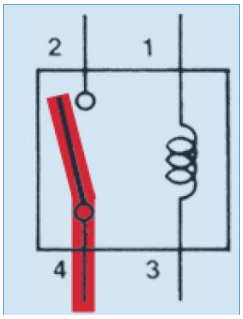

Figure 13: OFF condition of magnetic switch [9]

1.1.6 Siren Circuit

A siren circuit is a circuit which produce siren by connecting the circuit to the speaker as output as shown in Figure 14. The function of the siren circuit in this project is to produce siren at a certain basis. There are two conditions that will activate the siren which are:-

a) Presence of intruder
b) Users inserted wrong password more than the allowable attempts

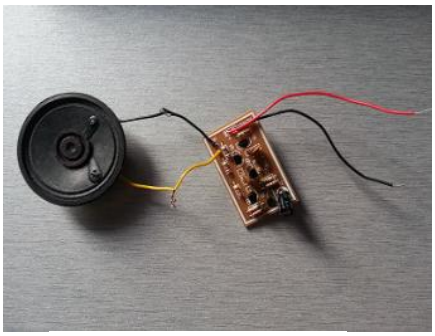

Figure 14: Siren circuit

1.1.7 Indicator (LED)

A light emitting diode (LED) is a semiconductor light source that as shown in Figure 15 act as an indicator. The red LED indicates door lock while the green LED indicates door unlock.

Figure 15: LED [10]

1.2 Problem Statement

Problem statements are the problems identified by observing the existing door access system. Through observation, there are three problems that have been identified in order to develop this project which are:-

1- Obsolete components

The existence of new technologies comes from the creation of new components. This fact shows that once the old devices are obsolete, there are no spare components could replace it. Therefore new system with new components has to be created.

2- Upgrading issues

Most of control access system nowadays uses PIC [11][12]. It would be difficult with PIC because every time upgrading needs to be done, the stand-alone PIC needs to be pulled out from the circuit and burned again.

3- Complicated programming

Since most of control access system nowadays uses PIC, many engineers will face difficulties if problem occur on the device. The reason being is because PIC is not an open-source IDE compared to Arduino. Therefore if problem occur, more time is needed for the engineers to create new coding for the device.

1.2 Objective

1. To create a door access system using Arduino approach.
2. To test the accuracy of this device.

1.3 Scope Of Study

1. To understand about door access system.
2. To understand about keypad.
3. To understand about biometric fingerprint scanner.
4. To study about Arduino and its application.

1.4 Relevancy / Significant / Contribution Of The Project

The Door Access System Arduino Based is proposed mainly for Tricubes Computer Sdn. Bhd. This company produces product and services for Enterprise Mobility and Identity Authentication. The presence of the Door Access System will help the personnel of this to have access to the building. It is also designed to help the engineers in the future to perform maintenance and upgrading work easily.

1.5 Feasibility Of The Project Within The Scope & Time Frame

The Door Access System-Arduino Based is designed to be technically feasible. It is designed to be simpler compared to the existing door access system. Since most of buildings nowadays implement the use of door access system, this project is economically feasible as it can be marketed around the world. It is also feasible within the scope and time frame because Arduino is an open-source IDE which is suitable to be used within the time frame which leads to less time consumption.

CHAPTER 2
LITERATURE REVIEW

Door access system has been widely used around the world. It is a type of security system that is created to help in securing people and assets in a building from unwanted cases such as burglaries and kidnapping. To develop a door access system, features or hardware such as keypad, smart card, RFID card and biometric are implemented. Besides hardware, software is also included in developing the door access system as it helps in interfacing the hardware and to have the desired system flow. Types of software or programming language being used in this system are PIC language programming, Matlab, Microsoft Visual C++, Arduino and many more.

In this project, keypad and fingerprint scanner are implemented in developing the Door Access System – Arduino Based. These two features were chosen because of its user-friendly, smart and high security system compared to other features such as face-verification, smart card, RFID card and many more.

Fingerprint scanner is a type of biometric sensors whereby it senses the human fingerprint for identification. Biometric consist of many types such as voice-recognition, face-recognition, fingerprint-recognition and other identification that consist of human body parts.

Based on a journal written by *Wheeler et.al.* (2000) on face-verification system, this system is time-consuming to build because the users need to have more than one images to separate ID and non-ID images for identification data storage purposes. Despite of its advantages of identifying intra and interdependencies, it is proven that this system is inefficient because it took 6 seconds to make decision while the aim is within 2 seconds [13].

The fact of time-consuming system has also been said in a journal written by *Ibrahim et. al.* (2011) on face-recognition system. Face-recognition is difficult to build as there are alot of factor needs to be considered during image capturing which are illumination, distance and an individuals head orientation. This system is also sensitive to aging and facial expression. It is also troublesome during experimental work as many faces need to be taken at nine different angles [14].

Another access control system project by using voice-recognition system done by *Rashid et. al.* (2008) is also a sensitive system as it will reject the voice input if there are background noise [15].

Cui et. al. (2009) agrees the fact of voice-recognition system being difficult. The reason being is because it needs to build up a speech model whereby the users have to pronounce the text according to the stated ones. Despite of its lacking in efficieny, this project done by Bo Cui and Tongze Xue has its advantages compared to other projects with similar feature by using a technology to filter low frequency disturbing [16].

As compared to the fingerprint scanner used in this project, dring experimental work, the elements needs to be consider are the illumination and humans sweat that may appear on an individuals finger. Implementing the fingerprint scanner produce a less time-consuming system as it can easily sense human fingerprint with a much higher percentage of accuracy which is 70% for the left thumbprint The reason being is because fingerprint scanner accuracy is only influenced less factor than face-verification which are by human's sweat and scratch surface of the scanner. Besides that the fingerprint scanner used in this project can make decision in less than 1 second.

The benefit of using fingerprint scanner was also said by *Zhu et. al*. (2011) in their journal that fingerprint-verification overcome the issue of losing ID card where in their project is car keys. Another advantage is that the ownership can never be passed to other people . An optical fingerprint scanner is implemented in this project compared to other biometric features is because it has more advantages as stated in Table 2 [17].

Technologies	Catholicity	Uniqueness	Stability	Collectible	Feasibility	Deceivability	Cost
Face shape	High	Low	Mid	High	Low	High	High
Ear shape	Mid	Mid	High	Mid	Mid	Mid	High
Hand shape	Mid	Mid	Mid	High	Mid	Mid	High
Fingerprint	High	High	High	Mid	High	Mid	Low
DNA	High	High	High	Mid	High	Low	High
Iris	High	High	High	Mid	High	Low	High
Retina	High	High	Mid	Low	High	Low	High
Palm	Mid	High	High	Mid	High	Mid	Low
Voice	Mid	Low	Low	Mid	Low	High	Low
Signature	Low	Low	Low	High	Low	High	Low

Table 2: Different biometric recognition technologies [17]

The quality of the scanned fingerprint is very important. To obtain a good quality fingerprint, the fingerprint sensor senses the skin types and humidity of the finger grain. The type of fingerprint used in this system is the optical sensor whereby optics sensor the CCD (Charge Coupled Device) [18, 19].

In order to interface or have the system functioning, softwares and programming language are used besides hardware. Project by *Wheeler et.al.* (2000) implements MATLAB for face engine and Visual Basic for interface [13]. While project by *Ibrahim et. al.* (2011) implements Microsoft Visual C++ and Visual Basic 2008 platforms for the application of Artificial Neural Network. Compared to Arduino which is used in this project, it implement a simple yet can be used by an advanced programmer to interface the hardware and develop the door access system [14].

In terms of communications, Arduino is much more efficient as it communicates by using USB cable compared to the project done by *Rashid et. Al* (2008) which uses parallel port that is less speed [15].

Table 3 below shows the comparisons of existing door access system with Door Access System – Arduino Based by its advantages and limitations of each system

No.	Author	Title	Advantages	Disadvantages / Limitations
1	Wheeler, G. V., Courtney, P., Cootes, T. F., & Taylor, C. J (2000)	Performance assessment of a face-verification based access control system	Identify intra and inter dependencies	1-An individual needs to have more than 1 image to separate id and non-id images. 2-Very sensitive 3-Less speed because it takes 6 seconds to make decision while the aim is within 2 seconds.
2	Ibrahim, R., & Zin, Z. M (2011)	Study of Automated Face Recognition System for Office Door Access Control	Able to improve the human identification by distinguish a person's particular face from other person's face images .	1-Difficult because had to consider many other elements such as illumination, distance and an individual's head orientation for capturing image. 2-Sensitive to aging and facial expression. 3-Subject needs to be very cooperative during image capturing to have accurate results. 4-Troublesome during experimental work because a lot of face positions needs to be stored. 5-Results are influenced by illumination and pose.

3	Rashid, R. A., Mahalin, N. H., Sarijari, M. A., & Abdul Aziz, A. A. (2008)	Security System Using Biometric Technology: Design and Implementation of Voice Recognition System (VRS)-	Provides adjustable security level setting account for variations	1-Very sensitive. It will reject the match if there are background noise 2-Less speed because it uses parallel port for communication interface.
4	Cui, B., & Xue, T. (2009)	Design and Realization of an Intelligent Access Control System Based on Voice Recognition	Implements fore-aggravation technology to filter low frequency disturbing	Difficult because it needs to build up a speech model whereby the users have to pronounce the text according to the stated ones.
5	G Zhu, Z., & Chen, F (2011)	Fingerprint Recognition-Based Access Controlling System for Automobiles	Overcome the issue of car robbery if the owners lose his car keys or his car keys been stolen	Designed specifically for automobiles

Table 3: Comparisons of existing door access system with Door Access System – Arduino Based

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Project Process Flow

The project process flow is illustrated as flow chart in Figure 16. Firstly the user will insert the password that has already been set by the system. If the entered password is correct, the user may proceed by entering their ID. Otherwise the user will be given three attempts to enter password. If wrong password is entered at the third attempt, alarm will be activated.

Next, each authorized user have a template of their own fingerprint saved in the memory. In order to enter the building, the users need to scan their fingers by placing their finger onto the fingerprint scanner.

During storing process for fingerprint scanner, the storing starts by enrolling the users ID. Once the users place their finger, the fingerprint scanner will capture the fingerprint. It will then extract the minutiae and store the output in memory.

Next the process continues by finding the match. For fingerprint, it uses the stored minutiae with the ones that was recently capture.

If the users minutiae matches their own minutiae which has already been stored before, the users may access the door as the magnetic door lock will be deactivated. Otherwise, the users have to enter their ID number again. The users will be given three attempts. If the users fail at the third attempt, alarm will be activated indicating the presence of intruders.

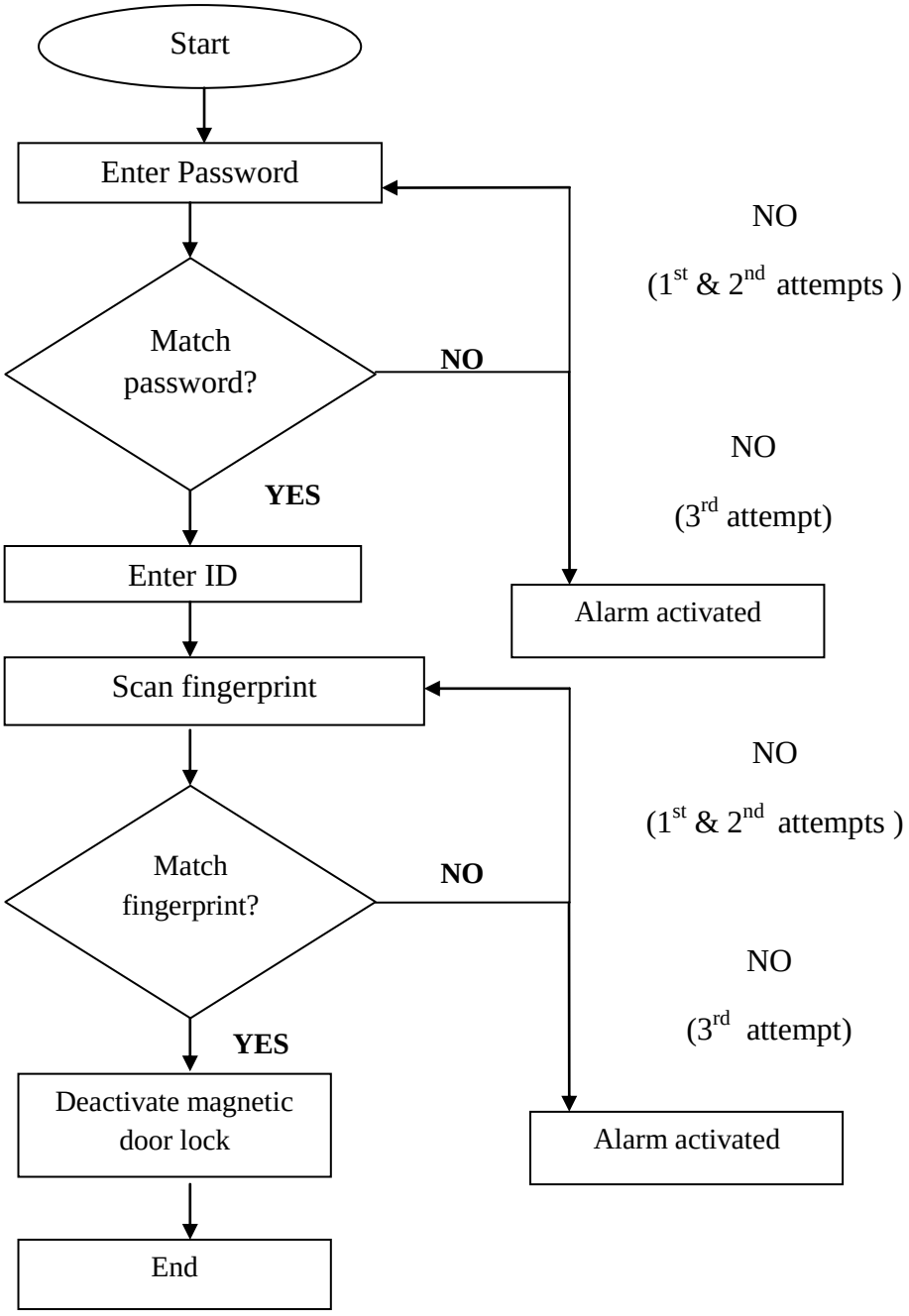

Figure 16: Flow chart of project process flow

3.2 Project Activities

The project activities are done according to flow chart in Figure 17. The procedure shows the activity from the beginning of the project until it is completed.

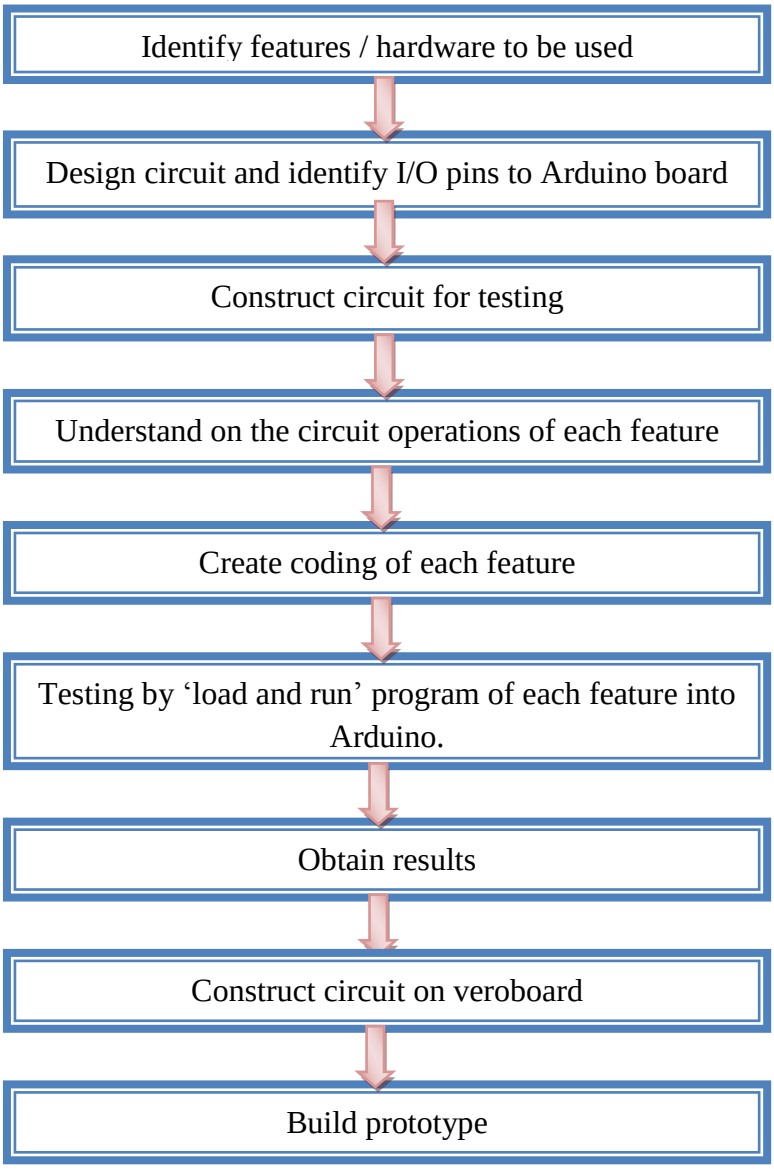

Figure 17: Flow chart of the project activities

3.2.1 Identify features / hardware to be used

Figure 18 shows the hardware used in this project. There are five main hardware which are 4x4 keypad, fingerprint scanner, Arduino Mega board and 16x2 LCD display. Keypad and fingerprint scanner are the features used to access the door. While the Arduino board platform is a platform that is designed to be used for testing by connecting the features to its I/O pins and uploading program to the Atmel Atmega2560 microcontroller. The function of LCD display is to display the output and the USB cable is used to communicate the Arduino programming language and the Atmel Atmega2560 microcontroller.

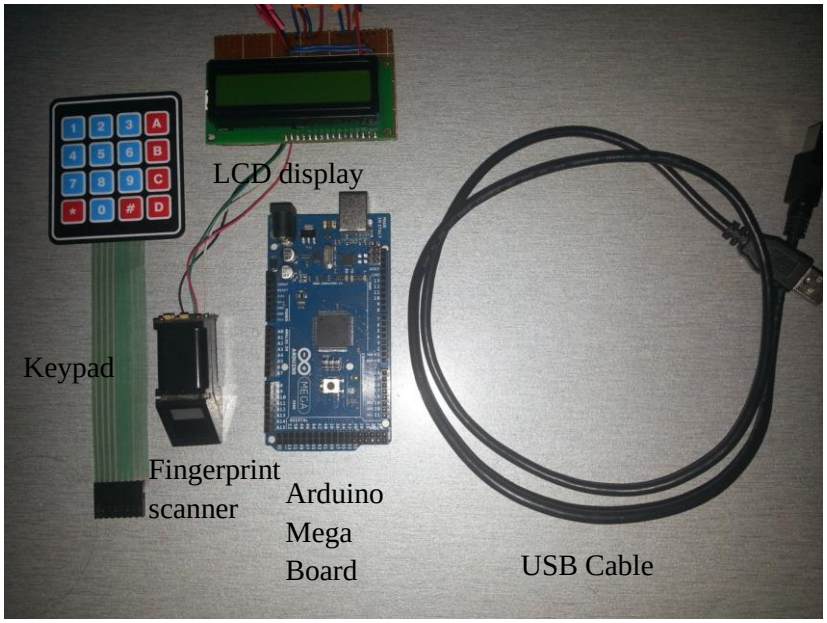

Figure 18: Hardware

3.2.2 Design circuit and identify I/O pins to Arduino board

The circuit diagram (Appendix A) of this door access system is designed by using Fritzing software which is a type of designing tools that supports Arduino. The connections of the features to Arduino I/O pins are shown in Table 4.

		Arduino I/O pins
Keypad	1	23
	2	25
	3	27
	4	29
	5	31
	6	33
	7	35
	8	37
Fingerprint scanner	Red	5V
	Green	12
	White	13
	Black	GND
LCD display	1	GND
	2	5V
	3	150Ω
	4	40
	5	42
	6	44
	7	NC
	8	NC
	9	NC
	10	NC
	11	46
	12	48
	13	50
	14	52
	15	5V
	16	GND
Magnetic Switch	1 end	11
	1 end	GND
Siren	Positive	9
	Negative	GND
Indicator	Red	11
	Green	10

Table 4: Connections to Arduino I/O pins

3.2.3 Construct circuit for testing

3.2.3.1 Keypad

The keypad used in this project is 4x4 keypad which have eight I/O pins. It is divided as rows and columns as Figure 19.

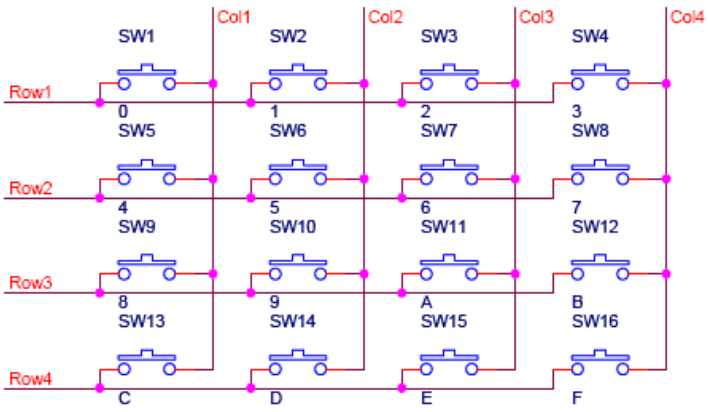

Figure 19: 4x4 Keypad schematic[4]

Based on Figure 20 the first four pins (pink, light blue, black, orange) of the keypad are the columns while the following four pins (red, yellow, dark blue, purple) are the rows. Circuit of the keypad is shown in Figure 21. The connections can be referred to Table 4.

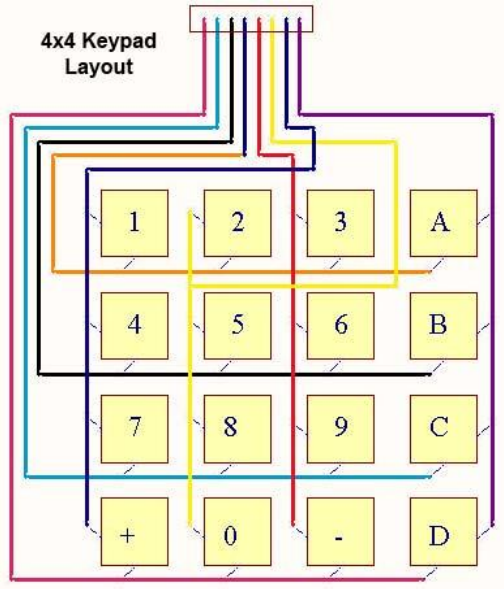

Figure 20: 4x4 Keypad layout [20]

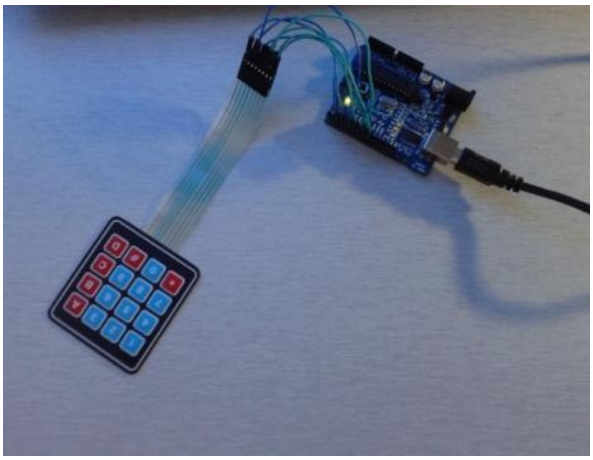

Figure 21: Constructed circuit of keypad

3.2.3.2 Fingerprint scanner

The fingerprint scanner has 4 wires that can be connected to Arduino. Figure 22 below shows the circuit connection of it. The connections of fingerprints scanner to Arduino I/O pins can be referred to Table 4.

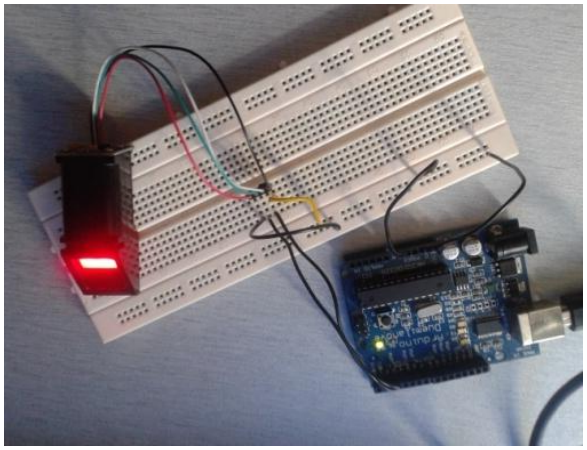

Figure 22: Constructed circuit of fingerprint scanner

3.2.3.3 LCD display

The LCD display is a 16 x 2 display. It is used to replace the Arduino IDE serial monitor to display the output. Figure 23 shows the constructed circuit of LCD display. The connections of LCD display to Arduino I/O pins can be referred to Table 4.

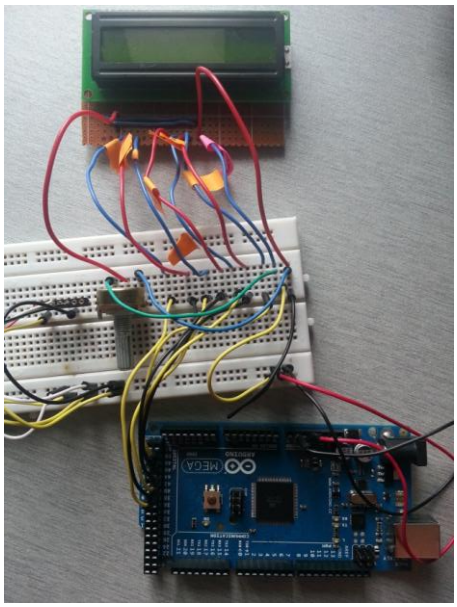

Figure 23: Constructed circuit of LCD display

3.2.3.4 Interface

After testing the keypad circuit and fingerprint scanner circuit by interfacing with Arduino separately, both of the circuit are then combined together with LCD display and Arduino to be interfaced. Figure 24 shows the interfacing circuit between keypad and fingerprint scanner with Arduino.

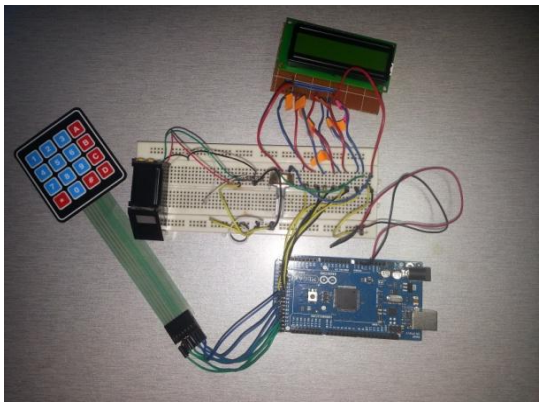

Figure 24: Constructed interfaced circuit

3.2.4 Understand the circuit operations

3.2.4.1 Keypad circuit operations

1. Arduino will sense the present of keypad by scanning D23,D25,D27,D29,D31,D33,D35 and D37
2. Pins at D23 until D29 are pins for rows, while pins at D31 until D37 are pins for columns.

3.2.4.2 Fingerprint scanner circuit operations

1. Arduino communicate with biometrics through UART.
   -UART (any voltage)
   -RS232 (+5 / -5)
2. D12→ for data flowing from Arduino to biometric sensor.
3. D13→ for data flowing from biometric sensor to Arduino.
4. The format of the data passing through D12 and D13 will follow the format in Figure 25.

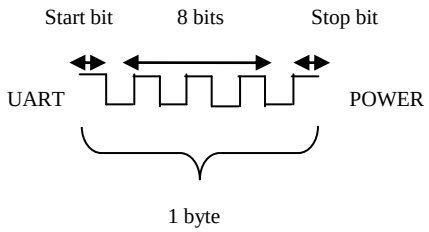

Figure 25 : Format used in transferring data of fingerprint scanner

5. The data contains in 8 bits.

→1st bit – start of bit

→end bit-stop of bit

3.2.5 Create coding of each feature

Since keypad and fingerprint scanner is the feature used in this project, therefore coding for these two features are created in the beginning. For fingerprint scanner it includes coding for enrolling and finger test. The output of the keypad and fingerprint scanner will be displayed using the serial monitor before it is displayed though LCD display. After each feature has its own programming, it is then been interface among the features itself. Below is the list of coding developed for this project. Refer Appendix C for coding.

1. 4x4 keypad coding
2. Fingerprint enroll coding
3. Fingerprint test coding
4. 4x4 keypad interface with LCD display coding
5. Password coding interface with LCD display
6. Fingerprint test interface with LCD display coding
7. Interface 4x4 keypad, fingerprint test and LCD display coding

3.2.6 Testing by 'load and run' program of each feature into Arduino

Testing are done after constructing each circuit and create coding. Before interfacing with LCD display, the output is displayed on the Arduino serial monitor. If the testing was a success, each circuit will be interfaced with LCD display to have the output on the display as shown in Figure 26.

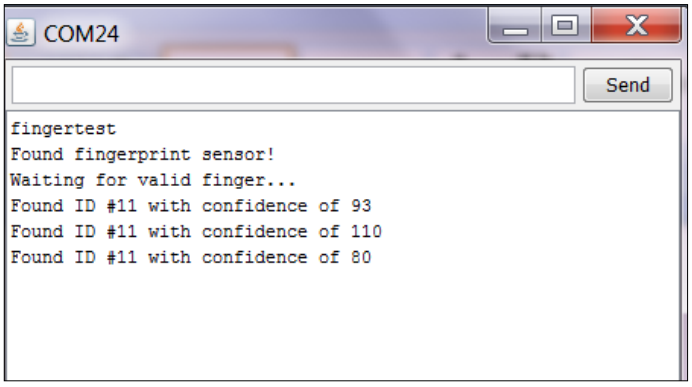

Figure 26: Example of output from Arduino serial monitor

3.2.7 Construct circuit on veroboard

After all the circuit connections have been confirmed, the circuit is constructed and soldered on veroboard as in Figure 27.

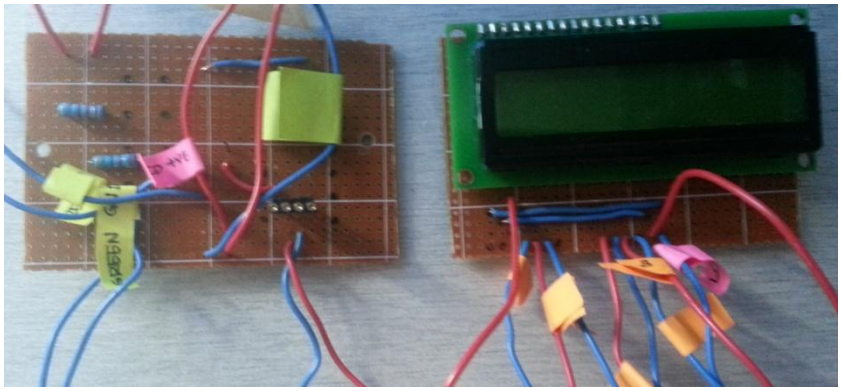

Figure 27: Constructed circuit on veroboard

3.2.8 Build prototype

The prototype is build to show the process flow of the system clearly as shown in Figure 28. It is designed with a door and a panel to insert the features which are keypad, fingerprint scanner and LCD display.

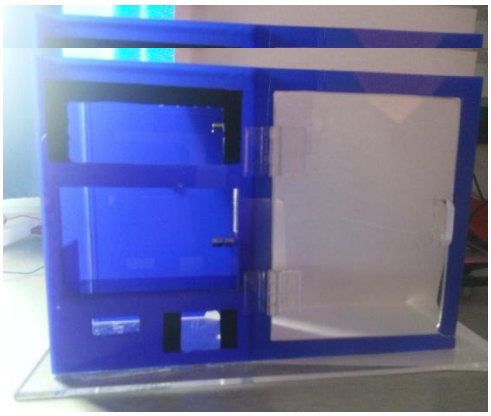

Figure 28: Door Access System – Arduino Based Prototype

3.3 Gantt Chart

Figure 29 shows the Gantt chart of the project. The function of the Gantt Chart is to plan on how to complete the project.

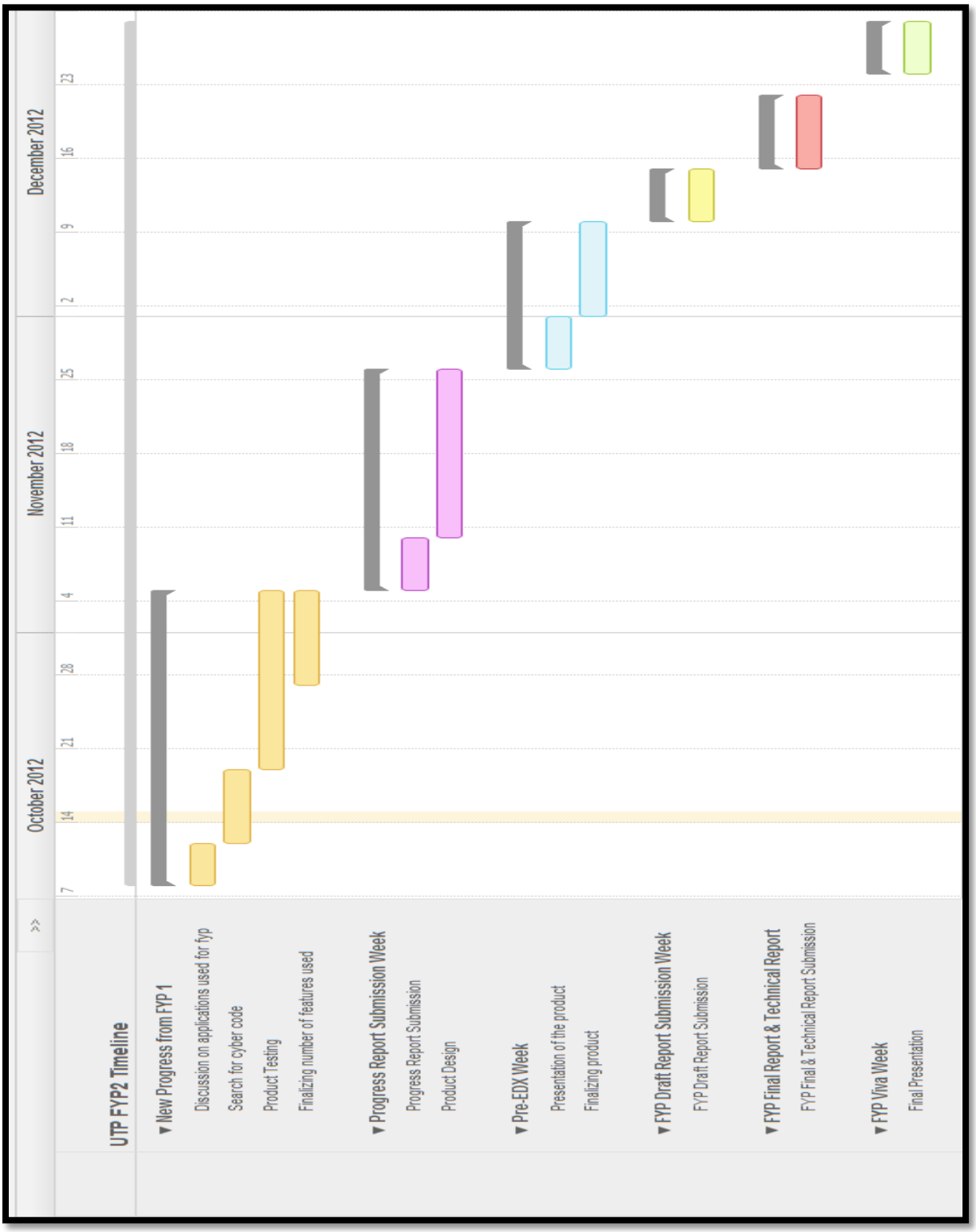

Figure 29: Gantt chart

3.4 Tools Required

3.4.1 Hardware

There are five main hardware used in this project. Figure 30 to Figure 34 shows the hardware and Table 5 states the functions of each hardware.

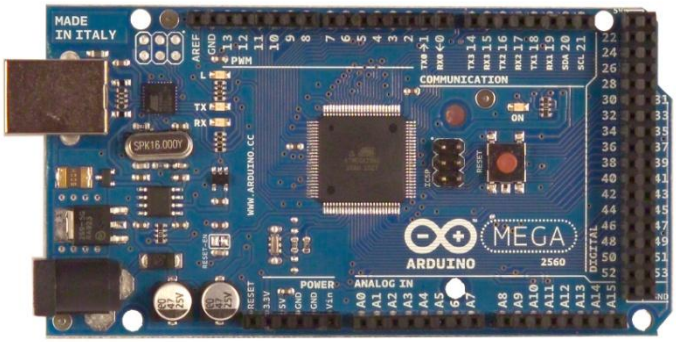

Figure 30: Arduino Mega 2560 Board [21]

Figure 31: USB cable [22]

Figure 32: Fingerprint scanner [6]

Figure 33: 4x4 keypad [3]

Figure 34: 16x2 LCD display [7]

Hardware	Function
USB cable	Connects the Arduino board to computer for uploading purposes
Arduino Mega 2560 Board	Testing purposes and interface Arduino with the features
Fingerprint scanner	Scan the users thumbprint
Keypad	To enter ID / password
LCD Display	Display the output

Table 5: Functions of each hardware

3.4.2 Software

3.4.2.1 Arduino programming

Arduino is an open-source microcontroller. It can be edited and loaded to the microcontroller by using a USB cable. Arduino is an inexpensive type of single-microprocessor prototyping platform. The software consists of standard programming language, which is similar to C/C++. To run the program, Arduino comes with a bootloader that runs on the board. The reason of implementing Arduino in this project is because it has many advantages compared to other microcontrollers such as PIC. It is comes with an ATMEGA2560 microcontroller whereby the program stored in ATMEGA2560 can be edited in the future for maintenance purposes. Figure 35 shows the development cycle of Arduino IDE whereby it consist of editing the coding, compile, upload and run.

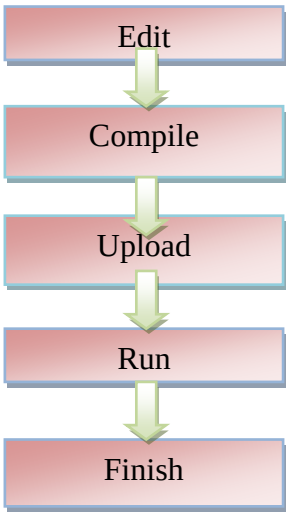

Figure 35: Arduino IDE Development Cycle

3.4.2.2 Fritzing

Fritzing is software that supports Arduino. The libraries include components such as sensors and displays. The purpose of using fritzing is to design a circuit diagram virtually.

CHAPTER 4
RESULTS & DISCUSSIONS

According to project activities flow chart Figure 17 above, after constructing the circuit, testing was done. Figures 36 to 47 shows the results obtained from each feature and the interfacing all feature with Arduino. During testing, the outputs obtained were displayed through serial monitor. The LCD display is added afterwards to replace the serial monitor.

4.1 Keypad

4.1.1 Password

Keypad is used to enter character and integer that is required to access the door. In this project, keypad is implemented for password feature and use to insert ID. The first stage to access the door is to enter password. Figure 36 shows a display for the user to enter the password. In this program the password is set as 'C141516'. If the users entered the same password as the ones set as in Figure 37, it will resulted as 'Successful, Now scan finger' as in Figure 38. Next the users may scan their fingerprint immediately for the next stage of door access system. Otherwise, if the wrong password is entered as in Figure 39, the LCD display will display as 'Wrong' as in Figure 40. While Figure 41 shows the output of intruders alarm.

Figure 36: Keypad output (password) at LCD display

Figure 37: Insert Password

Figure 38: Result for correct password entered

Figure 39: Wrong password entered

Figure 40: Result for wrong password entered

Figure 41: Output of entering 3 times of wrong password

4.2 Fingerprint scanner

4.2.1 Enrolling

The function of fingerprint scanner is to scan the users fingerprint. During scanning the fingerprint scanner will capture and store the users minutiae. To have a database of users fingerprint minutiae, the user needs to enroll their fingerprint. Figure 42 shows the result of an enrolled fingerprint. Once Arduino detected fingerprint scanner, the users will insert the ID that will be saved together with their fingerprint minutiae. According to figure above, the users fingerprint minutiae is enrolled with the ID:2. It is then stored in the fingerprint scanner onboard flash memory,

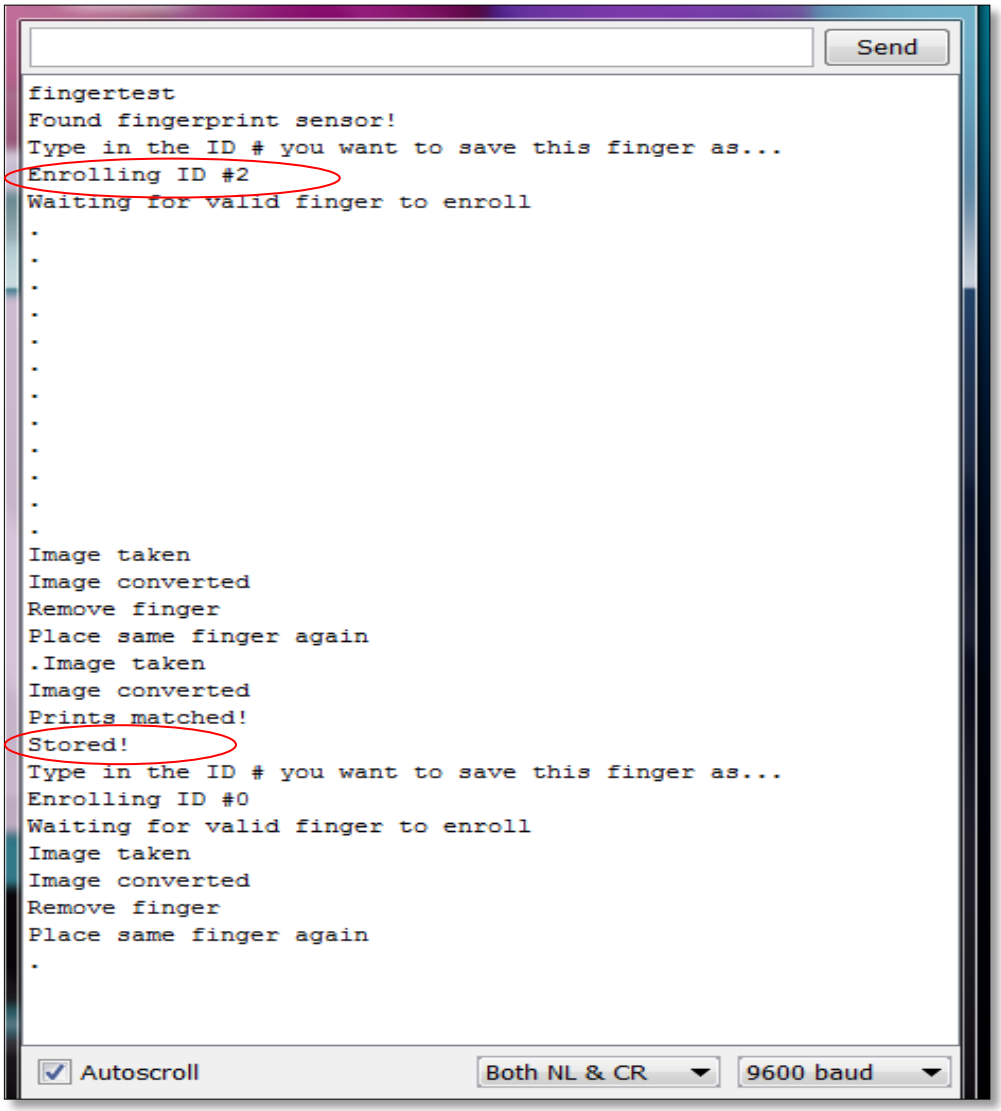

Figure 42: Fingerprint enrolling output at serial monitor

4.2.2 Finger test and matching

After enrolling the fingerprint, the stored minutiae need to be tested to test the accuracy of the fingerprint scanner. Figure 43 shows the finger test output at serial monitor. The user ID is found to be ID: 2. It states the confidence which actually measures the accuracy of the current scanned fingerprint and the ones stored in memory. The finger print scanner has a level of confidence from 0 to 255 which indicates from less accurate to very accurate. Figure 44 is a command display for the user to place their fingerprint. After scanned finger, Figure 45 shows the output being displayed at LCD display. The output indicates the current scanned fingerprint is matched with the stored minutiae with ID: 2.

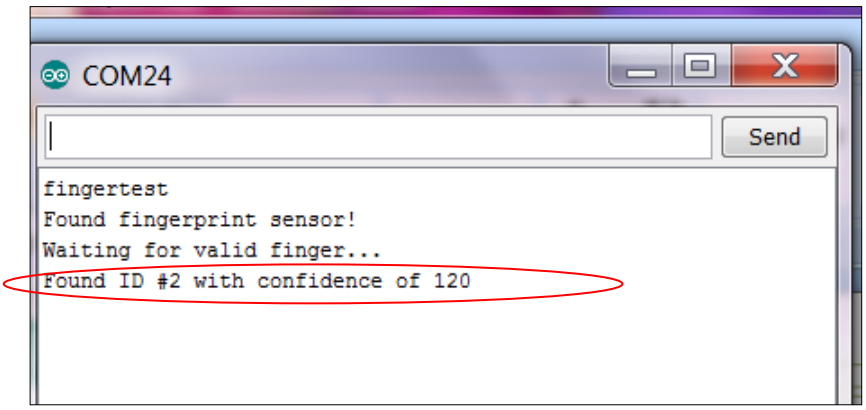

Figure 43: Finger test output at serial monitor

Figure 44: Finger test output at LCD display

Figure 45: Found match of fingerprint

4.3 Safety Feature (Intruder Alarm)

Intruder Alarm is added to acknowledge the safety guards of intruder. Figure 46 shows the process flow on detecting intruder.

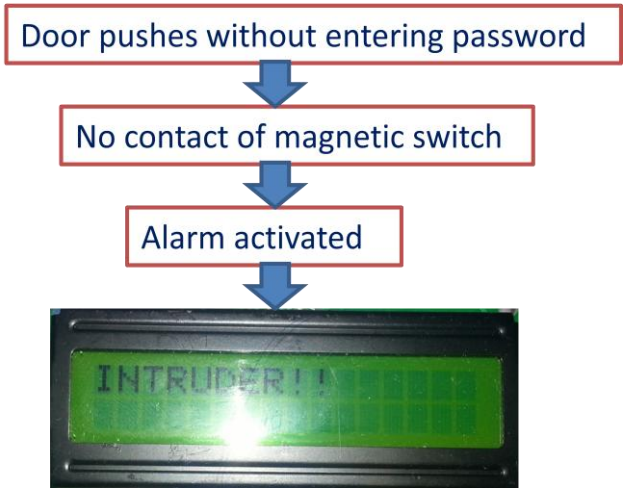

Figure 46: Process flow on detecting intruder

4.4 Interfacing

Figure 47 shows the final product. After all the features have been interfaced, it is then being placed together with the prototype.

Figure 47: Final product

4.5 Accuracy test

Accuracy test is performed to observe the security level of the fingerprint scanner. Figure 48 shows the result of the accuracy test based on the confidence level. The test was done on five individual with four thumbprints from each and one of them. The fingers scanned were, left and right thumbprint and also left and right index finger. From the result below, it shows that finger with the most accurate result is left thumbprint with the percentage of 70%, followed by right thumbprint, right index finger and left index finger with the accuracy of 67.2%, 41.4% and 30% respectively.

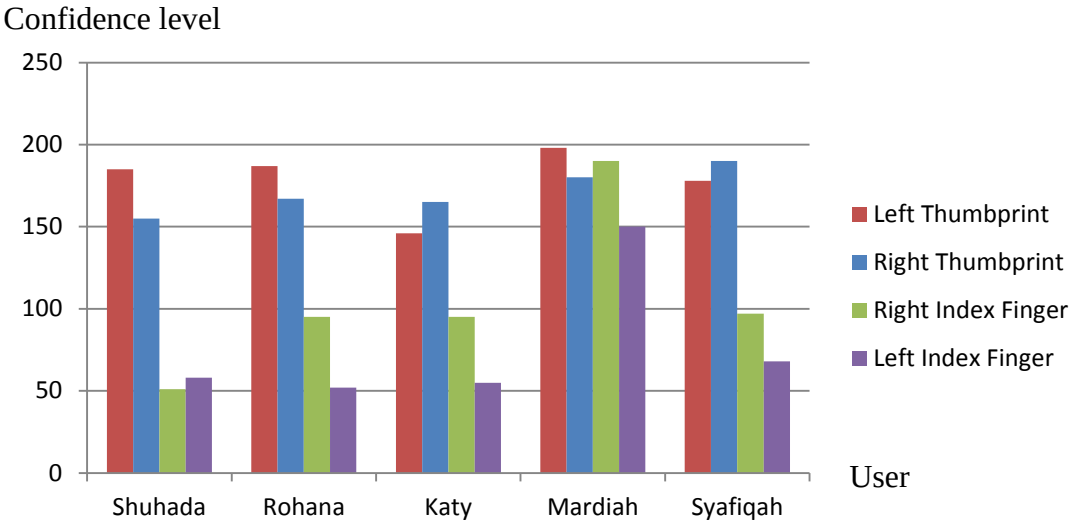

Figure 48: Result of accuracy test

CHAPTER 5

CONCLUSION

The implementation of door access system is considered to be a need for a building especially companies to have a security system in order to keep the people inside and assets to be safe from unwanted cases such as burglaries and kidnapping.

Tricubes Computer Sdn. Bhd. has been reported that the company's existing door access system have problems in maintaining due to its obsolete components that could not be replaced. The Door Access System – Arduino Based is developed to overcome this issue as Arduino does not use a lot of components with the existence of the Arduino platform board and Atmel AVR microcontroller. The Arduino approach also overcome the issue of upgrading as it comes with an Atmel AVR microcontroller which can be edited and reprogrammed many times [23]. Arduino is also known to its open source and cross-platform that could ease the task of a programmer.

The software used in this project is Arduino programming language which is similar to C++. Based on the research done [13][14][15][16][17][18][19], it shows that Arduino is much simpler compared to other and suitable to be used in this project. Besides software and approach, this project also differs in terms of its features which are keypad and fingerprint scanner. It clearly shows that the features used in this project are more efficient compared to the existing system.

There are two inputs used in this project which are keypad and fingerprint scanner. While the outputs are LCD display and magnetic door lock. Based on Figure 39, the fingerprint scanner has also high accuracy with the percentage of 70% for the highest fingerprint. The fingerprint scanner used is in this project also have high efficiency due to its time in obtaining results identifying minutiae which is less than 1 second in identifying minutiae.

For future work it is recommended to add another feature such as smart card to increase the security level. Smart card stores data such as name and ID of the owner and in future it can be used to match the entered ID using keypad.

In conclusion the implementation of a door access system using Arduino. Arduino is a less time-consuming programming because it is an open-source microcontroller. It has high quality system compared to the existing door access system. The features used in this system helps to overcome the security issues. The proposed system overcomes the issues of maintaining the device in future as Arduino comes with ATMEGA2560 microcontroller that can be edited to comply with any changing system. Adopting the keypad and fingerprint scanner features, creating a door access system- Arduino Based brings a whole new high security access system with a simple new approach.

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