



# LESSON PLAN: Development of a Fingerprint Authentication System to Open A Door/Drawer

## Lesson Description

This lesson will help students see the need for biometric authentication. Specifically, it will acquaint students with the methodology that lies behind the use of fingerprint capture, storage, and comparison to provide authentication. Students will use an Arduino to build a device that uses fingerprint authentication to open a door secured with a solenoid-type lock. They will then evaluate the effectiveness of the system that they have built.

## Prerequisite Knowledge

Students should have some experience with coding using any language for a code exploration/analysis component of the lesson. Some practice using a breadboard and an Arduino will be helpful but not necessary.

## Length of Completion

The lesson is designed to be completed in seven class periods that are approximately 45 minutes in length.

## Level of Instruction

This lesson is intended for high school students.

## Applicable Concepts

The lesson will involve all of the GenCyber cybersecurity concepts:

- **Availability:** A captured fingerprint stored in a system is available immediately for authentication purposes.

- **Confidentiality:** A captured fingerprint cannot be viewed. It is converted into a hashed numeric value that cannot be reversed to reveal the original fingerprint.
- **Integrity:** Once captured, a fingerprint cannot be changed because it has been hashed into a numeric value that cannot be reversed to reveal the original fingerprint.
- **Think Like an Adversary:** A fingerprint could perhaps be retrieved by an adversary and then copied, but hashing encryption makes such a scenario extremely improbable.

## Materials And Resources That Are Needed

fingerprint sensor

Arduino (processor) or Evive prototype platform

TFT touch screen

solenoid

miscellaneous materials for door (cardboard, possibly wood or plastic, hardware, glue, tape)

battery or DC current source

for day-3 warm up demo: 1-meter length of coated copper wire, a small tube (approximately 2-cm diameter), a 6-volt battery, a small piece of sandpaper to sand the ends of the wire use to make the solenoid coil

A PowerPoint presentation with instruction, all necessary information, and construction links is provided as a separate file.

## LEARNING OUTCOMES

- 1.1 The student will be able to describe the need for fingerprint authentication.
- 1.2 The student will be able to describe the fingerprint enrollment process.
- 1.3 The student will be able to describe the fingerprints inquiry and matching process. The student will be able to describe these devices: fingerprint sensor, an Arduino (processor), a TFT touch screen, and a solenoid.
- 1.4 The student will be able to explain the purpose of a prototype platform.
- 1.5 The student will build a system for fingerprint enrollment and inquiry. Details: the system will use a fingerprint sensor, an Arduino (processor), a TFT touch screen, and a solenoid.

- 1.6 The student will be able to inject available enrollment and inquiry code into the Arduino.
- 1.7 The student will build a simple door to which the system will be connected.
- 1.8 The student will test the efficacy of the system and make an estimate of its reliability.

## **Standards Addressed:**

### **NYSED Standards**

9-12.IC.1 Evaluate the impact of computing technologies on equity, access, and influence in a global society.

9-12.IC.4 Assess personal and societal trade-offs related to computing technologies and data privacy.

9-12.CT.2 Collect and evaluate data from multiple sources for use in a computational artifact.

9-12.CT.4 Implement a program using a combination of student-defined and third-party functions to organize the computation.

9-12.CT.9 Systematically test and refine programs using a range of test cases, based on anticipating common errors and user behavior.

9-12.CY.2 Describe physical, digital, and behavioral safeguards that can be employed to protect the confidentiality, integrity, and accessibility of information.

9-12.DL.7 Design and implement strategies that support safety and security of digital information, personal identity, property, and physical and mental health when operating in the digital world.

## *LESSON DETAILS*

### **Essential Questions**

1. Are fingerprints unique?
2. What is the fingerprint authentication? What is its value?
3. What is an Arduino?
4. What is a TFT screen?
5. What is a solenoid?

6. How can a solenoid be used as a locking mechanism?
7. What are fingerprint minutiae? What is their value in authentication?
8. What is fingerprint enrollment?
9. What is a fingerprint inquiry?
10. In simple terms, how can a fingerprint match be made?
11. How can the efficacy of a fingerprint authentication system be determined?

## Essential Vocabulary

**Arduino:** an open-source electronic platform based on easy-to-use hardware and software.

**Authentication:** the process of determining whether someone or something is, in fact, who or what it says it is.

**Biometrics:** the measurement and statistical analysis of people's unique physical and behavioral characteristics.

**Enrollment:** the process of capturing a person's fingerprint for use in future authentication.

**Evive:** a small all-in-one electronics prototyping device

**minutiae:** specific points in a fingerprint; the small details in a fingerprint that are most important for fingerprint recognition.

**sensor:** a device that detects or measures a physical property and records, indicates, or otherwise responds to it.

**solenoid:** a coil of wire usually in cylindrical form that when carrying a current acts like a magnet so that a movable core is drawn into the coil when a current flows.

**TFT screen:** a thin film transistor; a type of LCD flat-panel display screen, in which each pixel is controlled by from one to four transistors.

## Assessment

Materials for code analysis, presentation review, testing (enrollment and verification), and project evaluation are provided as separate files.

## LESSON IMPLEMENTATION

### Plan Implementation Outline

#### Day 1

- 1) Warm Up: Have students use an ink pad to make a thumbprint on a notecard. Working in a group, students should look at a selection of the cards (based on class size) to identify what they see as similarities.
- 2) Show PowerPoint: Development of a Fingerprint Biometrics Authentication System to Unlock a Door / Drawer (Part IA)
- 3) In class: Activity Sheet—Fingerprints Basics
- 4) Homework: Activity—Minutiae Practice (Quizlet)

#### Day 2

- 1) Show PowerPoint: Development of a Fingerprint Biometrics Authentication System to Unlock a Door / Drawer (Part IB)
- 2) In class: Activity Sheet—Fingerprint Matching
- 3) Assessment/Homework: Presentation Review #1

#### Day 3

- 1) Warm-Up: The teacher will have a student make simple solenoid coil while the other students observe. Another student will connect it to a 6-volt battery to attract a small paper clip into the coil.
- 2) Show PowerPoint: Development of a Fingerprint Biometrics Authentication System to Unlock a Door / Drawer (Part 2)
- 3) In class: Activity Sheet—Door / Drawer Design
- 4) Assessment/Homework: Presentation Review #2

#### Day 4

- 1) Activity: Door / Drawer Construction
- 2) Activity: Begin Circuit Assembly

#### Day 5

- 1) Activity: Complete Circuit Assembly
- 2) Activity: Integrate Door / Drawer with Circuitry
- 3) Activity: Enrollment and Verification

## Day 6

- 1) Activity: Enrollment and Verification (continued)
- 2) Homework: Code Analysis

## Day 7

- 1) Project Evaluation / Discussion
- 2) Review for Final Teacher-Created Assessment

## REFERENCES

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