User Specific Firearm Locking System
Project Proposal

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1. Introduction

1.1 Statement of Interest

This project was created to increase gun safety by preventing unauthorized use of a firearm. Instead of requiring a bulky and expensive gun safe to restrict access to a weapon, our system creates a portable and user friendly way to allow gun owners to have control over the firearm's operators.

1.2 Objectives

The goal is to create an authorization system that will only allow eligible persons to operate a firearm. The system will read the user's fingerprint and, if the user is authorized to use the gun, allow the user to respond to prompts on the LCD screen. Using the keypad on the control unit, the user selects the type, timed or pressure sensitive, of the unlock state. Once the user has selected the unlock type, this information will be wirelessly transmitted to a system attached to the gun that will automatically operate the trigger and magazine mechanical locking devices.

1.3 Benefits

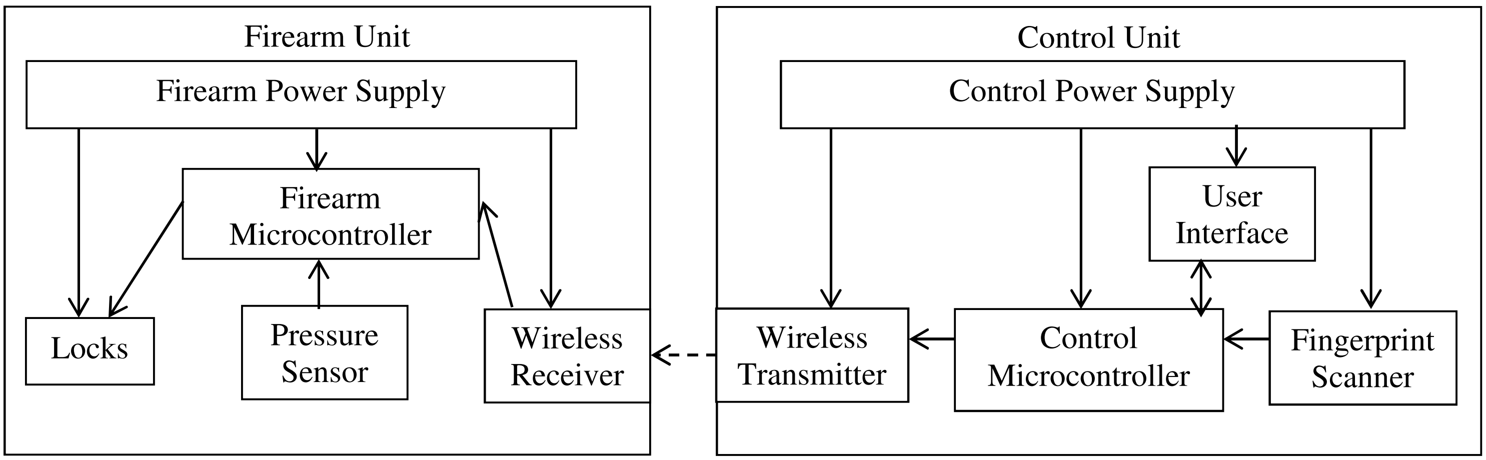
- Access to a weapon by authorized personnel only
- Additional weapon lock for increased safety
- Ease of mobility and access compared to traditional gun safe
- Increased security via fingerprint identification system

1.4 Features

- Keypad and LCD screen for simple user interface
- Wireless ability throughout the home
- Multiple user fingerprints accepted
- Fingerprint/user management system
- Automated locking for trigger and magazine
- Pressure or time unlock options

2. Design

2.1 Block Diagram



2.2 Block Descriptions

Fingerprint Scanner:

This is the main security measure for the project. It utilizes a fingerprint scanner to record and compare fingerprints from users while serially communicating exclusively with the microcontroller.

User Interface:

Composed of a keypad and LCD display, the user interface accepts prompt-based inputs from the user for the time unlock and fingerprint management options. It interfaces with the microcontroller via serial and I/O communication.

Control Power Supply:

This uses batteries to output a constant 3.3 volts to the microcontroller, user interface, fingerprint scanner, and wireless transmitter which are located in the control unit.

Control Microcontroller:

This microcontroller is in charge of communicating with all of the devices on the control unit via serial communication. It manages the fingerprint security data while also running the program that generates the locking and unlocking signals.

Wireless Transmitter/Receiver:

The wireless unit relays the decisions made in the control unit's microcontroller to the microcontroller on the firearm. Via serially transmitted data, the wireless unit enables the separation of the control unit and firearm unit. It consists of a transmitter in the control unit and a receiver in the firearm unit.

Pressure Sensor:

The pressure sensor is used to determine when a person is holding the firearm. This sensor implements one of the user selected choices for unlocking the firearm, creating a more user friendly interface. The pressure sensor only interfaces with the firearm's microcontroller via an analog signal declaring if the user is holding the firearm; depending on the user settings, this may hold the firearm in the unlocked state.

Locks:

The locks receive electrical signals that have been processed through the entire system and mechanically put the firearm into the proper state. The locking system interfaces with the firearm's power supply and microcontroller. The analog signal sent by the microcontroller will control the state of the locking mechanisms.

Firearm Power Supply:

The supply uses a battery pack to provide the necessary power for the implementation and proper functionality of the mechanical locks, microcontroller, and wireless receiver systems housed on the firearm.

Firearm Microcontroller:

Receives the locking and unlocking signals via the wireless receiver and controls the locking mechanism. This microcontroller also receives data from the pressure sensor which may be used to override the timed lock command.

2.3 Performance Requirement

- 2.3.1 Scanner holds and manages at least 20 users
- 2.3.2 Battery voltage within 10% of nominal voltage over current load range
- 2.3.3 100% reliability of LCD display/keypad user interface and menu navigation
- 2.3.4 Firearm power supply must have long enough battery life to power the firearm systems for 24 hours.
- 2.3.5 Pressure sensor must detect when a person is holding the gun 100% of the time
- 2.3.6 The mechanical locks should respond to the lock/unlock signal from the gun's microcontroller 100% of the time within 5 seconds of the lock or unlock signal being received.
- 2.3.7 Wireless range up to a distance of 100 feet, unobstructed. (Size of a typical house)
- 2.3.8 Maximum response delay of 100 ms for wireless communication

3. Verification

3.1 Testing Procedures

3.1.1 To test scanner capacity, input and authorize 20 different fingerprints to simulate 20 different users. Make sure each one is authorized and can unlock the menu on the control unit. Also try five fingerprints that are not authorized to make sure they do not authorize the menu.

3.1.2 To test battery voltage range, connect the control power supply to a variable load. Use an oscilloscope to scope the positive and negative terminals of the power supply. Starting at high load (low current ~0mA), take voltage measurements and slowly decrease the load until the maximum current flowing. Throughout this current range, the voltage should stay within 10% of the nominal value. (Figure 1)

3.1.3 In order to test user interface, press each number key and make sure the correct number appears on the LCD display. After the keypad and display are proven to be communicating effectively through the microcontroller, then check that all menu logic is correct. Every decision path should work flawlessly.

3.1.4 To test that the battery will last for 24 hours, it will be connected to a series resistance, to model the losses in the system and the components, and a LED. The LED should remain lit for the designated time to mimic the operation of the gun's subsystems.

3.1.5 To verify that the pressure sensor will detect the hand on the gun 100% of the time, the sensor will be connected to an LED that will light up when pressed.

3.1.6 To test the mechanical locks, a replicate of the signal that will come from the microcontroller will be fed to the mechanical system and it should lock/unlock as it would if the microcontroller were connected to it. When sending a new signal to the mechanical system, use a timer to verify that the system locks/unlocks less than 5 seconds after receiving the new signal.

3.1.7 Testing the wireless range will entail sending the unlock and lock command at 100 feet with no objects, excluding casing, between the two units for a total of 10 times. The transmission should be successful at least 9 times out of 10 times. To determine maximum range, walk further and further apart while sending the command every 10 feet until the command is no longer received.

3.1.8 To test the wireless timing, have a wired connection from the firearm unit's microcontroller to the control unit's microcontroller. A code will be sent wirelessly from the former to the latter, and when the signal is received, a feedback will be sent through the wired connection. The timestamps on the firearm unit for the original signal transmission and the feedback signal reception will be compared. The difference should be less than 100ms.

3.3 Tolerance Analysis

The locks are the most important subsystem in the project because all the work done by the other subsystems is for naught if the locks do not respond properly or promptly. It is important to verify that even as the power source begins to provide less current and a lower voltage to the mechanical locks, they will still respond to the signal from the firearm's microcontroller. This will be tested by, starting with the full voltage and current ratings of the power supply, sending incrementally decreasing voltages and currents to the mechanical systems until the system no longer responds to the microcontroller.

4. Cost and Schedule

4.1 Cost analysis

Labor:

$35/hr * 2.5 * 120hrs = $10,500 per person
Total labor for 3 group members = $31,500

Parts:

Description		**Price**
LCD Display	4 lines x 20 characters	$30.00
Keypad	12 keys	$4.00
Batteries	AA, 3v coin	$8.00
Wire (22, 16, 14 gauge)	~1 foot each	$6.00
Fingerprint Scanner	Optical with algorithms	$129.00
Circuit Board	PCB	$30.00
DC motor		$1.50
Springs		$0.50
Gears	#25	$6.00
Chain	#25 for track	$10.00
Pushbutton	For pressure sensor	$2.00
2 Microcontrollers	PIC16F887	$2.50 each
Wireless Transmitter/receiver	Lynx pair	$1.00
Total Parts Cost		**$233.00**

Total Cost (parts + labor) = $233 + $31,500 = $31,733.00

4.2 Schedule

Week	Task	Member
2/6	• Complete Proposal • Research LCD displays, and keypads	Steve
	• Begin designing locking systems	AJ
	• Begin studying microcontroller, transmitter, and receiver documentation	Yong
2/13	• Research serial interfaces and part options • Create pinouts for LCD display, and keypad	Steve
	• Sign-up for Design Review • Finalize design for locking systems • Build pressure sensor component	AJ
	• Design pinouts for microcontroller, transmitter, and receiver	Yong
2/20	• Order user interface parts • Finalize hardware pinouts for user interface	Steve
	• Test pressure sensor • Order parts for locking systems	AJ
	• Complete Design Review • Research microcontroller programming methods	Yong
2/27	• Begin coding for microcontroller	Steve
	• Begin locking system build	AJ
	• Wire up the microcontrollers • Create an interface for manual sending of local unlock/lock signals on firearm unit microcontroller	Yong
3/5	• Interface with keypad	Steve
	• Finish building locking system	AJ
	• Add the fingerprint scanner to the control unit. Test identifying different fingerprints.	Yong
3/12	• Interface with LCD display	Steve
	• Test locking system	AJ
	• Wire up the MC's and transmitter/receiver • Test wireless sending and receiving of simple bit codes	Yong
3/19	• Spring Break	N/A
3/26	• Sign Up for Mock Presentation • Testing of keypad and LCD display • Design of power supply for control unit	Steve
	• Begin build on power supply for firearm unit	AJ
	• Complete Mock-up Demo • Set up local timer-based signals for firearm unit	Yong

4/2	• Program user menus for locking • Finish design for power supply on control unit	Steve
	• Complete Mock Presentation • Continue building power supply on firearm unit	AJ
	• Implement and test controlling the firearm unit unlock/lock signals from the control unit microcontroller	Yong
4/9	• Begin testing and debug of control unit	Steve
	• Finish building power supply on firearm unit	AJ
	• Program fingerprint management logic	Yong
4/16	• Finish testing and debug of control unit with power supply	Steve
	• Sign up for Demo • Test power supply on firearm unit • Interface all systems on firearm	AJ
	• Sign up for Presentation • Full verification, testing, and troubleshooting for wireless system	Yong
4/23	• Complete Demo	Yong
4/30	• Complete Final Presentation	Steve
	• Complete Written Paper	AJ

5. Appendix

5.1 Test Graphs

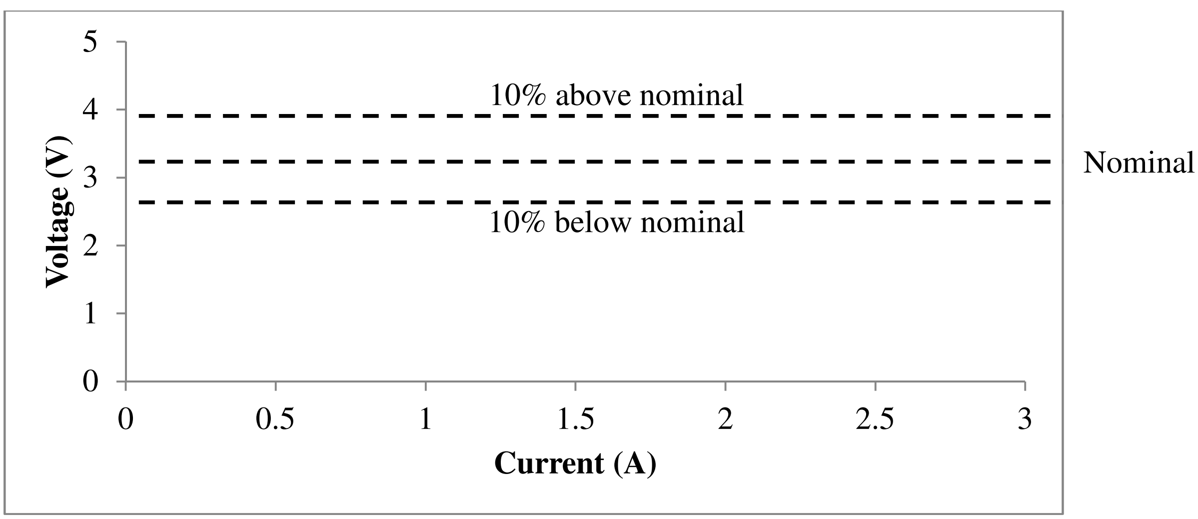


Figure 1.