Group 4 - iOpen
Requirements Specifications

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1. **Overview**

   Purpose: Every day many people open and close their front doors for a variety of reasons. These can include running errands, leaving for work, arriving home, inviting guests, and more. However, the process of having to repeatedly lock and unlock the door becomes tedious after a prolonged period. The iOpen smart-lock further improves users' quality of life by improving the security of their door(s). Unlike traditional locks that require users to manually lock and unlock, the iOpen can automatically unlock and lock itself through several methods such as fingerprint, RFID card, and more. iOpen can even unlock and lock with a traditional key as a failsafe should other methods not work or if users prefer a traditional key. This way, iOpen can cater to a larger audience by including users who desire a more futuristic product as well as users who prefer traditional unlocking and locking methods.

   Objective: The iOpen expects to improve users' quality of life and security by eliminating the minor inconvenience of manually unlocking and locking a door repeatedly. Security is boosted exponentially as the methods to unlock are always on the users' person through their smartphone and fingerprint. Users will no longer have to worry about losing or making spare keys since users will always have the methods to unlock on their person. Furthermore, iOpen addresses social good by incorporating AI in a meaningful way. As users continue to use iOpen, data will be collected on when users unlock and lock most often. Through this data, iOpen can preemptively prompt users through their smartphones to lock or unlock at those specified times.

2. **Statement of the Problem**

   Design Needs:
   - Lock unlocks when smartphone/RFID card in range
   - Hidden keyhole for physical key to act as failsafe
   - Smartphone app with instructions on how to use iOpen

   Expected Benefits:
   - Increased security
   - Improved quality of life
   - Simplify process of unlocking/locking door(s)

   Key Considerations:
   - Creation of app and/or website that links with lock
   - Amount of fingerprints that can be added unknown
   - Implementing physical key as failsafe should other methods fail
   - Risk of fingerprint scanning incorrectly or not at all

3. **Operational Description**
   - Features:
     - The app offers a range of unlocking methods. You can unlock the door remotely via the app, or tap to unlock using your mobile device (available for both iOS and Android) or with the included RFID card. Additionally, fingerprint scanning is available, which will be located on the base of the door handle. Lastly, as a safety measure, the lock comes with a physical key. The keyhole is hidden behind the fingerprint sensor, which can be moved by sliding it out of place.

- User Manual:
    - For this section of documentation, we will briefly go over the initial setup of pairing your lock with your mobile device, connecting the lock to Wi-Fi, and adding your fingerprint(s). The very first time you open the app, it will prompt you to create a new account. This can be done using Google Login or by email and password. After registering and logging in successfully, the second step will be to connect the lock to your mobile device via Bluetooth. After pairing, the app will walk you through connecting the lock to your Wi-Fi network, which enables remote unlocking. The last step in setting up is to add a fingerprint. As of now, the amount of fingerprints that will be able to store has not been determined yet.
- User Interface:
    - Our app is designed to be user friendly and supported on both iOS and Android. The app is developed using React Native and styled by Tailwind, or in this case NativeWind. The design of the app is UX focused and easy to navigate. The primary screens are the Login Screen and the Main Screen. The most visible item, and main feature on the Main Screen, is a large button that will enable remote unlocking. Another key feature in the app is the hamburger button in the top left corner, which shows options for Device Info, Account Settings, adding or deleting fingerprints, and options related to RFID authentication.

4. Requirements Specification

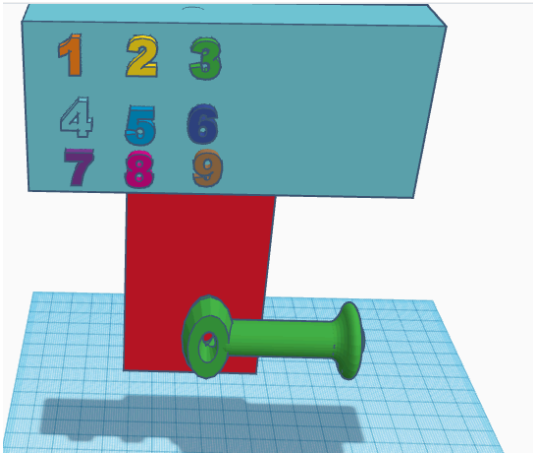
- Power Source:
    - When it comes to our product “iOpen!!” We will have a lot of amazing features and functions. First, let's talk about the power source, our first primary source is going to be a rechargeable battery or direct power supply.
    - You might think to yourself what if there's no power or if the batteries die and you can't open the door!! Don’t worry we have a back up plan for that which is going to be a manual key entry for emergency access. For you to access the lock cylinder it would be located behind the touchprint.
- Locking Mechanism:
    - Servo Motor: With iOpen the locking mechanism is powered by a servo motor that controls the lock and unlock actions. This isn't an ordinary motor you will find but this motor is highly responsive, capable of turning the locking cylinder smoothly and securely. The motor’s control would be tied directly to the input from the access sensors, which we at iOpen promise that only authorized users can activate the mechanism.

- Auto-Lock Feature: Another one of our standout features here at iOpen!! is the auto-lock feature. Meaning that after you have unlocked the door, iOpen will automatically re-engage the lock after a preset amount of time (you the user decides the time) if no activity is detected. We know sometimes we're in a hurry and we forget to close the door, so this feature ensures your home remains secure, even if you forget to lock the door manually.

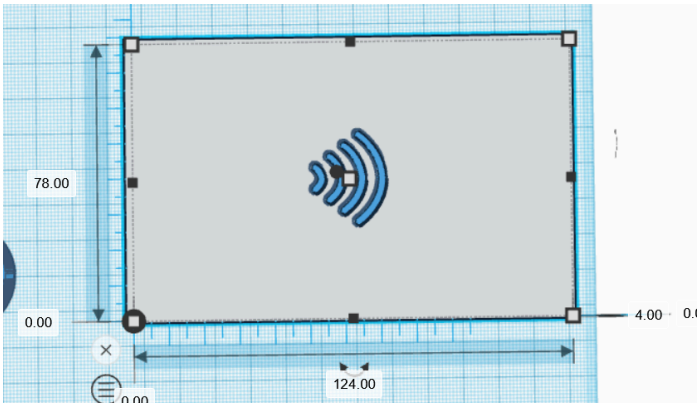
- Security and Access:
  - Fingerprint Sensor: iOpen will include a fingerprint sensor, which will allow you to unlock the door with just a touch of your finger.
  - NFC/RFID Sensor: Then for those who prefer to use cards/key fobs or even want to relive those dorm days at college don't worry with an NFC/RFID sensor will provide quick, contactless access.
  - Bluetooth/Wi-Fi Connectivity: For remote access, iOpen is equipped with Bluetooth and Wi-Fi capabilities, allowing you to control and monitor your lock from our mobile app, no matter where you are at.

Component	**Input**	**Output**
Servo Motor	Electrical signal from MCU	Unlocks lock mechanism
Fingerprint Sensor	Fingerprint scan	Binary access signal (granted/denied)
NFC/RFID Sensor	card proximity	Binary access signal (granted/denied)
9V/coin cell battery	Electrical power	Powers the system
Backup Key	Manual entry using key	Mechanical unlock

5. Design Deliverables



This was our first "design"that was made on the website tinkercad. This was the first version we had when we thought about the iOpen lock. Originally it was with a number pad but now imagine it without the numbers.



Here we have the card that will allow access to the iOpen to unlock.

6. Preliminary System Test Plan

1. Fingerprint scanner functionality
    a. Ensure that scanner correctly registers, and verifies user fingerprint
        i. Test fingerprints of multiple users for authentication and rejection
        ii. Response time for authentication
        iii. "Smudged" fingerprint testing
2. Wireless Touch Sensor
    a. Ensure that wireless sensor correctly reads and authenticates key fob/card
        i. Register multiple cards/fobs
        ii. Test range of sensor
        iii. Test RFID vs NFC
3. Raspberry Pi System Integration
    a. Test combinations of keyfobs and fingerprint scans
    b. Make sure the system responds to a "hierarchy" when multiple authentication methods are presented
        i. What happens when key card and fingerprint are both presented
4. Lock and Security
    a. Make sure it locks AND unlocks
    b. Ensure motors are strong enough to push lock all the way
    c. Ensure data between scanner/sensor and raspberry pi is encrypted
5. Environmental Testing
    a. How does it function under cold, heat, rain, etc.

7. Implementation Considerations

- Power source
    - Expected to use a battery of some sort, (9v/coin cell battery)
- Backup plan with key
    - Need to find a location on where the key will be
- 3D Printing /(we gotta learn how to)
    - Make sure material is capable of sensing key fob/card/bluetooth/etc
- Design wise
    - Need to decide which lock and handle format we want to use. Determining what kind of door design will work the best with automatic lock.
    - Would we need to go with a double lock or a single lock of the door?
- Size of the lock
    - Smaller size is optional, but may sacrifice other important uses
- Cost of items
    - May possibly get funds from the school
- Creating an item that is small, but still successfully implements the elements it needs to be a successful lock
    - Need to find a compromise that doesn't sacrifice large amounts of efficiency in order to maintain itself

- Will use a web based app with React and TypeScript as a prototype rather than a mobile app
    - Next semester, will make a a mobile app using React Native
- Item availability, some items that we need may be out of stock
    - A solution may be to look at different places or look at what can be a successful substitute that will continue to fill the same role as the previous item
- Problem with voltage, making sure that the temperature is not too hot to damage functionality
    - We may need to increase or decrease voltage along with adding things like heat sinks or air ventilation that can keep the overall temperature of the equipment at a safe level
    - Voltage needs to be figured out depending on how much space is needed for wiring

8. **Attachments**

Items to buy -

Part	Need	Specs	Price
Micro Servo - MG90D High Torque Metal Gear : ID 1143 Micro Servo with Metal Gear	Important for moving the lock for the door and can be controlled with any servo code, hardware, or library	Voltage : 4.8V to 6V DC Size : 22.8 x 12.2 x 28.5 mm	$9.95
Ultra-Slim Round Fingerprint Sensor and 6-pin Cable : ID 4750 Ultra Slim Round Fingerprint Sensor and 6-pin Cable	This will be used as another way of access in opening the door	Sensor diameter: 20.8mm Cable assembly length: ~100mm	$19.95
Micro NFC/RFID Transponder - NTAG213 13.56MHz : ID 2800 : Adafruit Industries, Unique & fun DIY electronics and kits Micro NFC/RFID Transponder	Responsible for communicating between door and card to allow open access	Dimensions: 15.6mm x 6mm	$2.95

13.56MHz RFID/NFC Card - Classic 1K : ID 359 RFID/NFC Card	Reader that can communicate with the RFID/NFC transponder	85.5mm x 54mm x 1mm /3.36" x 2.1" x 0.03" 6.3 grams / 0.2 oz Works about 4" away from reader	$2.50
https://www.homedepot.com/p/Prime-Line-Passage-Door-Latch-9-32-in-and-1-4-in-Square-Drive-Steel-Chrome-E-2440/202890844?source=shoppingads &locale=en-US Prime - Line Passage Door Latch	Latch lock that will keep the door closed and locked when servo pushes lock closed	Height: 2.25 in Width: 1.375 in Diameter: 2.25 in	$3.83
Duracell Coppertop 9V Battery, 2 Count Pack, 9-Volt Battery with Long-lasting Power, All-Purpose Alkaline 9V Battery for Household and Office Devices 9V battery Or Amazon.com: Duracell 2032 Lithium Battery, 2 Count Pack, Child Safety Features, Compatible with Apple AirTag, Key Fob, and other devices, CR2032 Lithium 3V Cell, 2032 Battery, Lithium Coin Battery Coin battery	Battery source	Duracell 2.0 Count Or Duracell 2.0 Count Lithium Metal Batteries	$8.67 or $3.22
GeekSmart Aluminum Black Smart Keyless Entry	Door handle that can be implemented with a fingerprint sensor,	3 lbs. 4 Batteries Required Aluminum material	$61.00

Door lock with Featuring Fingerprint L-B201-Black - The Home Depot Smart Keyless Entry Door Lock Featuring Fingerprint	can be replaced with the previous sensor listed above which can include more fingerprints		
	Total Price:		~ $108.85

Marketing Studies -

- In a study by *International Association of Certified Home Inspectors,* "34% of burglars enter through the front door; 22% enter through the back door" A combined 56% of robberies occur through exterior doors. This research is relevant because a secure door with proper security acts as a deterrent in robbery and other malicious activities.
    - Burglar-Resistant Homes - InterNACHI®
- A study by *Access Residential Hardware* showed that "70% of people have left their houses before without remembering whether or not they locked the door." Additionally, "Another 60% of respondents reported that they have come home to find an unlocked door." With proper technological advancements in a lock, one can control the status of their lock using the website that will control our lock. This will reduce the percentage of people coming home to unlocked homes since it can be accessed via web based applications.
    - House Door Statistics & Trends | 2022 Data
- *ALARMS.ORG* states that for a year, there are 1,650,000 million home break ins during a year. Producing a smart lock can reduce the percentage of home break ins.
    - Burglary Statistics: The Hard Numbers | National Council For Home Safety and Security
- *Pew Research Center* involves statistics regarding handicapped people, "...about 42.5 million Americans with disabilities…" iOpen can successfully improve the quality of life especially those who are handicapped and struggle opening doors. The door can be unlocked with web access which can help relieve the stress of struggling to unlock the door.
    - 8 facts about Americans with disabilities.

Literature Review -

- Automatic Door Locks company *august* provides useful input with implementing things like smart lock or auto lock. The door can be used as an example when it picks up that the door is closed.
    - Automatic Door Locks | Keyless Door Locks | August Home
- *Autodesk Instructables* is a project gives insight about how we can use a website to enable a door. This technique also uses Rest API and Raspberry Pi which may act as a guideline in our coding environment.
    - Building a Web Enabled Door Lock Using Rest API and Raspberry PI : 4 Steps - Instructables

- Article *Security Things to Consider When Your Apartment Goes 'Smart'* author Lesley Carhart explains issues that may arise with smart locks. Getting information from this article can help support out lock by creating solutions to common problems with smart locks.
    - Security Things to Consider When Your Apartment Goes 'Smart' – tisiphone.net
- Document which explains the necessary guidelines for a smart lock. This includes security, software, and implementations
    - ETSI TS 103 815 V1.1.1 (2024-01)