# Smart Portable Key

## Project Proposal

## ECE 445

**TA: Igor Fedorov**

**Aashay Shah**
**Akshay Chanana**

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# 1.0 Introduction

## 1.1 Statement of Purpose

This project was chosen because there are no devices presently available in the market that allows the user to wirelessly access multiple locks used for general purposes. There is a high demand for secure portable locks and this project aims to fulfill that need. The main focus will be to provide a portable and secure lock system with a smart key that will be used to unlock multiple locks wirelessly.

## 1.2 Objectives

### 1.2.1 Goals:

- Develop a portable secure key that can unlock multiple locks
- Secure the key with a fingerprint scanner and enable encryption so as to prevent physical hacking by just sending a high signal
- Allow the smart key to access locks wirelessly
- Develop multiple locks with electric and mechanical components

### 1.2.2 Functions:

- Panel of switches to choose between different locks
- Wireless communication between transmitter and receiver
- Fingerprint scanner to validate smart key
- Microcontroller to validate encryption

### 1.2.3 Benefits:

- Instantaneous access to any of the locks
- Saves the hassle of carrying multiple keys or keys at all
- Physical hacking of the device not possible
- Portable and secure locking system

### 1.2.4 Features:

- Easy to use and carry around
- RFID communication modules for transmitter and receiver
- Reliable, secure and hack proof
- Long system life as it basically runs on batteries
- Cheap and fast access to the locked system

# 2.0 Design

## 2.1 Block Diagrams

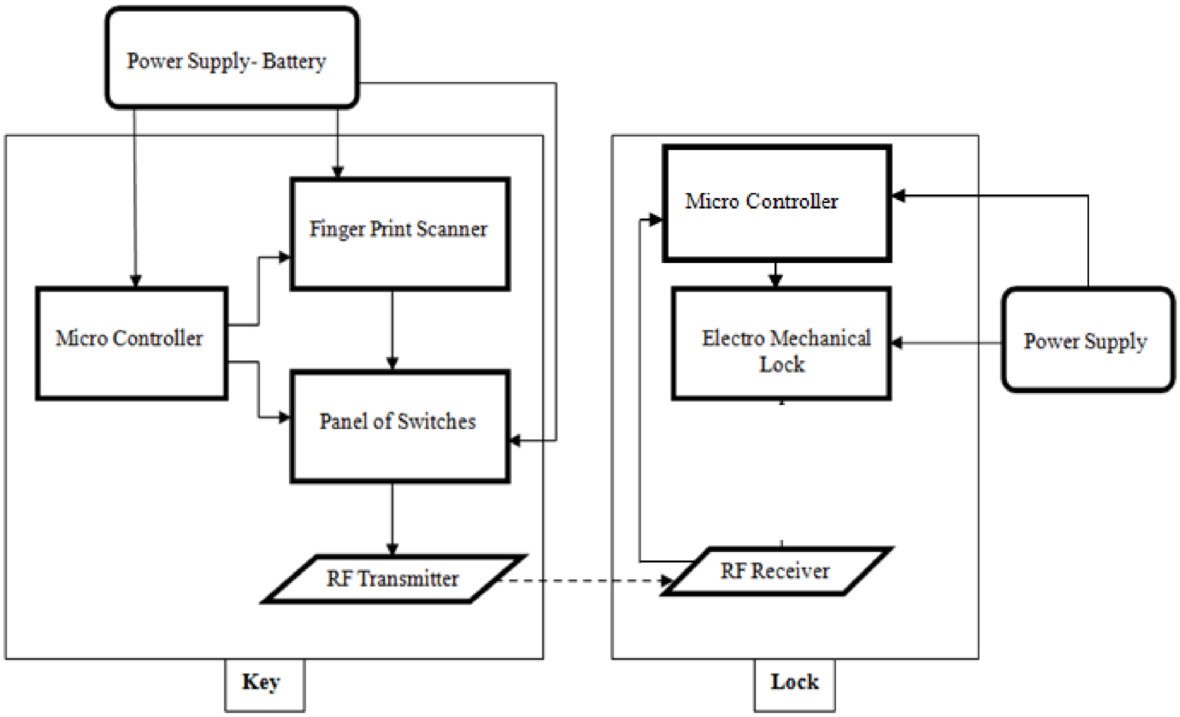


**Figure 1. Detailed Block Diagram of the key and lock system to be implemented**

## 2.2 Block Description

The lock and key system shown above in Figure 1 will be implemented in this project with its components described below.

*Power Supply (Key):*
This will be responsible for powering the entire circuit on the key side of the design which includes the fingerprint scanner, microcontroller and the RF transmitter. We are planning on using AA batteries or the button cells to provide an overall constant 3V source.

*Power Supply (Lock):*
This will be just like the supply on the key side. It will be used to power the controller and the RF receiver. The microcontroller should be able to send a signal to the electromechanical component which will then implement the unlocking mechanism. It will probably consist of dry cell batteries and can be sufficiently bulky in contrast to the power supply on the key as it will not be carried around. Exact details are to be worked out with the Machine Shop professionals.

*Fingerprint Scanner:*

This is the security measure used on the design of the key module. It is used to record and verify multiple fingerprints from users. Upon validation of the correct user it will send data serially over to the microcontroller connected to it. The microcontroller will then check this data and further activate the panel of switches for further unlocking the locks.

*Panel of Switches:*

These will consist of three switches that are directly used for unlocking the same respective number of locks. This panel will get activated by the microcontroller after successful verification by the fingerprint scanner. Once activated, this panel will allow the user the option of unlocking any of the three switches. We plan on having button switches for each of the locks, which on pressing will transmit a RF signal with some encryption to the receive side on the lock.

*Microcontroller:*

The microcontroller used in the key module will be the MSP430. This will be the main control unit of the module. The microcontroller will be powered by the power supply (key) and is a good option as it has low power consumption as well as a low cost. It will process the data from the fingerprint scanner to validate that it has read the right fingerprint and only then activate the panel of switches after which an RF signal will be transmitted to the particular lock needed unlocking. Another microcontroller will also be on the receive side to process the incoming signal at the receiver and then initiating the unlocking mechanism.

*RF Transceiver:*

The key will have a RF transmitter and the lock will have a RF receiver to implement the wireless communication between the two components of the design. Thus making use of RF will also let us unlock the device from a distance. This communication module will be able to relay data to and from the microcontroller on both, transmit and receive side.

*Electromechanical Lock:*

The electromechanical component on the lock will be the module implemented to click it open on receiving the correct signal from the key. The controller will send a signal to the electric part which will in turn transform to a mechanical procedure that will help to unlock the device.

## 2.3 Performance Requirements

- Battery life should be long and thus overall efficiency of power supply should be more than 50%.
- Instantaneous response (i.e. greater than 1s) after triggering switch on panel
- Fingerprint scanner holds multiple users
- Fingerprint scanner relays data to microcontroller correctly for validation

- Microcontroller should be able to activate the panel of switches within a reasonable delay
- Able to accurately transmit and receive within a certain range (~ 20m)
- Able to efficiently perform unlocking using the electromechanical component

## 3.0 Verification

### 3.1 Testing Procedures

- Fingerprint Scanner: Test multiple users by inputting and authorizing many different fingerprints. Also check multiple times for every user and also for users that are not authorized to make sure they are denied access. Test the connectivity between the serially connected scanner and microcontroller to check for valid data being sent between the two.

- Power Supply: The requirement for this is to last a long time with the usual daily use. Switching on all components and leaving them in that stage will give us a good estimate on how long the battery is supposed to last. After which we will estimate the battery life by testing multiple times daily.

- Panel of Switches: This panel will be tested by making sure that it gets activated when the microcontroller sends a signal for activation. We will also test each individual switches that will send signals to the locks when pressed, by checking for a high signal.

- Wireless Module: This is achieved by the RF transceivers and is the most important module of the entire design. The data should be exchanged with perfect accuracy and reliability. By building this module on the bread board we can initially test it by sending a huge number of test data cases. We can then test it at various distances and then check for the transfer rate by noting timestamps on the receive and transmit side.

- Microcontroller: This will be an easier module to test as we can have test scripts that check for all the situations our controller encounters. The controller should always behave correctly in order for our system to respond the way we want.

- Lock: On the successful working of the above modules, the receive side should be able to communicate with the electromechanical lock so as to click it open. It is important to make sure that if the power source begins to supply less current (or/and a lower voltage), the lock will still respond to the microcontroller up to a certain lower bound. This can be tested by continuously supplying decreasing power to the electromechanical lock until we can find the lower bound at which our design doesn't respond.

### 3.2 Tolerance Analysis

The tolerance analysis will be based on the sustainability of our communication module i.e. the RF transceiver. This is the most important part of our design. If this communication doesn't work, we will not be able to send any kind of signal to the unlocking mechanism. In order to test this system we will send multiple signals from the transmit side to the receive side and test for connectivity, data validation and transfer speed at different range of distances between transmit and receive side. We want an accuracy of 100% for data transfer and also a fast transfer rate so as to not have a huge delay between the pressing of the key and actually getting the lock unlocked.

## 4.0 Cost and Schedule

### 4.1 Cost Analysis

#### 4.1.1 Labor

| Group Member | $/Hour | Hours/Week | Number of Weeks | Multiplier | Total/Person |
|---|---|---|---|---|---|
| Aashay | 30 | 15 | 12 | 2.5 | $13500 |
| Akshay | 30 | 15 | 12 | 2.5 | $13500 |

Total Labor Cost = $27000

#### 4.1.2 Parts

| Part | Price/Unit | Quantity | Total |
|---|---|---|---|
| MSP430 Microcontroller | $5.89 | 2 | $11.78 |
| Fingerprint Scanner | $130 | 1 | $130 |
| Electromechanical Lock | $125 | 3 | $375 |
| RF receiver/transmitter | $7 | 2 | $14 |
| AA Battery Pack | $2.95 | 2 | $5.9 |
| 3V Lithium Button Cell Pack | $2.00 | 1 | $2.00 |
| PCB and circuit elements | $25 | 1 | $25 |

Total Parts Cost = $563.68

### 4.1.3 Grand Total

| | |
|---|---|
| Labor Cost | $27000 |
| Parts Cost | $563.68 |
| **Total Cost** | **$27563.68** |

## 4.2 Schedule

| Week | Akshay | Aashay |
|---|---|---|
| 2/4 | Proposal and figuring out the parts that would be needed | Proposal and figure out the power supply components. |
| 2/11 | Look up how the fingerprint scanner would work with the microcontroller and the RF transmitter. | Figure out the design and the working of the lock and the panel of switches. |
| 2/18 | Design the working of the microcontroller and the finger print scanner and make sure it takes the correct fingerprint. | Go to the machine shop and explain what kind of locks and the panel of switches would be needed. Also, help in designing the working of the microcontroller with the fingerprint scanner. |
| 2/25 | Design review | Design review |
| 3/4 | Connect the microcontroller to the panel of switches and make sure it works when the correct finger print is inputted. | Connect the microcontroller to the panel of switches and make sure it works when the correct finger print is inputted. |
| 3/11 | Send the signal from the RF transmitter to the receiver and make sure it works when correct signal is given. | Research on how the panel of switches would send the correct signal to the RF transmitter to transmit to the receiver. |
| 3/18 | Spring Break | Spring Break |
| 3/25 | Design the PCB layout and make sure it matches the schematic. | Make sure that the RF transmitter transmits the correct signal and the receiver receives it. |
| 4/1 | Adjust the PCB after what was found once debugging was complete. | Work together so that the PCB can be adjusted correctly. |
| 4/8 | Confirm that the correct lock receives the signal once the panel switch is activated. | Implement the RF receiver and the lock opening system for all the locks. |
| 4/15 | Connect everything together such that everything is working is sync. | Connect everything together such that everything is working is sync. |
| 4/22 | Demo week. | Demo week. |
| 4/29 | Final Presentation and Final Paper | Final Presentation and Final Paper |