INTERNATIONAL UNIVERSITY - VIETNAM NATIONAL UNIVERSITY, HCMC

School of Computer Science & Engineering

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FINGERPRINT RECOGNITION

FUNDAMENTAL CONCEPTS OF DATA SECURITY

First semester, 2020 – 2021

Lecturer: Dr. Dang Tran Khanh

Group 9:

Full name	***Student's ID***
NGUYỄN THỊ TRƯỜNG AN	ITDSIU18002
NGUYỄN TRẦN KHÁNH DUY	ITDSIU18049
NGUYỄN NGỌC KHÁNH	ITDSIU18025

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1. INTRODUCTION

1.1. Description of the topic

- Recognition of persons by means of biometric characteristics is an emerging phenomenon in modern society. It has received more and more attention during the last period due to the need for security in a wide range of applications. Among the many biometric features, the fingerprint is considered one of the most practical ones.
- Another reason for the popularity of fingerprints is the relatively low price of fingerprint sensors, which enables easy integration into PC keyboards, smart cards and wireless hardware, etc.
- Any Fingerprint Identification System (FIS) has two phases, fingerprint enrolment and fingerprint matching (identification or verification).
- First you have to go through a process called **enrollment**, where the system learns about all the people it will have to recognize each day. During enrollment, each person's fingerprints are scanned, analyzed, and then stored in a coded form on a secure database. Typically it takes less than a half second to store a person's prints and the system works for over 99 percent of typical users (the failure rate is higher for manual workers than for office workers).
- Once enrollment is complete, the system is ready to use—and this is the second stage, known as **identification**. Anyone who wants to gain access has to put their finger on a scanner. The scanner takes their fingerprint, checks it against all the prints in the database stored during enrollment, and decides whether the person is entitled to gain access or not. Sophisticated fingerprint systems can verify and match up to 40,000 prints per second!

1.2. Objectives of the topic

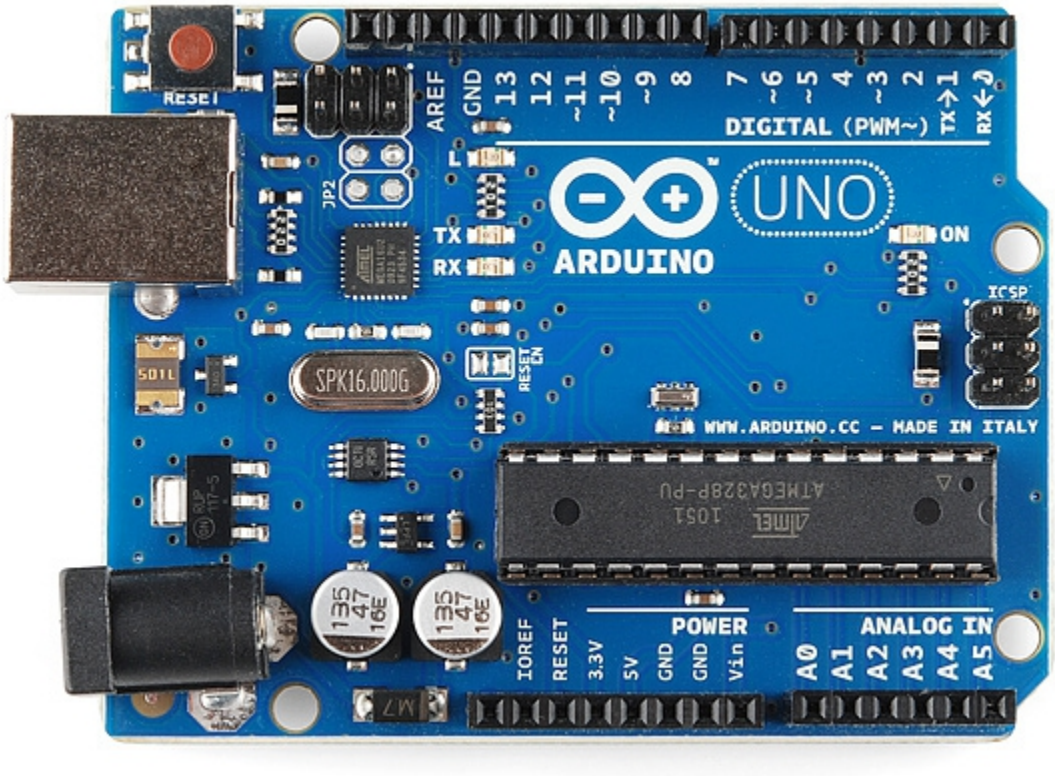
The main objective of this lab project aims to implement the Fingerprint Sensor Module with the Arduino that can enroll a new fingerprint and verify fingerprint.

2. REQUIREMENTS

2.1. Arduino

- ***Arduino*** is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

- The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board -- you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package.



- Thanks to its simple and accessible user experience, Arduino has been used in thousands of different projects and applications. The Arduino software is easy-

to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux.

- Currently on the market there are many versions of Arduino such as Arduino Uno R3, Arduino Uno R3 CH340, Arduino Mega2560, Arduino Nano, Arduino Pro Mino, Arduino Lenadro, Arduino Industrial...

➔ WE ARE USING ARDUINO UNO R3 FOR OUR PROJECT.

2.2. Fingerprint sensor

- Fingerprint sensors are widespread in smartphones and other wearables, as well as in smart industry and smart home applications for entry identification and data security. The two most common fingerprint sensors in use today are optical sensors and capacitive sensors.
- Optical fingerprint sensors have been around for a while. The way an optical scanner works is by shining a bright light over your fingerprint and taking a digital photo. The light-sensitive microchip makes the digital image by looking at the ridges and valleys of the fingerprint, turning them into 1's and 0's, and creates the user's own personal code. Figure 1 shows how the light source reads the fingerprint and where that information goes. The disadvantage to this, while highly unlikely, is that a digital photo can be replicated.

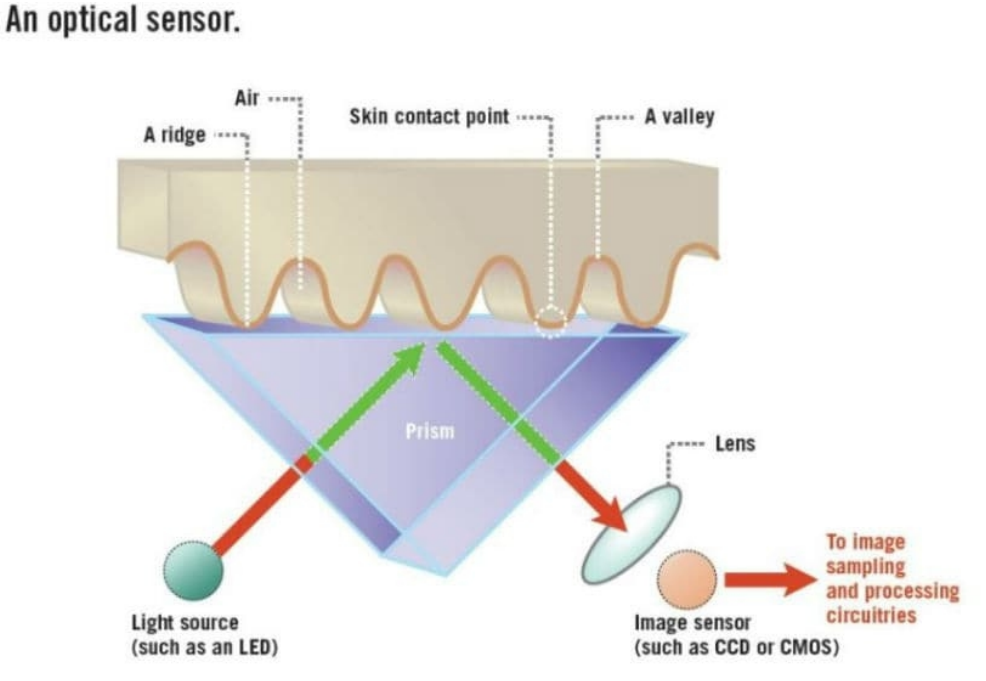


Figure 1: Light source taking a digital image of a fingerprint.

- In today's world, capacitive fingerprint scanners are more common and found on phones. Similar to the capacitive touchscreen, it measures your finger by using human conductivity, creating an electrostatic field, and creating a digital image based on the electrostatic field.
- To go into more detail, the capacitive fingerprint scanner uses tiny capacitor array circuits that track the detail of a fingerprint. It uses the ridges of your fingerprint that is placed over the conductive plates which changes the charge stored in the capacitor, while the valleys (air gaps) leave the charge on the capacitor unchanged. An operational amplifier integrator circuit tracks these changes that can then be recorded by an analog-to-digital converter, where this digital data can be analyzed. Figure 2 shows the physics behind this.

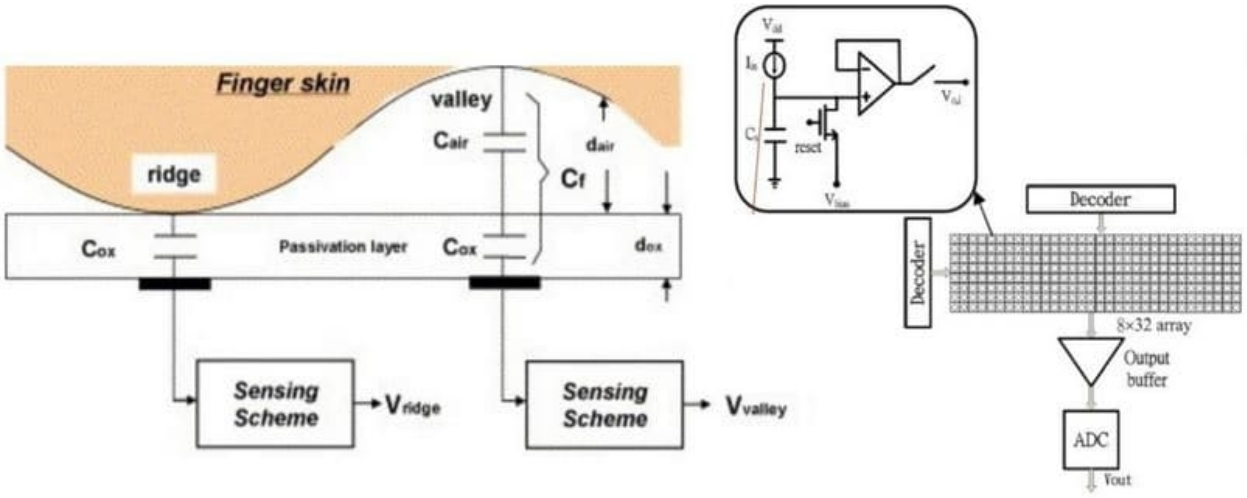


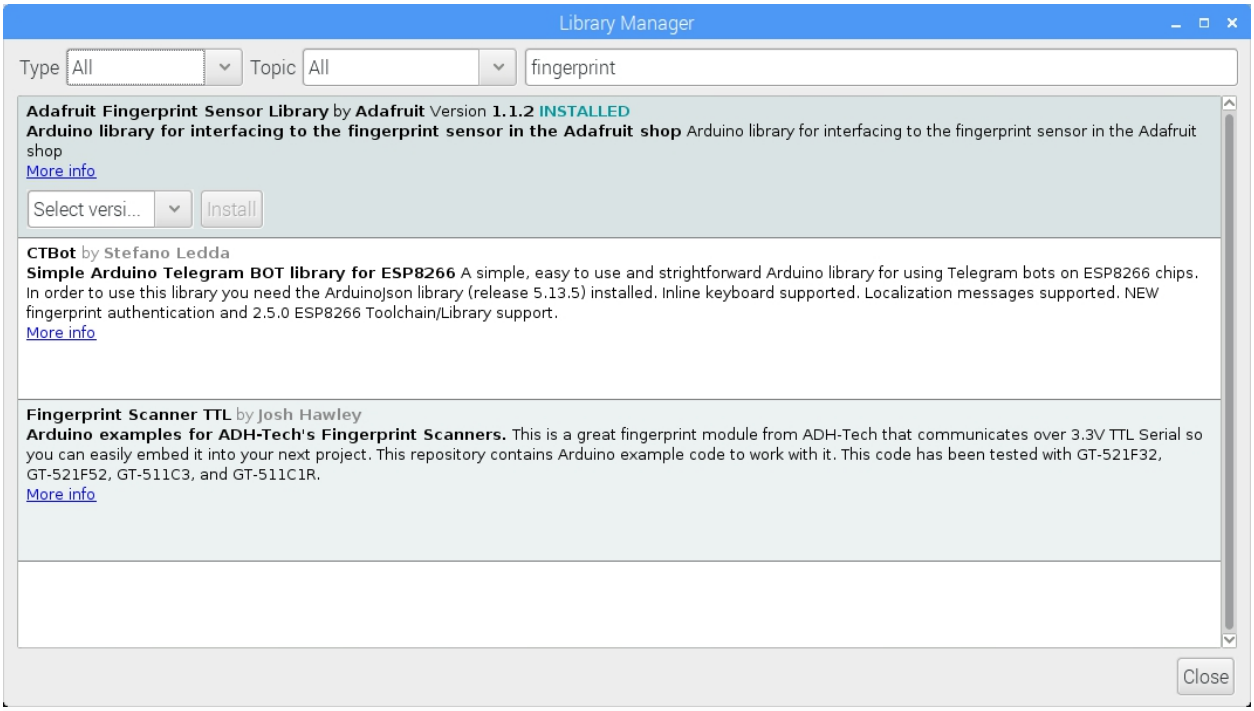
Figure 2: How a capacitive fingerprint scanner captures digital images

- This technology is a lot harder to bypass since an image cannot get passed capacitive fingerprint sensor and other materials will record different changes in charge on the capacitor. While it is more expensive, it's also more complex and secure.

  ➔ WE ARE USING OPTICAL FINGERPRINT SENSOR AS608.

2.3. Downloading the Adafruit Fingerprint Library

Adafruit has a library that is simple and easy to understand. In order to download the library, open the Library Manager and type in 'fingerprint;' the library is shown below as the "Adafruit Fingerprint Sensor Library by Adafruit."



The Adafruit library has multiple examples, two of which will be the basis for the rest of this tutorial. The two examples are named:

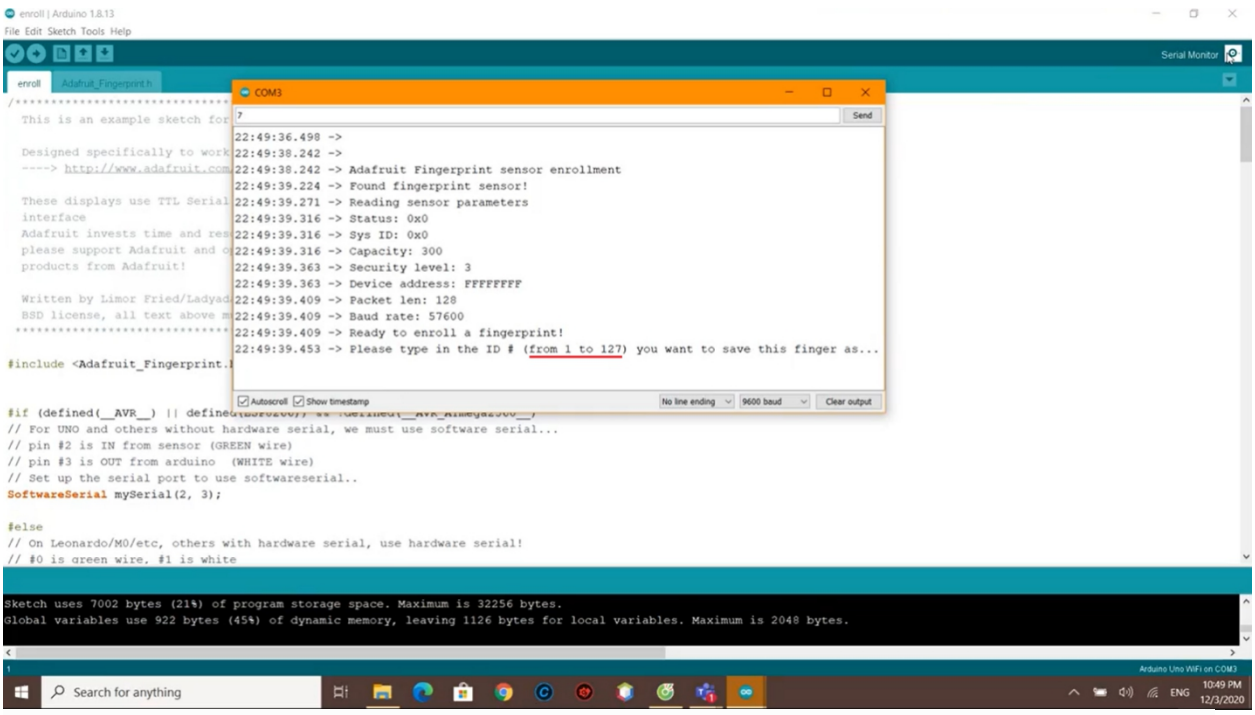
- enroll
- fingerprint

The enroll example should be uploaded before testing the other algorithms. This process is outlined in demo.

3. DEMO

3.1. Enrolling a new fingerprint to identify

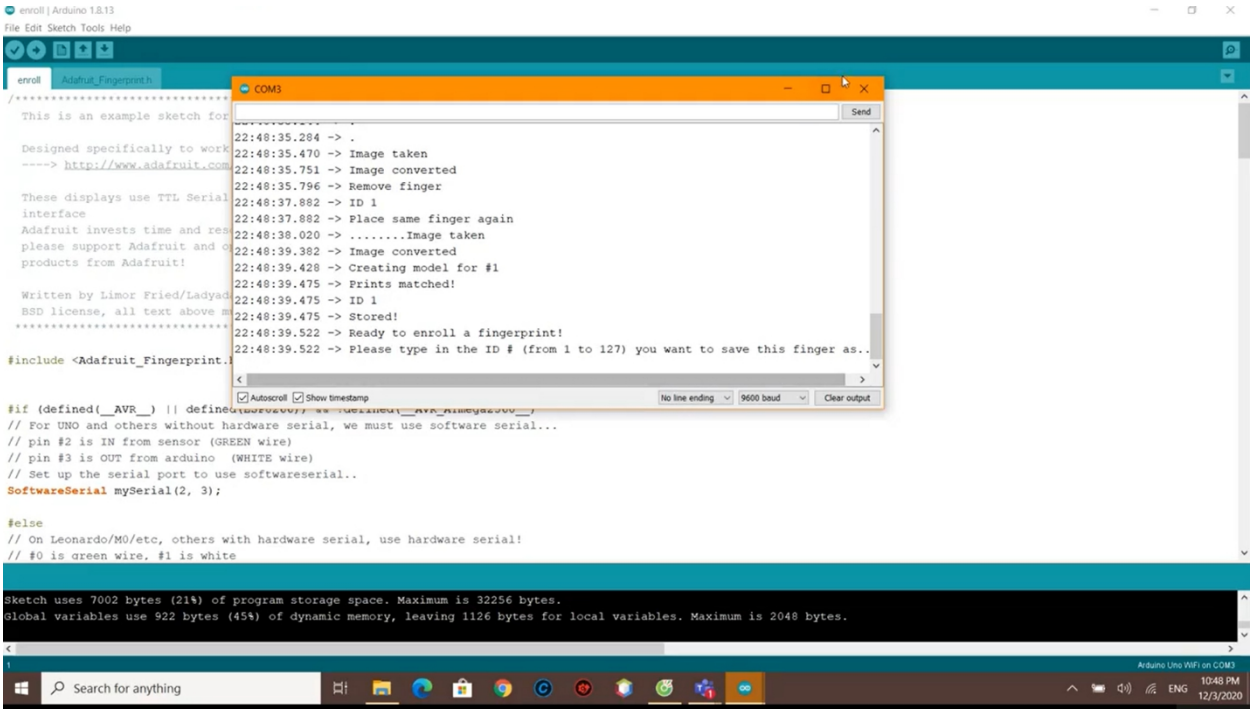
- First we need to train the fingerprint sensor to recognize the fingerprints that we want to accept.
- The user will allow the user to create up to 127 unique fingerprints that can be recalled later.



- The general process for enrolling a fingerprint is as follows:

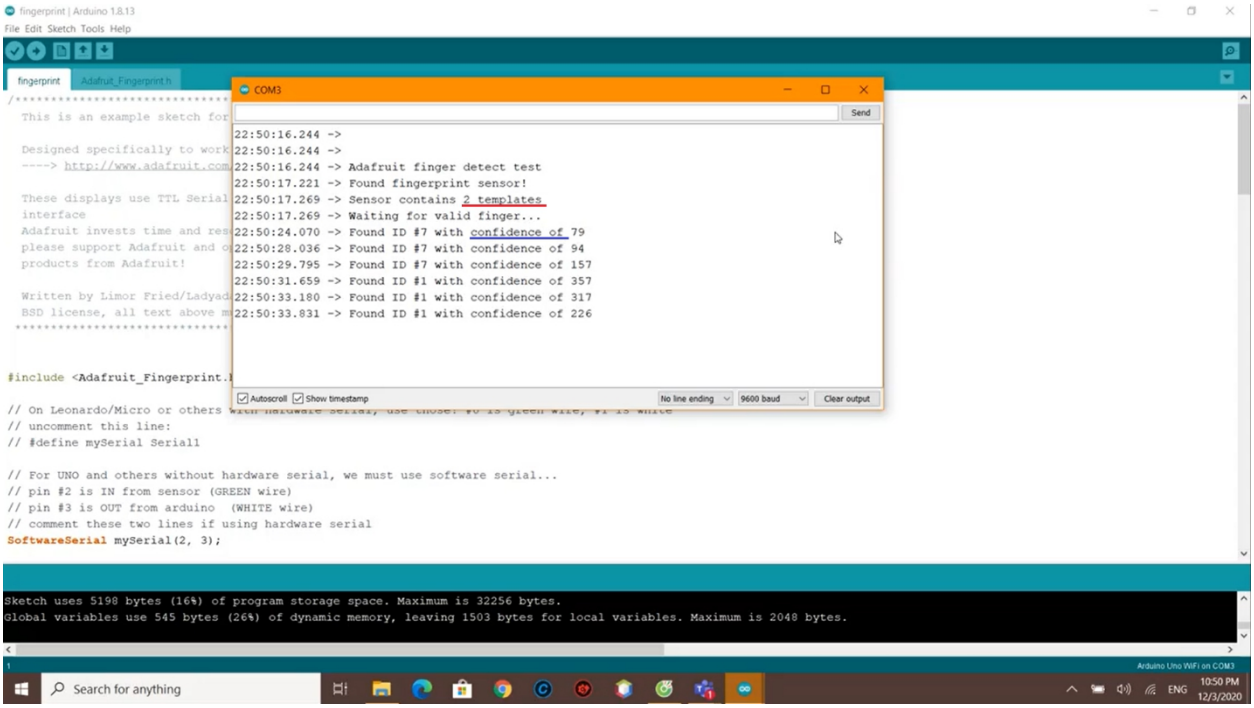
1. Enter integer
2. Place finger on sensor
3. Remove finger when instructed
4. Place finger on sensor again
5. Wait for the sensor to verify the print and printout “Stored!”

Below is a screenshot of the example output onto the Serial Port using 1 as the fingerprint index.



3.2. Fingerprint identification

At this point, the assumption is that one or more fingerprints have been enrolled into the AS608 sensor. Now, we can test if the Arduino and fingerprint module can re-identify those enrolled fingerprints and deny unfamiliar fingerprints. Of course we have to have **enrolled** a fingerprint first! If we have not yet, nothing printouts.



- 2 templates mean there are 2 fingerprints stored.
- The 'confidence' is a score number (from 0 to 255) that indicates how good of a match the print is, higher is better. Note that if it matches at all, that means the sensor is pretty confident so you don't have to pay attention to the confidence number unless it makes sense for high security applications.

Videos of demonstration and source code link:

- The video demonstration of our group: https://tinyurl.com/yxbwmuz7
- The video demonstration on the Internet in details: https://tinyurl.com/yxwazshf
- Source code: https://tinyurl.com/y59ohee5

4. CONCLUSION

4.1. Project summary

This lab project introduced the basic principles of working with the AS608 fingerprint module with the Arduino platform. Specifically, the Adafruit library was used, which handles a lot of the interaction involved with identifying and enrolling fingerprints. The simplest implementation of the fingerprint sensor was explored, first by enrolling a unique fingerprint, and then verifying the print later. In the second video demonstration, the acceptance of recognized fingerprints and the denial of unrecognized fingerprints was illustrated by the different LEDs. The applications in fingerprint identification are numerous and, at the least, fun and interesting. The introduction given here is meant as a stepping stone for getting involved with fingerprint identification with Arduino, and with the inexpensive and easy-to-use hardware and libraries available, the possibilities are endless from here!

4.2. Each member's contributions

17/10 – 18/10	Discussion and choose the topic
18/10 – 19/10	Prepare project proposal
20/10	Proposal day
24/11 – 30/11	Implement the Fingerprint Sensor Module with the Arduino (Trường An)
30/11	Prepare powerpoint slides (Khánh Duy)
01/12	Presentation day
03/12 – 07/12	Prepare, finalizing report (Ngọc Khánh)
08/12	Submission day

REFERENCES

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https://learn.adafruit.com/adafruit-optical-fingerprint-sensor?view=all

https://www.arrow.com/en/research-and-events/articles/how-fingerprint-sensors-work

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