ECE- 411 Practicum: Product Design Specification (PDS)

1. Executive Summary

Security has always been one of humanity's most basic concerns, especially when it comes to a person's home. Basic door locks have remained largely unchanged for centuries. But now, thanks to electronic actuators and the ever-shrinking physical footprint of inexpensive microcontrollers, it is now easier than ever to advance this technology we use on a daily basis, and make it easier than ever for a user to securely lock and unlock their doors.

We are planning on building a fingerprint door lock system which will eliminate the need for physical keys, which can be lost or stolen. With this product, the user will no longer have to carry, keep track of, and protect a physical key, because the only thing they need to unlock their door is their fingerprint—something they will always have on them, and which can't be stolen.

2. Market Analysis

2.1 Intended Customers

Our product is primarily targeted toward residential homeowners. Specifically, those who value a balance between not only security of their home and belongings, but also convenience of access to those things.

2.2 Competition

Our primary competition is with traditional physical key locks, as well as a limited number of biometric lock companies.

Compared to a traditional physical key lock, the primary benefit of our product is the convenience of a digital lock that opens with only a fingerprint. This eliminates the need to carry and protect a physical house key. The fingerprint lock also allows users to open their door without fishing out their keyring and sorting through their many keys.

While a handful of biometric fingerprint lock companies exist on the market today, these systems are all incredibly expensive, costing anywhere from $150 to well over $1000. Because the technology on which our product is based is so simple and inexpensive, we can easily undercut the market, potentially by half or more.

2.3 Pricing

We expect the components for this system to cost under $50 per unit. This will allow us to sell at a price from $50–$75, which is well under that of even our least expensive competitors.

3. Requirements

The minimum viable product must allow an end user to unlock the door or enclosure onto which it is installed with only their fingerprint—no other object or device required. Additionally, the device must allow a user to add or change enrolled fingerprints entirely on the device itself.

4. System Architecture

At its core, the device will be controlled by a small microcontroller board (an Arduino UNO will suffice). The microcontroller will receive input from the fingerprint sensor for enrolling fingerprints and operating the lock. When an enrolled fingerprint is detected, the microcontroller will output a 5-volt signal to a 12V relay, which will then power the solenoid lock module.

The lock will remain disengaged for a specified amount of time before automatically reengaging. The design of the bolt in the lock module will allow the door to be shut even if the lock is engaged.

The button inputs and LCD screen will be the method by which a user configures the device, including setup, options, and changing or enrolling new fingerprints.

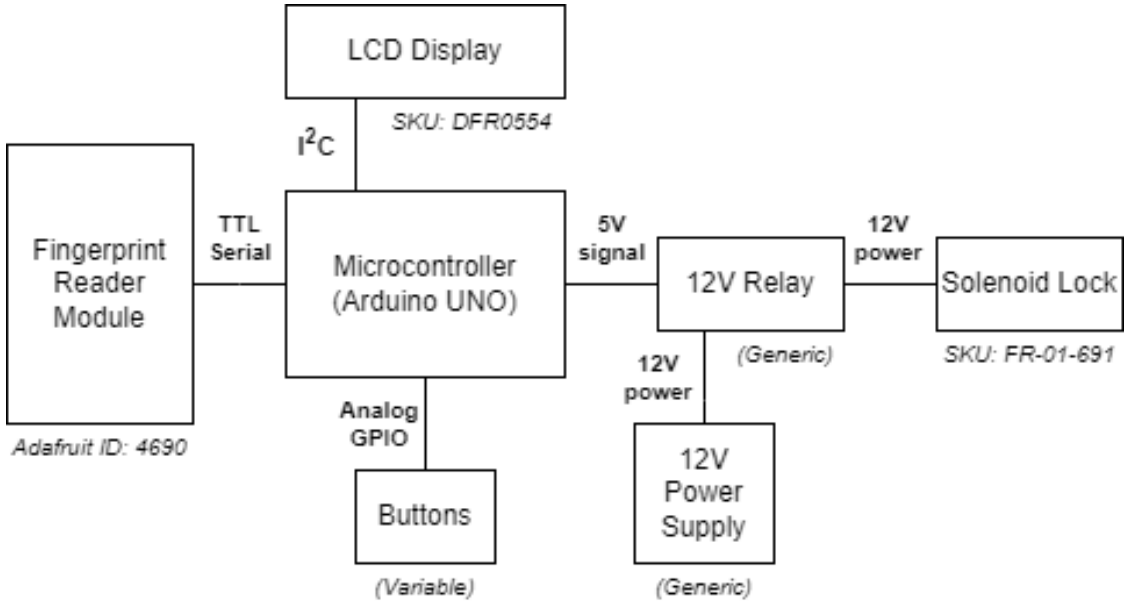

Figure 4.1 — Level 1 block diagram for biometric locking device

5. Design Specification

- Microcontroller:
  - Any miniature microcontroller board
    - We anticipate using an Arduino Uno or similarly inexpensive microcontroller board.
- Sensors:
  - Biometric fingerprint sensor module
    - Adafruit product ID 4690
  - Button(s) and/or keypad for configuration
    - Either a keypad module, or an array of momentary pushbutton switches.
- Actuators:
  - Solenoid door lock module
    - Retracts lock tongue to disengaged lock. Specifically designed to allow the door to be shut while the lock is engaged.
    - FlyRobo SKU: FR-01-691

    - 12V relay module
        - Generic 12V relay which will detect a 5V output signal from the microcontroller, then deliver 12V power to the solenoid lock module.
    - LCD display module
        - I^2C 16x2 LCD display module provides user feedback during operation.
    - 12V power supply
        - Generic 12V power supply module
        - If possible, a backup battery system (even low-capacity) would be ideal
- Additional Details
    - Development environment:
        - While Arduino may not be the most robust software environment, it is nevertheless very simple and accessible, which should ease development.
    - PCB:
        - We will be designing and printing a custom PCB which will accept connections to the control buttons and LCD, as well as any electronic components needed for this segment of the design.