SCURE ACCESS

July 25th, 2021

Dr. Andrew Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, BC V5A 1S6

Re: ENSC 405W/440 Project Proposal for DoorID™ by SCURE Access

Dear Dr. Rawicz,

Please find the attached document, "DoorID™ Project Proposal" produced by SCURE Access, as to fulfil the requirement of the ENSC 405W Capstone A course. Our product is an automatic door access system that will utilize facial recognition to allow eased entry for disabled individuals entering their homes.

Within the document, we will propose various project details to ensure a well-rounded understanding for the significance and need for our project in the market. The project scope, market outlines, product risks and benefits, projected timelines, and cost considerations will all be detailed within this proposal. After reading this document, our company is confident that the DoorID will be seen as a useful approach in improving the accessibility for the disabled community and those interacting with them.

Our company comprises of six senior engineering students. Majority of the company stems from Computer Engineering, including Taranpreet Kaur, Manmeet Singh, Siavash Rezghi and Arshdeep Bhullar. Laura Vargas and Mena Shalaby are contributing from the Systems Engineering program.

Thank you for taking the time to consult our project proposal documentation for the DoorID™. If there are any questions concerning our product functionality or requirements, please contact Siavash Rezghi at 604-441-6361 or srezghig@sfu.ca.

Sincerely,

Siavash Rezghi

Siavash Rezghi
Chief Executive Officer
SCURE Access

DoorID Project Proposal

SCURE Access' Automatic Door Access System Using Facial Recognition

July 25th, 2021

Simon Fraser University

School of Engineering Science

ENSC 405W

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Table of Contents

List of Figures

List of Tables

Executive Summary

Living with a disability can be very difficult and it affects everyone differently. People with physical disabilities often feel frustrated since they cannot perform certain activities that people without physical disabilities are capable of. Independent living is one of the important subjects for this community. Independent living means that a person lives in his or her own apartment or house and needs limited or no help from their caregiver. Meaning, the person may not need any assistance or might need help with only complex, rather than day-to-day living skills.

Finding and providing options that help the disabled community become more independent with their needs can be difficult, as disabilities vary greatly in severity, ability, and age groups. SCURE Access has the mission to provide its product, DoorID™, to fulfill and ease a daily task performed by the disabled and elderly population. The simple and frequent act of entering one's home can cause great discomfort and difficulty to individuals living with a disability. DoorID™ aims to ease this task by providing an automated system that will analyze a user's face upon entry, and perform a sequence to unlock, open, close, and lock a door.

The automatic door access system will consist of three main subsystems: image capturing, image processing, and a door opening/closing system. The DoorID™ will utilize a camera positioned near the front entrance, which will track and identify individuals approaching the door. Once individuals are identified, their image will be used in our facial recognition system to allow access into the house once matched with an approved user in the database. The user will also have access to our application, where images and videos of themselves can be added into the database and cloud services.

We at SCURE Access believe there is a strong need for our product in the market. Not only is there no other product combining both the automation of entering home doors with advanced facial recognition technology, but the focus of aiding those that have physical, developmental, behavioral, or sensory impairments is not often seen in today's market. Our product doesn't discriminate on age, race, gender, or tech-ability as it can be easily and successfully used by varying demographics. Beyond our proof-of-concept and engineering prototypes, we have plans to extend the usability of our product to further increase accessibility for potential users. This includes remote access into homes via our secure application and integration into various door types (sliding doors, swinging doors).

Our company is passionate about the DoorID™ and improving the everyday lives of those living with a disability. Although the simple act of opening a door doesn't distress us personally, we understand and appreciate the struggles of others and hope to help where possible, if even in the smallest way. Our team of diversely skilled engineering students is motivated in applying our software and hardware experience into this project, to provide a comfortable, efficient and eased method of accessibility into the homes of many.

1. Introduction

Accessibility for individuals with a disability has always been a topic of large importance. However, for those not frequently interacting with this demographic, it may be easy to dismiss the difficulty and inconvenience of simple tasks such as entering one's home. In Canada alone, over 6 million people identified as having at least one type of disability in 2017 [1]. Disability incidences have been reported to increase with age, as 13% of people aged between 15-24 identify as having a disability, compared to 47% for those 75 years and above [1]. Majority of the people studied claimed to have a disability relating to pain, mobility, flexibility and mental health, but sight, hearing, dexterity, learning, memory and developmental disabilities are also commonly reported.

Therefore, SCURE Access sees a need to further the market of accessibility, as many products do not account for this large, diverse, and important community. In order to help this demographic in a small, yet significant way, SCURE Access proposes the DoorID™, a product to open home doors via face recognition.

1.1 Project Overview

Accessibility and being independent are very important to an elderly or people with disabilities [2]. Accessibility Services Canada (ASC) defines accessibility as, "the design of products, devices, services, or environments for people who experience disabilities". Contrasting with accessibility are the barriers, specified by ASC as, "a circumstance or obstacle that keeps people apart" [3. These barriers can include physical, social, transportation, communication and social barriers [3]. The simple task of opening doors in such environments can be a large barrier for those with a disability [4].

The DoorID™ by SCURE Access is taking accessibility one step further, to ensure that people of all abilities have a comfortable, convenient, efficient and secure means of entering their homes. As disability types can vary in complexity, severity, and age demographics, the DoorID™, aims to provide a simple solution to opening and entering doors, without any discrimination based on ability.

The product can be generally explained through its three stage implementations. The first stage consists of an image capturing subsystem that uses an exterior camera near one's front door. Once an individual's face is detected by the camera, their image is sent into a facial recognition system. The second stage consists of an image processing subsystem, where the facial recognition algorithms are used to verify if a person is an authorized user. Real time image data will be sent through the algorithm and compared against pictures from the database of authorized users. When a face is successfully matched, the door mechanisms of the final stage begin. Here, specialized locks will be triggered to unlock the door, and prompt a connected motor to open a sliding door for the proof-of-concept prototype. Finally, when the individual(s) are safely inside the home, the DoorID™, will be signaled to close and lock the door.

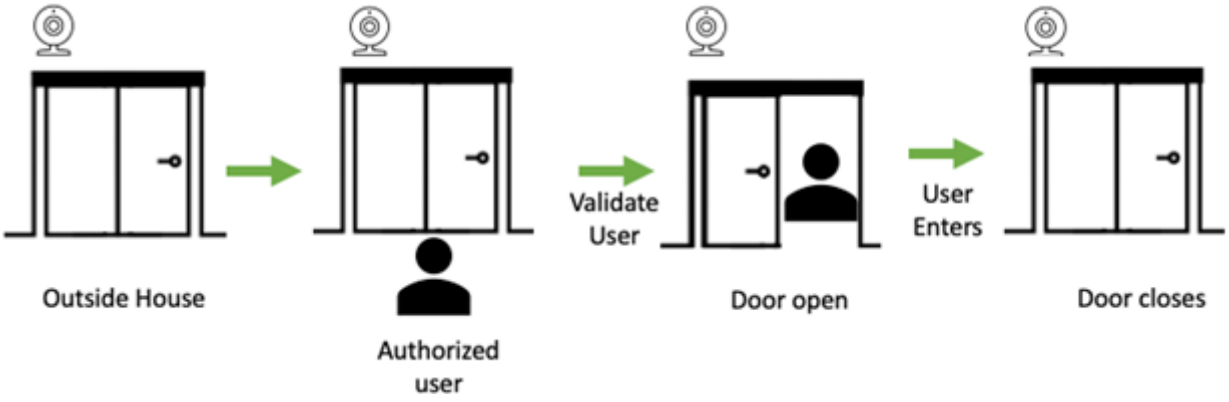

Figure 1: A quick overview how system would work from outside.

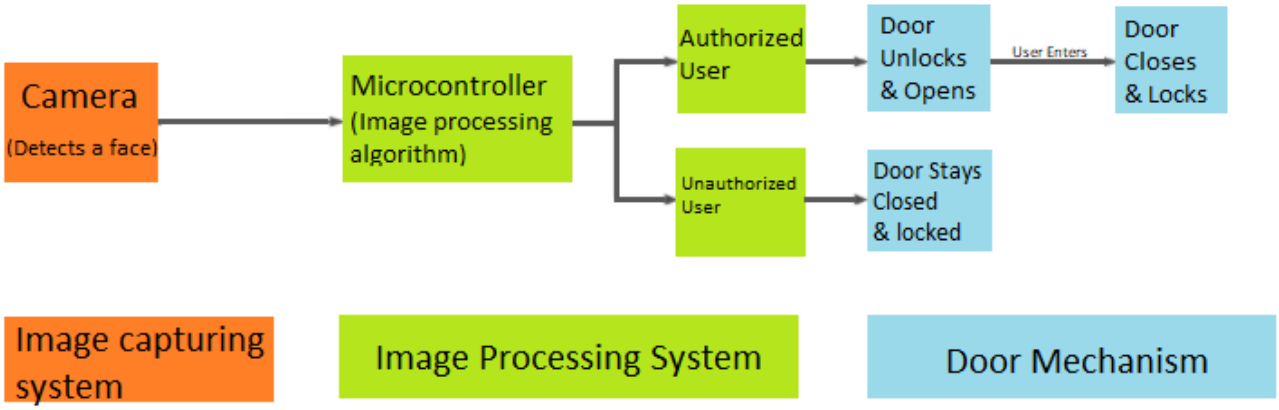

Figure 2: Implementation Pipeline.

1.2 Scope

Government and society need to keep improving accessibility for people with disabilities, although we have come a long way. We still need to focus on improving certain issues that people still face in their daily lives. One such problem they face is opening doors with keys, as it can be an issue for some people. Our product DoorID focuses on providing ease of entrance and exit of the house by using face recognition, and opening doors for people that live there.

The scope of our product DoorID is to build a face recognition algorithm where the product will be placed at the top of the sliding door, the algorithm correctly defines a person's face at different times of the day and weather using depth camera and image analysis within reasonable specificity. Our project will also focus on making sure that software for setting up the DoorID app is user friendly and has a robust security system.

The product DoorID will be able to do all the above defined features because of:

- The camera is capable of providing an inbuilt depth measuring device.
- Using different training models to do image analysis and face recognition.
- Taking depth camera data to make sure that the values that camera's face is a real person.
- Creating app which is accessible by making sure that the setup is easier.
- Storing pictures of customers in cloud and using that for verification when they are entering the doors.
- Focusing on improving user experience while trying to enter doors.

The prototype device will work on 90 x 50 x 50 cm but our device will work on much smaller pieces. Also, our prototype's door will be a sliding door but SCURE Access plans on building this prototype for other doors as well.

In the final steps of prototyping, once the prototype has been assembled into a singular device, beta testing will occur to make sure that the device works for customers properly (face recognition, door opening), and ways to improve their accessibility, as well as what other ways can we improve the accessibility on the doors.

Finally, once the product is out with customer, we can make sure to monitor the door as well as app security to see how this has improved their daily activities; Or were there any problems in setting up DoorID and whether there are still some issues that need to be ironed out. This would help us a great deal in order to provide excellent customer satisfaction and security.

2. Market Rationale

DoorID™ would allow eased accessibility to many groups, the target population are individuals with a disability such as injured, physically impaired, wheelchair user, visually impaired, and learning disability, among others. According to Statistics Canada, in 2017, one in five (22%) of Canadian population aged 15 or over had some kind of disability [5]. The market size is 6 million+ Canadians aged 15 and over [5]. If expanded to the United States the market size would surpass 61 million adults given that 26% of Americans aged 18 or over have some kind of disability [6].

According to the Americans with Disabilities Act (ADA), in the US, people with disabilities are the largest and fastest growing minority and they control $1 trillion in total annual income [7]. Even though DoorID™ could be beneficial for adults with different disability types it would be particularly beneficial for people with mobility, cognition and vision disabilities.

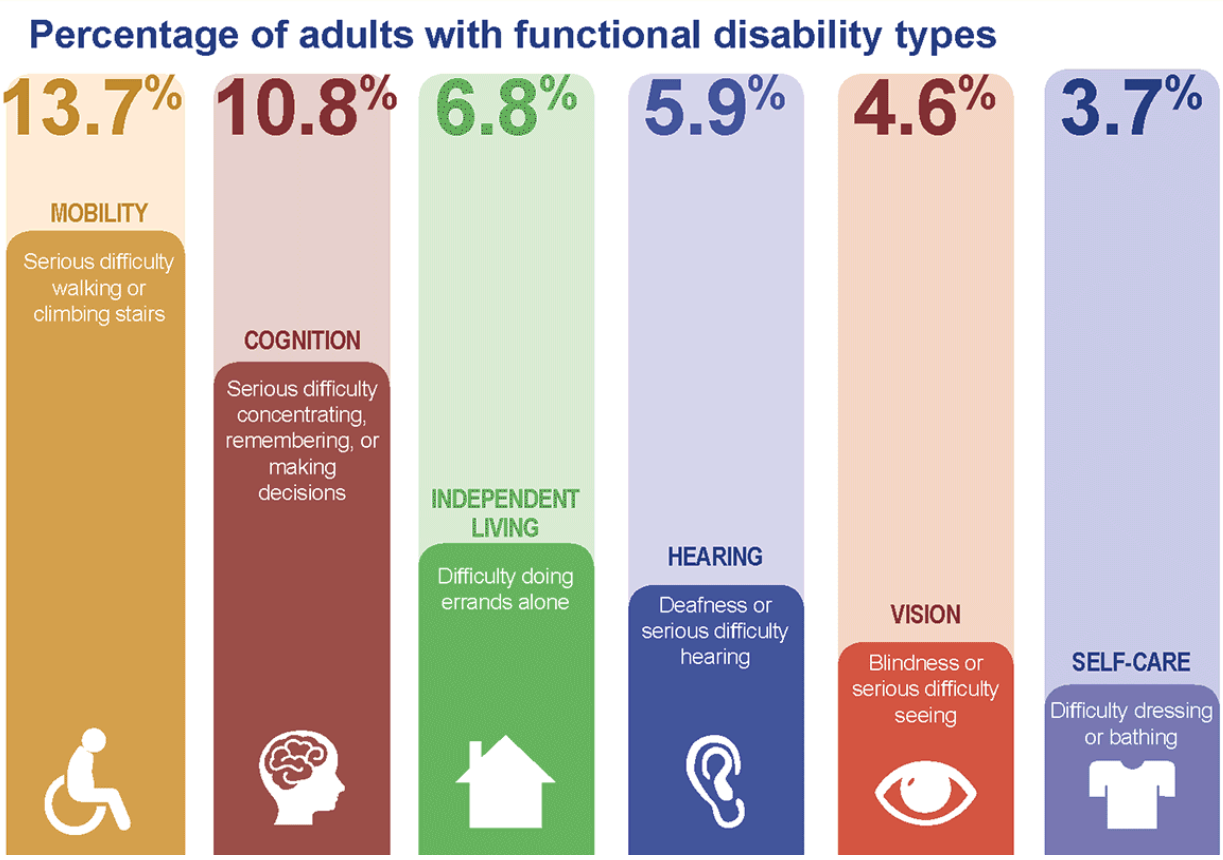

Figure 3: Percentage of adults with functional disability types in the US [6].

As a company we aim to develop our product having the target market always into account therefore since the beginning we have looked for first person accounts of individuals with disabilities experiencing difficulties opening and accessing doors. We achieved this by watching different videos and doing interviews. The ADA outlines the following as the most common door accessibility issues: width, force required to open, maneuver space, handles/doorknob's location and feasibility of use, and closing speed [7]. Furthermore, in order to better understand the target market SCURE Access contacted the Center for Accessible Learning (CAL) at SFU which agreed to publish a customized survey [8] in their newsletter.

3. Competition Rationale

Current popular alternatives for residential access control systems are smart locks that make use of keycodes, cards, fingerprints, eye scans, among others in order to grant access to the user. Some companies that are highly competitive in the access control systems are Honeywell and Yale. From our research we found door unlocking/locking and door opening/closing systems that operate on a commercial level. In the residential level the options are restricted to door unlocking/locking. The difference in prices between the commercial level products and the residential level products is significant. Given our target market the door opening/closing mechanism is highly important since we want to make the system as smooth as possible for the user. This means non-contact face detection, face recognition, door unlocking, door opening, door closing and door locking.

Research also suggested that most of the verification methods required the user to make contact with the reader or lock such as to enter the passcode, read the card or fingerprint. Face recognition will not require the user to make any contact with the system.

Swiftlane offers a Face Recognition Access Control system starting at around $1,300 USD per door [9]. Their system uses face recognition to unlock the door and they allow user self-enrollment via a complete cloud-based system. The Swiftlane product makes use of 2D and 3D data to protect against spoofing attacks [9].

Another similar product is IDEMIA VissionPass which performs one second face verification using 2D, 3D and infrared cameras [10]. IDEMIA's product has an integrated contactless card reader as an alternative for face recognition [10]. In case of tampering the anti-tamper sensor will send a signal and activate an alarm via the integrated microphone [10]. This product can be connected through the gate controller to a third party product as a door latch or equivalent [10].

The main difference between the products currently available in the market and DoorID™ is that the latter includes the door opening and closing mechanism while still maintaining the high threshold needed to ensure security and safety.

4. Risks and Benefits

4.1 Risks

SCURE Access has tried to minimize risks associated with usage of DoorID™ but some risks are still present. One of the biggest risks is spoofing authorized user's identity and entering the house by using a photograph of the users. So, DoorID™ should be able to distinguish between real people and photographs to prevent the action stated above. SCURE Access has made sure that the stated risk

does not cause any problem by adding a check to see if it's a real person or a photograph using depth sensor in image analysis algorithm to ensure users safety.

Second risk is identifying whether the image analysis algorithm can identify an authorized user with high sensitivity and specificity. SCURE Access is trying to make an image analysis algorithm as accurate as possible by considering sensitivity and specificity as parameters for defining accuracy of DoorID™. SCURE Access would also keep a threshold for high sensitivity and specificity where the door would not open if threshold is not met to ensure users safety.

Third risk is preventing users' data from leaking or getting lost. To recognize authorized users, user's photographs and some basic information would be stored on cloud servers. Therefore, cloud servers need to be secure. SCURE Access is trying to use a third-party cloud server which gives SCURE Access an opportunity to encrypt the data in the environment where users' information is stored. To prevent the user's data to get lost in cloud server, SCURE Access would also take a backup for user information.

Fourth risk can be tampering of the camera since it is placed outside. To prevent tampering SCURE Access has designed the product in a way where most of the components are inside the user's house. Since the camera would be placed outside of the user's house, to prevent camera tampering by an outsider the camera would be mounted on a higher location which is not easily accessible.

4.2 Benefits

Despite all the risks stated above for DoorID™ there are many benefits for the product. DoorID™ ensures that people of all abilities have a comfortable, convenient, efficient, and secure means of entering their homes. DoorID™ product includes many benefits as discussed below

Stakeholders:
DoorID™ might seem a little expensive at first but this is a product designed to provide a prominent level of accuracy, performance, and safety to SCURE Access customers. As the product is developed more features would be added in future upgrades making the product worth paying the amount. SCURE Access would try to reduce the cost in future as much as possible without compromising users' safety and products performance and level of accuracy

Users:
It may be easy to dismiss the difficulty and inconvenience of simple tasks such as entering one's home for individuals with disability. DoorID™ aims to provide a simple solution to opening and entering doors, without any discrimination based on ability. DoorID would give an opportunity for users to enter without the need to unlock the door or applying muscle power to push the door to open or close it. For example, if an individual has muscle pain and cannot apply a lot of force they can simply stand in front of the camera and the door will open for them. The future updates for the product would provide users a mobile application. The main purpose of the application would be to give users a method to upload or remove pictures if they want. If the user wants to remove their

previous pictures and upload new one, they could remove their pictures from the cloud server and upload new ones. In future features the application would notify the users that someone is present outside. Through this feature users can check who is outside remotely without going near the door. The future features would also have an ability to lock or unlock doors through application remotely. So, the users can allow anyone inside if they want to without be opening the door manually and if the users are not home and they want to double check if the door is locked, they can lock it through this feature. All the feature stated above try to make life easier for users while ensuring that user's safety and privacy is not compromised.

Users Family or Acquittance:
In future DoorID™ would give an opportunity so that multiple users from same household can be connected to the application. There might be an authentication code for security reasons. The users can give authentication code to multiple users who they feel safe with. This would help the user's family or acquaintances to see who is visiting the house to make sure the users or the house is safe. In future DoorID™ would also allow multiple users to be identified as authorized users at the same household.

World:
SCURE Access has tried its best to design DoorID™ product to use a cradle to cradle method to reduce environmental impact. The product has been designed so that components from DoorID™ are durable and can be reused.

5. Company Details

SCURE Access is composed of six senior engineering students:

Siavash Rezghi - CEO (Chief Executive Officer)
Siavash is a fifth-year Computer Engineering student with the background of business ownership and leadership. He is detail-oriented and systematic with an organized approach and positive attitude. Siavash's technical experiences lie within Information and Technology as well as hardware and mechanical expertise. With his leadership and management skills, Siavash will strive to have a respectful dynamic team where all the opinions and voices will be heard throughout the project. Siavash will be managing the company’s operations and overseeing the budget. He will be keeping an eye on performance improvement, company growth and reports from the other company members.

Taranpreet Kaur - President
Taranpreet is a fourth-year Computer Engineering student. She is a person who pays extra attention to details and works with a positive attitude. Her previous experience includes working as software developer thus having a good experience with software and development of web applications. In her extra curriculum she has done some database courses and has interest in learning more about image analysis. At SCURE Access, she would be focusing more on the software side of the company and would be working with the image analysis team. In the business side of the company, she would be

taking care of proper allocation of resources, workforce, forming goals and making sure they are completed in a timely manner.

Manmeet Singh - COO (Chief Operating Officer)
Manmeet is a fourth-year Computer Engineering student. A person who is a quick learner he also works with a positive attitude. His work experience includes being a software developer thus can be good with software and development of web applications. In the extra courses that he took throughout his curriculum he has done some cloud computing courses, as well as database courses, with a bit of circuit handling in hardware with chips. At SCURE Access he would be focusing on the microcontroller that we will be using throughout the project, as well as acting as a full stack developer working on software in image analysis when it is needed. In the business side of the company, he would be making sure that people are communicating well enough within the team, and if people are having troubles meeting their goals, helping them out with it.

Mena Shalaby - CFO (Chief Financial Officer)
Mena is a fifth-year Systems Engineering student whose interests include image and signal processing as well as communication networks. Her experience includes systems/software testing during coop positions as well as research internships for retinal image processing at SFU's Biomedical Optics Research Group (BORG). Mena will contribute to SCURE Access by applying her diverse experience into the hardware and software systems of DoorID. Additionally, she will be responsible for the financial aspects of the product as CFO.

Arshdeep Bhullar - CTO (Chief Technical Officer)
Arshdeep is a fifth-year Computer Engineering student whose expertise lies in understanding business needs and designing the right software solutions while adhering to good engineering practices. His experience includes programming IoT devices as a research assistant at Simon Fraser University, contributing to code base as a full stack engineer at Article, and building all kinds of software and web solutions as a freelancer. Arshdeep will utilize his programming and software development skills to ensure that product functions as desired from the technical side of things. Additionally, Arshdeep will also ensure the technical team is on the track and completes all milestones before the deadlines.

Laura Vargas - CMO (Chief Marketing Officer)
Laura is a fifth-year Systems Engineering student. Laura's relevant work experience includes commercial access control systems at a company in Colombia and image processing at SFU's Biomedical Optics Research Group (BORG). Laura has also completed some extracurricular courses in Machine Learning, DevOps and Technological Entrepreneurship. Given her experience Laura will be working in the technological side in the Face Recognition pipeline and in the business side she will be performing as the Chief Marketing Officer.

6. Project Planning

The project DoorID™ will be completed in three stages by the SCURE Access team. In every stage, we will add new features to the product by thoroughly testing the requirements at each stage.

Table 1: Project Stages.

Stage	Prototype
Stage I	Proof of Concept (PoC)
Stage II	Engineering Prototype
Stage III	Final Product

The first stage will be completed during ENSC 405W term in summer 2020. The prototype at the end of Stage I is intended as a Proof of Concept prototype and will have limited functionality. The basic functionality at this stage includes:

- Real time face detection
- Real time image analysis
- Working door mechanism
- Door will open on a positive match
- Door will stay locked on a negative match

During the stage II of the product, which will be completed during ENSC 440 term in Fall 2020, additional functionality would be added to the prototype completed in stage I.

- Using an iOS mobile app to give/revoke access for any user
- Improvement to the real time face detection mechanism
- Improvements to the image analysis algorithm
- Adding a feature to customize the time taken by the door opening/closing mechanism

During the stage III of the product, which will be completed after the completion of ENSC440 term, additional functionality would be added to the prototype completed in stage II and would be the best version of the product ready to be launched into the market. The final prototype would include a setup manual, iOS/Android apps to add/revoke access for users, and optimized software algorithms to process face detection and run image analysis.

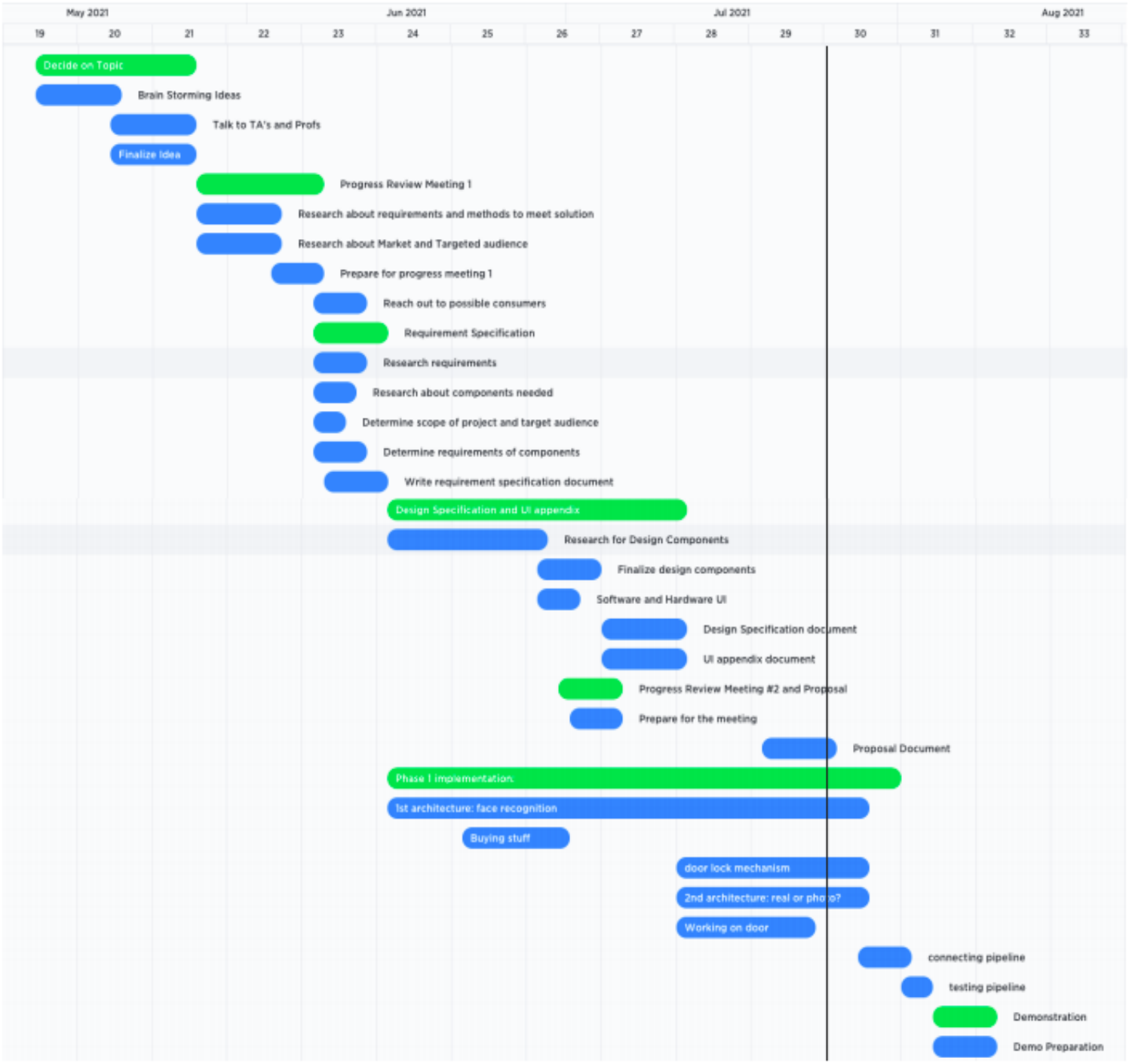

Figure 4: Gantt Chart for ENSC 405.

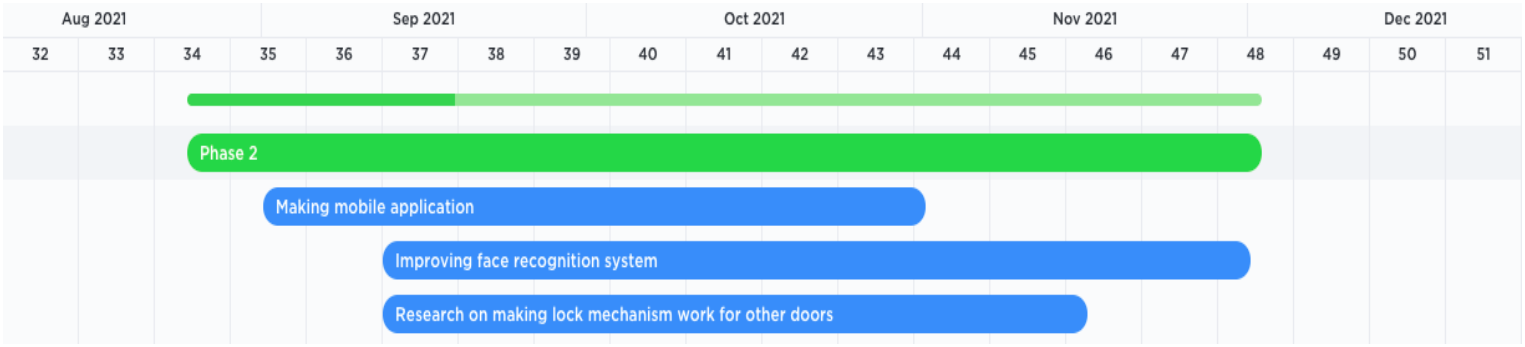

Figure 5: Rough Gantt Chart for ENSC 440.

7. Cost Considerations

7.1 Cost Estimate

Listed below is the estimated cost for the DoorID™ project supplies. A large portion of the cost in the proof-of-concept prototype is from the highly specialized camera used within the image capturing stage (Intel RealSense Depth Camera) as well as the Raspberry Pi 4 used as the microcontroller unit. As completing this alpha-phase project may come with some unexpected expenses, the cost estimate is expected to slightly vary towards the end of the term. For the engineering prototype to be created in ENSC 440, design considerations have not been explicitly confirmed. Therefore, only an approximate cost range can be identified. Components used in the proof-of-concept stage will be reused and will not need to be repurchased for the engineering prototype.

Table 2: Estimated, Up-To-Date Cost for Proof-of-Concept Prototype.

Component	Description/Use	Cost ($CAD)
Raspberry Pi 4, adaptor, SD card and protective case	To be used as the microcontroller unit that communicates with all components of the project.	180
Intel RealSense D435 Depth Camera	Used in the image capturing system to capture 2D and 3D image data, sent to the image processing pipeline.	236
Batteries and Voltage Adaptors	To be used as power sources to supply voltage for various components.	40

Sliding door and mechanical components	Includes pulleys, tracks, gears, rails, brackets, hangers, and various mechanisms that are combined to form a sliding door system.	50
DC Motor and Motor Controller	DC motor is used in connection to the pulley system, to power the sliding door. The motor controller module connects to the Raspberry Pi and will communicate with the motor.	25
Electric Door Lock	To be used in the door frame, to lock or unlock once signaled to do so.	20
Relay Module	This is used as a switch and signals the electric door lock to unlock and lock.	12
Electrical Wiring, solder and battery connector	Used for electrical connectivity of components.	30
GPIO Expansion Board	Board attaches to input/output pins of the Raspberry Pi, to allow for more space for connectivity.	12
USB RFID reader and key fobs	An IC card reader (13.56Mhz) and IC cards to allow alternate credentials for access	35
Passive Infrared (PIR) Sensor	This is a pyroelectric sensor that detects object movement up to 7 meters, and it is checked before closing the door	12
	Total Cost	**$652**

Table 3: Estimated Cost for Engineering Prototype.

Component	Description/Use	Cost ($CAD)
Dual-Voltage Power Supply	A more specialized dual voltage supply could be used to power required components, to minimize the various sources used in the Proof-of-Concept	50-100
Mechanism for Opening Swinging Doors	A new mechanism may be designed to allow our product to operate on swinging doors	100-200
Cloud Storage, 1 TB	A secure cloud storage would be used for user data, such as images and videos used for the facial recognition.	10-20/month
	Total Cost	**$160-320**

Based on our current estimated prototype costs, the company expects to charge customers up to $2000 for the finalized, market ready, production model. However, this is just an estimate, and this value may increase or decrease based on upcoming production costs.

7.2 Funding

Company Self-Funding
For the Capstone A course, due to the current circumstances the company has had to outsource and personally purchase most of their components and supplies to create the proof-of-concept prototype. The company is well documenting their expenses and hopes that the following available funding options will help cover all costs for products developed in ENSC 405W and ENSC 440.

Engineering Science Parts Budget
The School of Engineering Science at SFU has allocated $50 to be used for components available in the engineering labs. Although most of the components needed for the proof-of-concept prototype have already been purchased, the company will utilize this funding for any remaining hardware components and wiring needed within the ENSC 405W term. If not, the company plans to spend the $50 in parts required for the engineering prototype to be built in ENSC 440.

Wighton Engineering Development Fund
The Wighton Engineering Development Fund will be presented to the company by Dr. Andrew Rawicz, following ENSC 440, after completion of the engineering prototype. The company is documenting all expenses and hopes to be reimbursed for as much as possible given this funding. The Wighton Fund is given to students in special courses, such as ENSC 405, where funding is preferentially given for projects helping the society. Since our project is aimed to help those with disabilities and the elderly, SCURE Access would be a great candidate to receive this fund.

Engineering Science Student Endowment Fund (ESSEF)
The Engineering Science Student Society (ESSS) provides the ESSEF to projects created by undergraduate SFU students. For funding that is not covered by the Wighton Engineering Development Fund and the ENSC Parts Budget, the company is hoping that the ESSEF will provide a small amount to cover remaining costs. As this funding is split into different categories for eligibility, SCURE Access and the DoorID would fall under Category B (Entrepreneurial) and Category C (Class).

8. Conclusion

The DoorID™ by SCURE Access gives an ability to enter and exit with ease without any discrimination based on an individual's ability. SCURE Access team strives to improve accessibility not only for our community's elderly and disabled individuals, but also for everyone across the globe. DoorID™ is an automatic door opening and closing mechanism with face recognition intended to improve accessibility and independence. The product includes 2 main parts, camera and image processing, and door opening and closing mechanism. The Intel RealSense SDK 2.0 captures an image of an individual who is approaching a door then passes it to the image procession system to perform 3D image analysis. If it is a positive match, it will grant access to the individual to enter. Upon this access, the door mechanism would unlock and open the door for the user. After entering, the PIR sensors will scan the area to assure safe door closing. If there are no obstacles or users around the area of the door frame, the mechanism continues to close and lock the door.

Throughout the paper, we have provided the background, needs and a complete analysis of DoorID™. This product is a onetime investment for less than $1000 and could be used for a long period of time. Every individual enters or leaves the house at least once a day. So, this system would be useful on a daily basis and users would not need to worry about carrying their door key or entering the garage code. This would be really helpful for elderly and disabled as it is really hard for them to perform any physical activity depending on their disability. This product has the potential to change the lifestyle of how people enter or leave their homes and is a really innovative, out of the box development.

9. References

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