ABSTRACT

The sensor is a device used to sense the conversion of physical and non-electrical quantities to be measured and processed. Currently, they are widely used in the fields of cars, industrial production, civil, office, environment... Optical sensor is a type of sensor based on the characteristic properties of light such as particle and wave properties. One of the important applications of optical sensors is the fingerprint sensor used to identify fingerprints, widely used in fingerprint door locks, laptop security, timekeeper… thanks to the security and high convenience. Researching and applying fingerprint recognition to life is one of the important and highly practical. Therefore, we have received and implemented the topic "Close and open the door system using the fingerprint sensor". This report has focused on the basic identification of fingerprints, adding and removing fingerprints. From there, the microcontroller will control the relay to close or open the electric lock. Due to many subjective and objective reasons, the research team has gained some important results in the research and fingerprint identification, but there are still many limitations and shortcomings of the topic that the research team has not overcome yet. So the team would like to thank and look forward to helping teachers and friends.

Bangkok, September 2019

The Author team

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Tran Anh Kiet

……
Bui Dang Khac Huu

The Advisor team

……
Dr. Pasapitch Chujai

……
Dr. Maetee Kunrugsa

……
Ms. Kanyuma Jitjumnong

ACKNOWLEDGMENT

During the period of internship, I received plenty of enthusiastic help and support that helped us to overcome all difficulties and have meaningful time here.

Firstly, I would like to express thanks to the School Board of the King Mongkut's University of Technology Thonburi and the Faculty of Industrial Education and Technology creating favorable conditions for us to take our internship.

Secondly, sincerely thank Dr. Pasapitch Chujai, Dr. Maetee Kunrugsa and Ms. Kanyuma Jitjumnong, our supervisor who gave us useful guidance and advice that help us to finish my internship successfully. From this advice, we can improve my English skills in a job.

Thirdly, I would like to express my gratitude to Prof. Nutthanun Moolsradoo, who gave us chances to an internship here, help us gain a lot of experiences in English communication.

Last but not least, we are grateful to all of the lovely students here who contributed to help us overcome my internship.

In short, we really thank all people helping us to finish this internship report.

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Chapter 1: INTRODUCTION

This chapter will introduce an overview of the project such as why the team made this project, the research method, the layout ...

1.1. The importance of the research

Security is very important for us nowadays, we can store and preserve important things. If we use a normal lock, it is easy to hack and break the lock. One of the things that can answer that problem is fingerprint security. Therefore, this research will help individuals to improve security and applicability in the home.

1.2. Objectives of the research

Learn, analyze fingerprint patterns, control the relay to close or open the electric lock and display information on the LCD screen.

1.3. Research tasks

- Research using the fingerprint sensor module.
- Research using UART communication standards.

1.4. Research methods

- Read documents related to the microprocessor and basic electronics.
- Learn how to use related software
- Look up documents on the Internet.

1.5. The layout of the research

- Chapter 1: Introduction.
- Chapter 2: Fundamental knowledge.
- Chapter 3: Design and experimental procedure
- Chapter 4: Results and dicussion.
- Chapter 5: Conclusion.

Chapter 2: FUNDAMENTAL KNOWLEDGE

This chapter will introduce the important components used in the project including fingerprint sensor, Arduino Uno R3 and electric lock.

2.1. Introduction the Fingerprint sensor module

Fingerprint sensor modules, like the one in the following figure, made fingerprint recognition more accessible and easy to add to your projects. This means that is is super easy to make fingerprint collection, registration, comparison and search.

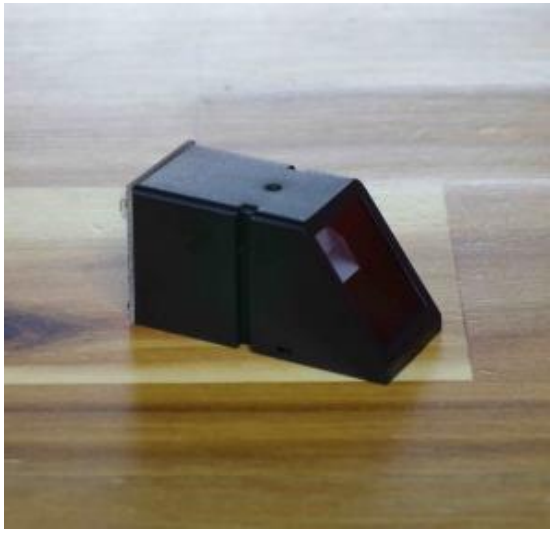

Figure 2.1: A fingerprint sensor

JM-101 fingerprint module is a fingerprint processing module for integrating the light path and fingerprint processing part, has small volume, low power consumption, simple interface, high reliability, fast recognition and good adaptability for dry or wet finger, quick search speed of fingerprint.

2.1.1. Hardware interface

Table 2.1: Hardware interface of the fingerprint sensor

PIN No	Name	Type	Function description
1	+3.3V	In	Module power positive input
2	TX	Out	Serial data output. TTL logic level.
3	RX	In	Serial data input. TTL logic level.
4	GND	-	Signal ground. Connected with power ground internally.

5	Touch	Out	Sense signal output, high level effectively as default.
6	Touch Vin	In	Touch-sensitive power input, 3.3 V power supply.
7	D+	-	USB D+
8	D-	-	USB D-

2.1.2. Hardware connection

It can communicate with the MCU of 3.3V or other MCU through serial port. Considering the overall power consumption of the circuit, the fingerprint module only has two kinds of mode working and not working, no sleep or standby mode. When closing power input of fingerprint module, the fingerprint module will not work. When the MCU functions need to access the fingerprint module, input power to fingerprint module, fingerprint module works, complete the corresponding command. If you don't use the fingerprint module anymore, cut off the power supply, the fingerprint module module turns into not working mode.

2.1.3. Touch-sensitive

The default access voltage of touch-sensitive input power supply is 3.3V. The high level of touch sensing signal output is effective. The touch signal output is low level when there is no finger put on acquisition window. When fingers are put on the acquisition window, the touch signal output changes into a high level. The signal can be connected to interrupt pin or IO port of MCU by a certain circuit. When the induction signal is received, the MCU is awakened to supply power for fingerprint module and then fingerprint module start to work.

2.1.4. Serial protocol

Semi-duplex asynchronous serial communication is adopted.The default baud rate is 57600 bps, which can be customized to other baud rates.The transmitted frame format is 10 bits, a 0 level starting position, 8 data bits (low in front) and 2 stop bits, no check bits.

2.1.5. Time of electrical delay

After the module is supplied power, about 100ms time is required to initiate the work. During this time, the module can not respond to the command of upper machine.

2.1.6. UART data packet transmission

Before UART transmits data packets, it is first to receive the instruction packet of the data packet, then send the request package after the transmission is ready. Finally, begin to transmit the data packet. The data packets mainly include: packet header, chip address, packet identifier, packet length, data and checksum.

Packet identifier of data packet is mainly divided into two types: 02H and 08H. 02H: data packet and follow-up packet . 08H: the last packet, the end packet.The data length is pre-set, mainly divided into: 32, 64, 128, and 256.

For example, the length of data to be transmitted is 1K bytes, and the data in the packet is 128 bytes in advance, so the data of 1K bytes is divided into 8 packets. Each packet includes: 2 bytes packet header, 4 bytes chip address, 1 bytes packet identifier, 2 bytes packet length, 128 bytes data, and 2 bytes checksum. The length of each packet is 139 bytes.In addition, in 8 packets, the packet identifier of first 7 packets is 02H, and the packet identifier of last packet is 08H. Finally, it is important to note that it will not be extended to 139 bytes in any other way if the length of packet does not reach 139 bytes.

2.2. Introduction the Electric Door Lock

Figure 2.2: Electric Door Lock

2.2.1. Features

- Slim design, security, and stability, low power consumption.
- Designed with the open frame type and mount board, easy to install.
- Connected to a stable power supply, the central slug will be drawn and open when it’s energized. And when it is not energized, the slug will stick out and close. It doesn’t use any power in this state.
- Suitable for doors, file cabinets, display cabinets, lockers, drawers, etc.

2.2.2. Specification:

- Voltage: DC 12V
- Current: 1A
- Energized Forms: Intermittent
- Magnetic Force: 0.3kg
- Unlocking Time: 1s
- Continuously Energized: ≤20s
- Rated Stroke: 10mm
- Cable Length: 240mm
- Size: 55×42×29mm

2.3. Introduction the Arduino Uno

Arduino is used for building different types of electronic circuits easily using of both a physical programmable circuit board the usually micro controller and piece of code running on computer with USB connection between the computer and Arduino.

Programming language used in Arduino is just a simplified version of C++ that can easily replace thousands of wires with words.

Figure 2.3: Arduino Uno.

The most important element in Arduino Uno R3 is ATMEGA328P-PU is an 8-bit Microcontroller with flash memory reach to 32k bytes.

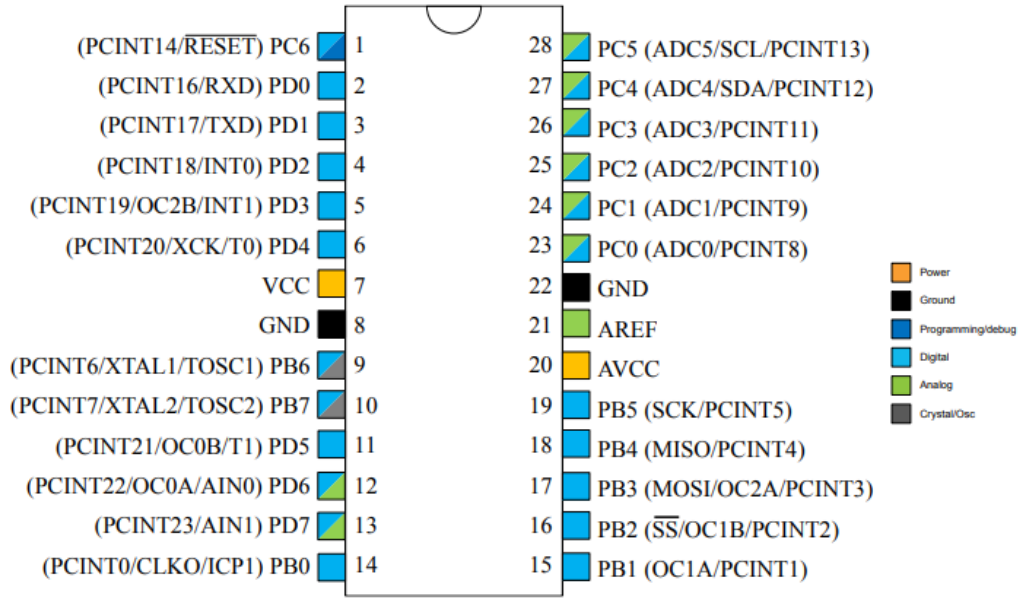

Figure 2.4: Pin configuration of ATMEGA328P-PU.

High Performance, Low Power AVR

❖ **Advanced RISC Architecture**

- 131 Powerful Instructions – Most Single Clock Cycle Execution
- 32 x 8 General Purpose Working Registers
- Up to 20 MIPS Throughput at 20 MHz
- On-chip 2-cycle Multiplier

❖ **High Endurance Non-volatile Memory Segments**

- 4/8/16/32K Bytes of In-System Self-Programmable Flash program memory
- 256/512/512/1K Bytes EEPROM
- 512/1K/1K/2K Bytes Internal SRAM
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
- Data retention: 20 years at 85°C/100 years at 25°C
- Optional Boot Code Section with Independent Lock Bits
- In-System Programming by On-chip Boot Program
- True Read-While-Write Operation
- Programming Lock for Software Security

❖ **Peripheral Features**

- Two 8-bit Timer/Counters with Separate Prescaler and Compare Mode
- One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Mode

- Real Time Counter with Separate Oscillator
- Six PWM Channels
- 8-channel 10-bit ADC in TQFP and QFN/MLF package
- Temperature Measurement
- 6-channel 10-bit ADC in PDIP Package
- Temperature Measurement
- Programmable Serial USART
- Master/Slave SPI Serial Interface
- Byte-oriented 2-wire Serial Interface (Philips I2 C compatible)
- Programmable Watchdog Timer with Separate On-chip Oscillator
- On-chip Analog Comparator
- Interrupt and Wake-up on Pin Change

❖ **Special Microcontroller Features**

- Power-on Reset and Programmable Brown-out Detection
- Internal Calibrated Oscillator
- External and Internal Interrupt Sources
- Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby

❖ **I/O and Packages**

- 23 Programmable I/O Lines
- 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF

❖ **Operating Voltage:**

- 1.8 - 5.5V

❖ **Temperature Range:**

- -40°C to 85°C

❖ **Speed Grade:**

- 0 - 4 MHz@1.8 - 5.5V, 0 - 10 MHz@2.7 - 5.5.V, 0 - 20 MHz @ 4.5 - 5.5V

❖ **Power Consumption at 1 MHz, 1.8V, 25°C**

- Active Mode: 0.2 mA
- Power-down Mode: 0.1 µA
- Power-save Mode: 0.75 µA (Including 32 kHz RTC)

Chapter 3: DESIGN AND EXPERIMENTAL PROCEDURE

This chapter will cover the designs and programming parts that the team has made, including system diagram design and algorithms.

3.1. Block diagram

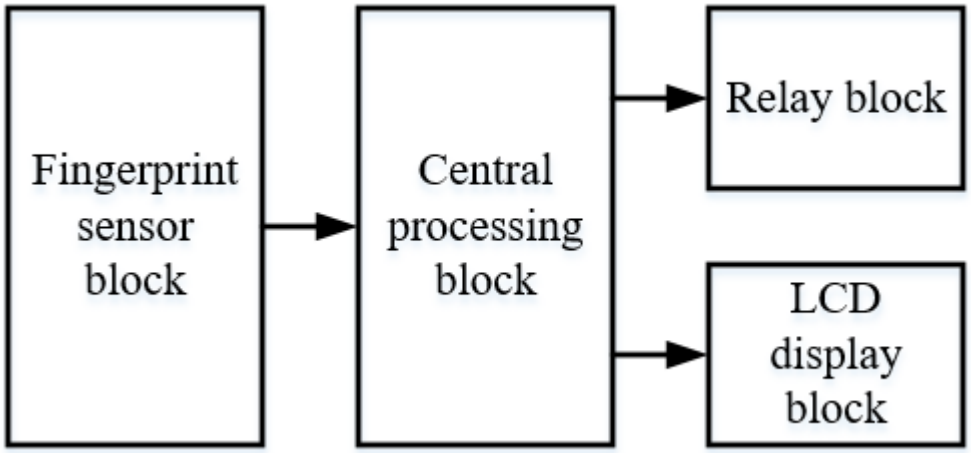

Figure 3.1: Block diagram of the system

The function of each block:

- The fingerprint sensor block: This block is used to receive fingerprints for processing.
- The central processing block: This block is used to receive data from the fingerprint sensor, send those data to the LCD display block and control the relay block.
- The relay block: This block is used to control the electric lock.
- The LCD display block: This block is used to display information.

3.2. Algorithm flowchart

3.2.1. Mainprocess

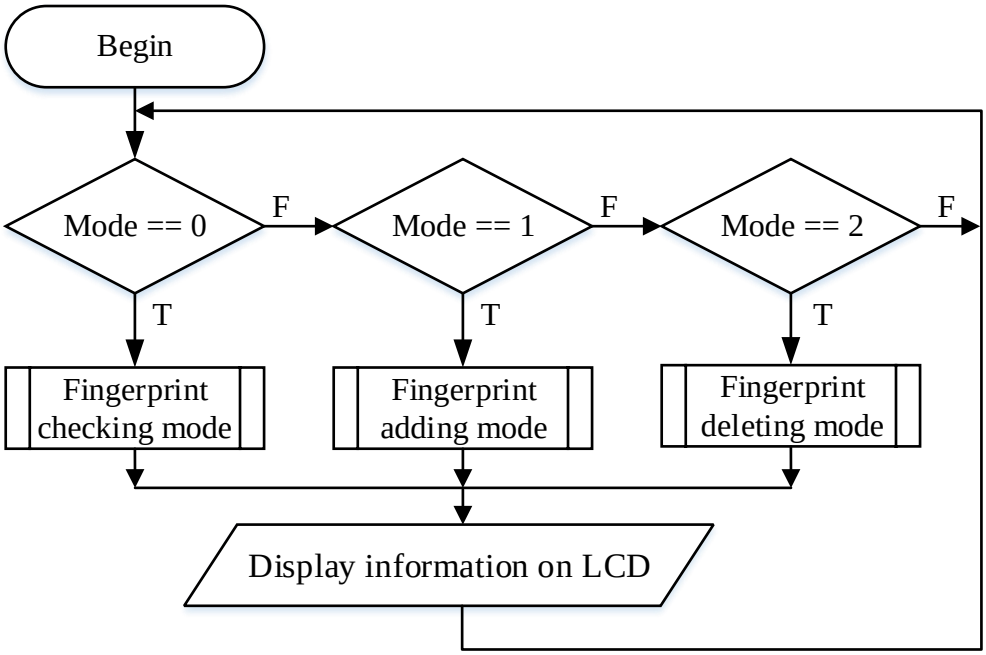

Figure 3.2: Mainprocess of the system

Explain the flowchart:

- The system will operate with 3 modes: checking mode, adding mode and fingerprint deleting mode.
- The system will select the mode based on the Mode button:
  - If Mode = 0, the system will select the fingerprint checking mode.
  - If Mode = 1, the system will select the fingerprint adding mode.
  - If Mode = 2, the system will select the fingerprint deleting mode.
- All information of the mode will be displayed on the LCD.

3.2.1. Subprocess

❖ **Subprocess Fingerprint checking mode**

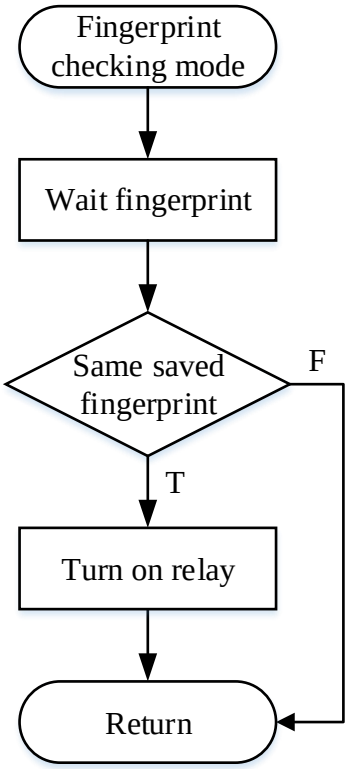

Figure 3.3: Subprocess Fingerprint checking mode

Explain the flowchart:

- In this mode, the system will wait for a fingerprint to check.
- If there is a fingerprint, the system will check if it matches the saved fingerprint, if yes, the relay will be turned on, otherwise return to the main program, notifying that the fingerprint does not match on the LCD.

❖ **Subprocess Fingerprint adding mode**

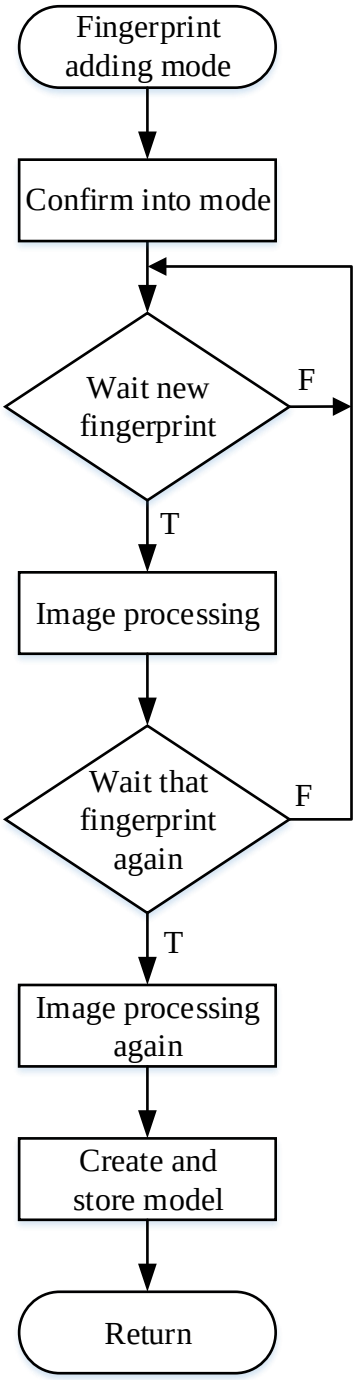

Figure 3.4: Subprocess Fingerprint adding mode

Explain the flowchart:

- In this mode, the system will confirm to enter the fingerprint adding mode with one of the saved fingerprints.
- After that, the system will wait for a new fingerprint. If yes, the system will process the image of that fingerprint pattern. Then, the system will ask to

place that fingerprint again. If the fingerprint matches, the image will be processed again, then the model will be created and saved. If the fingerprint doesn't match, start over again, adding a new one.

❖ **Subprocess Fingerprint deleting mode**

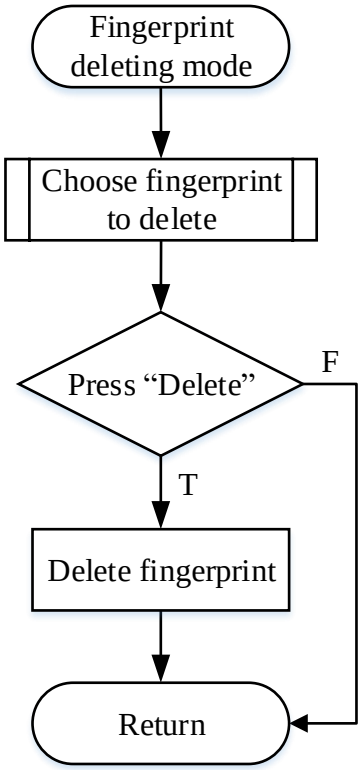

Figure 3.5: Subprocess Fingerprint deleting mode

Explain the flowchart:

- In this mode, the system will choose the fingerprint you want to delete.
- After selecting the fingerprint, if the Delete button is pressed, the system will delete that fingerprint. otherwise return to the main program.

❖ **Subprocess Choose fingerprint to delete**

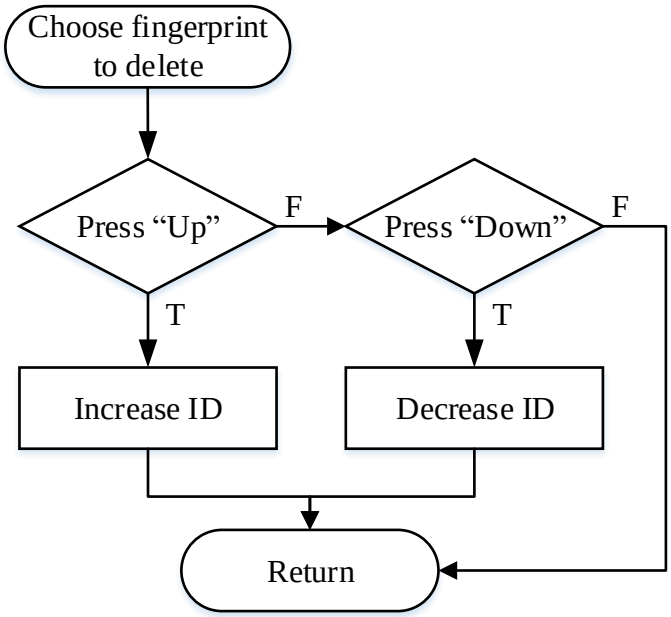

Figure 3.6: Subprocess Choose fingerprint to delete

Explain the flowchart:

- In this subprocess, we will select the fingerprint to be identified by the ID.
- If the Up or Down button is pressed, the ID will increase or decrease accordingly, then return to the subprocess Fingerprint deleting mode.

Chapter 4: RESULTS AND DICUSSION

This chapter will cover the results the team has achieved after completing the project, including hardware and software.

4.1. Box design components

Figure 4.1: Main interface of fingerprint lock.

4.2. Results

Case 1: Correct fingerprint identification

Figure 4.2: Correct fingerprint identification.

When the fingerprint is correctly identified, the door lock will automatically open and can be imagined we can enter the house then if you put your finger is deviated with the sensor sometimes the system will not recognize correctly.

Case 2: Wrong fingerprint identification

Figure 4.3: Incorrect identification of fingerprints.

When the fingerprint is incorrectly identified the door lock will not open, we can review whether the finger fits with the sensor and most importantly the finger is not wet.

Case 3: Add fingerprints

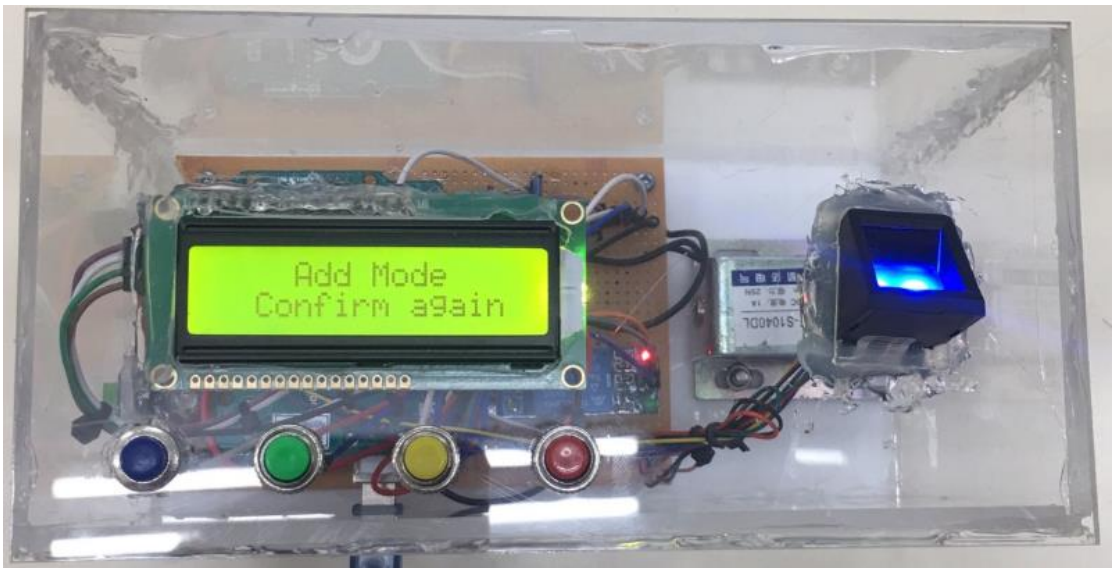

Figure 4.4: Process of adding a new fingerprint – step 1.

Figure 4.5: Process of adding a new fingerprint – step 2.

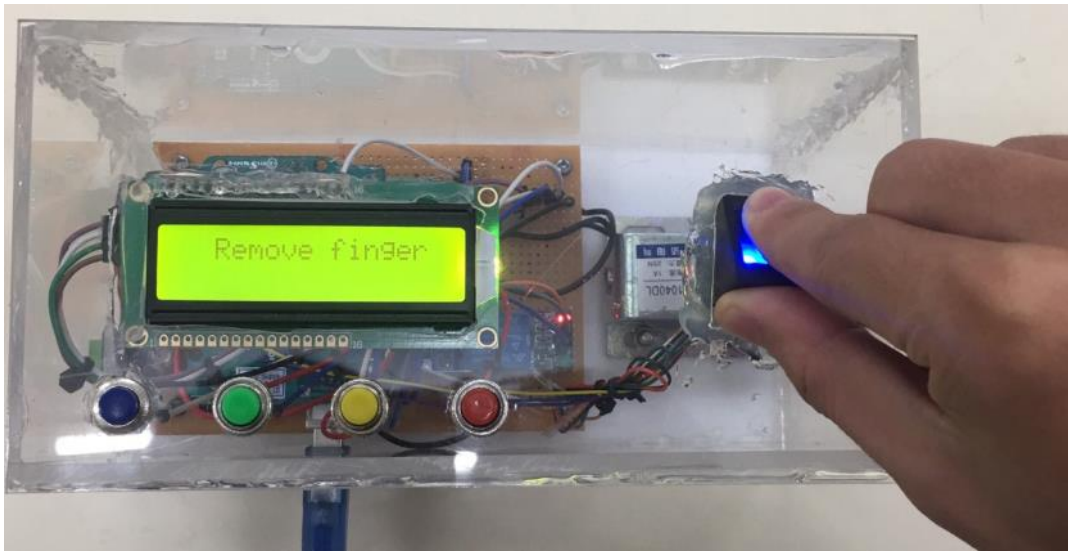

Figure 4.6: Process of adding a new fingerprint – step 3.

Figure 4.7: Process of adding a new fingerprint – step 4.

Figure 4.8: Process of adding a new fingerprint – step 5.

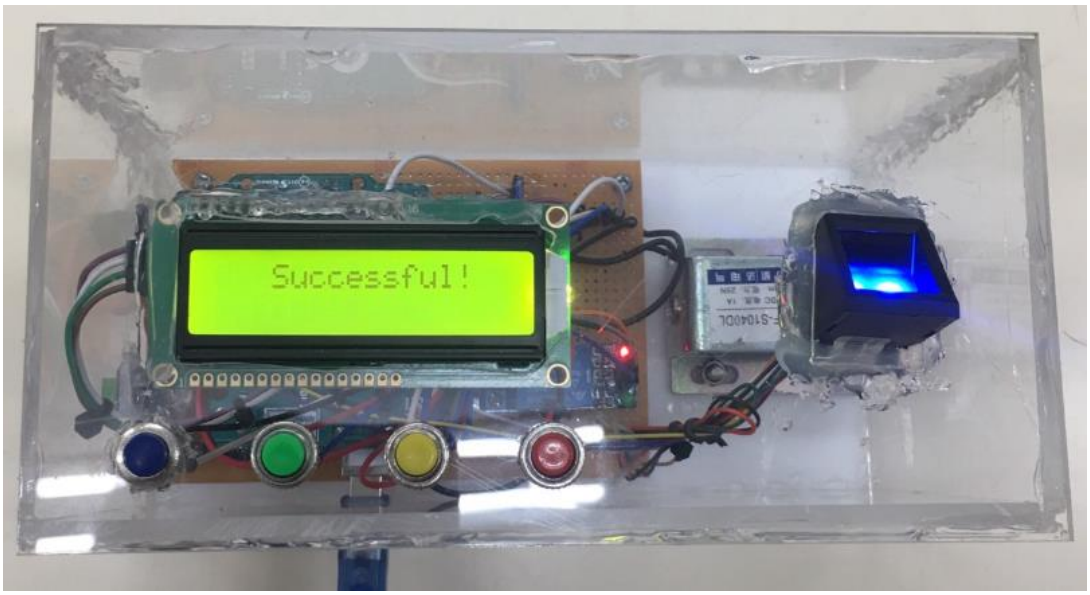

Figure 4.9: Add fingerprint successfully.

We can add fingerprint templates up to 127 samples.

Case 4: Delete fingerprints

Figure 4.10: Process of deleting a fingerprint – step 1.

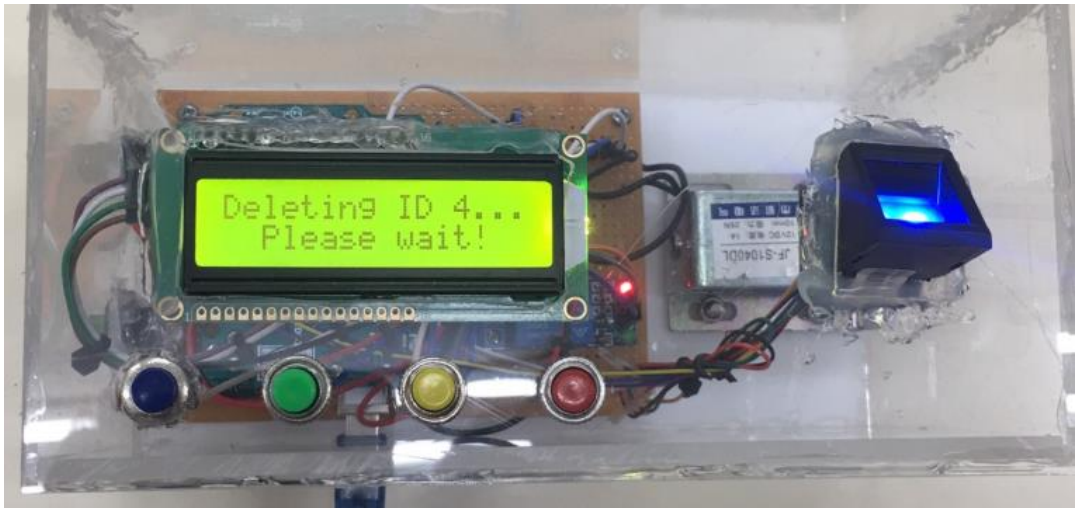

Figure 4.11: Process of deleting a fingerprint – step 2.

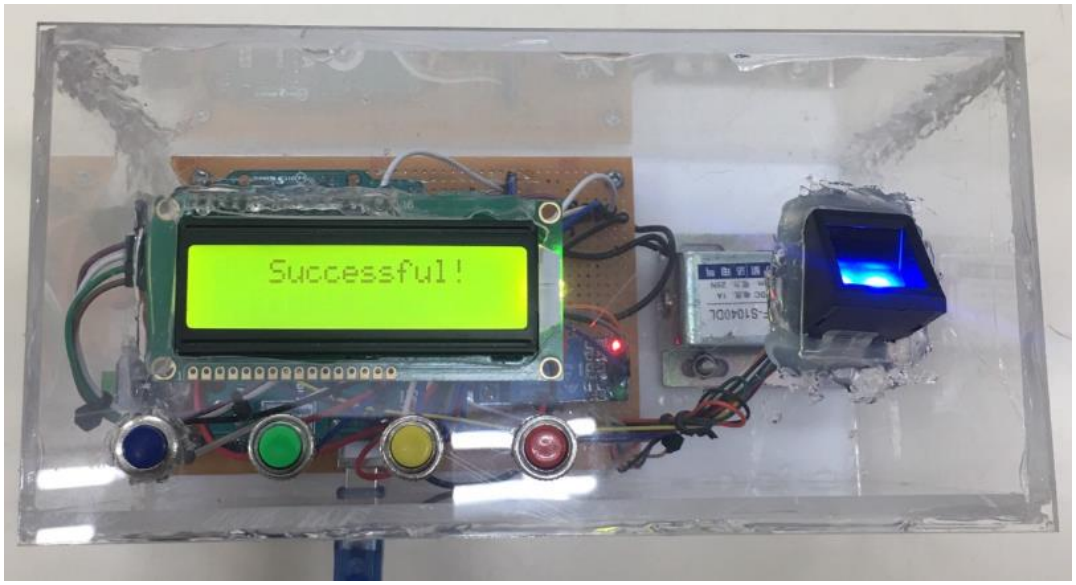

Figure 4.12: Delete fingerprint successfully.

Similar to adding a fingerprint, if there are unused fingerprints and want to free memory we can delete them. We can delete any fingerprint but make sure there is always one fingerprint in memory to handle other functions.

Chapter 5: CONCLUSION

This chapter will summarize the advantages, disadvantages and future development direction of the project.

5.1. Conclusion

Through the above results, the group has summarized the following points:

Advantages:

- Compact circuit size, boxed for easy transport.
- Reasonable price.
- High security.
- Fast fingerprint recognition speed.

Disadvantage:

- Box design was not beautiful.
- The sensor is made of plastic so it is easily damaged.

5.2. Development

- Collapse the circuit.
- Boxed to other standards such as no dust, scratches.
- Data management by web.

REFERENCES

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