January 31, 2018

Andrew H. Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 405W/440 Project Proposal for Home Attender

Dear Dr. Rawicz,

Enclosed is the Project Proposal for Home Attender as part of the requirements for ENSC 405W/440. Our group is aiming to design an advanced home security system which uses thermal vision to detect intruders and fires.

The purpose of the following document is to provide information on how our group plans to design the prototype. The proposal will explain the scope and risks of creating such a product, as well as the benefits involved. It will also detail the development timeline and allocated budget of the Home Attender

Our group consists of five dedicated and passionate Engineering students: Isaac Qiao, Benjamin Ji Fung Ng, Christopher Se Chern Chiu, Qing Yang Li, and Ruisi Wang. With two Systems Engineers and three Computer Engineers, we believe we have the skillset to create an excellent product while also gaining plenty of knowledge along the way.

Thank you for taking the time to review our proposal. Please feel free to contact any of us at bqiao@sfu.ca or (778) 927-4893 if you have any questions or concerns.

Sincerely,

Isaac Qiao
Chief Executive Officer
Home Attender

Proposal for Smart Home Security System

Project Team

>*Isaac Qiao*

>*Christopher Chiu*

>*Ruisi Wang*

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Executive Summary

Home security systems are prevalent in almost every Canadian home and gives people a sense of safety by protecting them from intruders. However, it is common for the average security system to trigger false alarms, which can be extremely frustrating to deal with. It causes unnecessary strain on the emergency responders and incurs a fee. Additionally, the typical security system just includes the alarm system and do not account for other safety features. Our company's proposed project will include an integrated system which will utilize alternative methods of intruder detection and additional features to solve the aforementioned issues.

The Home Attender is a scalable security system which integrates various components into a more complete product. It will include components as accelerometers, a thermal and optical camera module, networking, a storage for recorded data, and a phone application to alert the user of criminal activity and fires.

Consumer trust in a product is paramount in the security industry, and therefore our group must ensure the risks are identified and addressed. Our company recognizes that the design quality is essential to the success of this product and are committed to conduct research and make necessary changes to migrate any potential risks in order to increase reliability of our system.

Benefits of the Home Attender include convenience, allowing the owner to setup an alert system and receive information about dangers from wherever they are. The system will use thermal cameras for increased accuracy in detecting intruders and fires, greatly reducing the chance of a false alarm. The Home Attender is also designed to be a scalable system and can be extended to protect large facilities such as farms or shopping centers. The scalability factor will also allow additional security features to be developed added to the Home Attender in the future.

Our company's primary target market is the private home sector. Currently no system out in the market incorporates all the elements we propose for this product, which we believe will make the Home Attender attractive for customers.

There is a lot of competition in this market which use devices such as cameras to augment their security service. However, the average competitor can easily consume large amounts of bandwidth because of their data streaming. Our system is designed to only send data through the network when necessary to lessen the data usage.

Our group consists of five engineering students with experience in the electrical, computer, mechanical, and software fields. Our expertise in these fields allow us to integrate the different components into a complete system for our product. We believe we have the necessary experience to bring the Home Attender to completion.

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Introduction

A major area of concern to Canadian homeowners is the issue of home security. The Canadian Statistics Report shows that there is an increase breaking and entering [1], which requires more advanced security systems. The average home security consists only of an alarm system triggered by physical contact, and do not integrate other elements. However, there are many technologies available which can provide a safer environment for residents. The goal of Home Attender is to combine many of these elements into a more sophisticated and reliable product for the average homeowner.

One of the problems that can occur with the typical security system is false alarms, which will put unnecessary strain on the emergency responders and incur a fee. To avoid this problem, Home Attender will have an app to allow a homeowner to flag a false alarm and be alerted of any intrusions. The app will allow the user to quickly find out about any possible intrusions and give them the option to alert the authorities if the intruders are unwelcomed.

As part of the integrated system, the Home Attender a fire detection system. It will use a thermal camera to detect and alert the user of a possible fire. The system will also attempt to perform a localize fire suppression to minimize water damage.

The core of the Home Attender will have many different components dedicated to specific optimized tasks. Each component is simple and our goal is to combine the various simple elements together to create an integrated system. Our system design is aimed to be cheap and efficient in terms of cost to performance to allow for wide scale usage. The Home Attender will be scalable to allow deployment in different house layouts and expansion into other markets.

The following document will describe the features of our product:

- High-level description of the design
- Risks and benefits involved
- Market landscape for this product
- Cost estimations and funding
- Project deliverables

Scope

The goal of our company is to develop an affordable, sophisticated, and user-friendly security system for an average home user, with better diversity than those used in the industrial, commercial, or militarized industries. The system will contain the following components: thermal imaging and optical camera, accelerometers, mobile application, wireless communication to home speakers, and networking and server.

Tracking Camera Module

The module uses two different cameras to provide recording and automated tracking.

Optical Camera module

The purpose of the camera module is to offer facial and motion footage to be used as evidence for police or insurance agencies. The camera will also allow brief footage to be sent to the homeowner for false alarm identification.

Thermal Imaging Camera

The thermal camera will be used to detect heat signatures emitting from living organisms and the high temperature in fire. Thermal imaging will also help track movement outdoors during dense fog or under low visibility conditions.

Accelerometers

Accelerometers will provide supplemental tracking in cases where the cameras are tracking multiple heat signatures and provides redundancy to the overall system. The accelerometers will be buried underground using protective housing.

Networking

The network incorporates a simple and cost-efficient traffic route to limit the amount of bandwidth and data used.

Server/Local Storage

The system's data storage capability is to store and archive images, footage, and other collected data for use as evidence for police and insurance agencies or for personal use.

Mobile Application

Provides user with a convenient control platform that allows users to access the camera in real time, modify security system settings, and alert them to potential safety risks.

Bluetooth Alarm System

When an intruder or fire is detected, user is notified through both the alarm system and the app. The camera module notifies the local computer, which then activates the alarm system and sends an alert to the mobile app.

Risks

Reliability

There are many risks which are involved in the implementation of a successful security system, and Home Attender is no exception. Our product deals with sensitive fields such as home surveillance and fire prevention, meaning that failure could result in serious repercussions. Care must be taken to ensure that the Home Attender is able to detect intruders and fire accurately. Additionally, the product must be able to function at all times without interruption, as the aforementioned dangers could happen at any point. Ideally, it should also possess a long service life, so that replacement of the product will be a trivial issue. Since the Home Attender contains a storage feature for recorded data, it has to be protected properly, as there is private information being stored. Deficiencies in any of the above features can be considered as risks to the success of the Home Attender. Having a product that customers can rely on is arguably the most important factor when it comes to security systems.

Expertise

In order to reduce the risk of product unreliability, the first step that needs to be taken is at the design level of the product. Proper research should be done to ensure that the concepts are practical. This leads to another risk that our project possesses, which is the expertise of our group members in the subject. Our group has minimal prior knowledge regarding thermal cameras and security system design, which increases the chance of mistakes being made during the design of the Home Attender. In order to make up for this deficiency, our group should spend extra effort to analyze the topics involved using both the resources available online or at SFU.

Integration

As defined in the project background, the Home Attender consists of numerous components such as a server, thermal cameras, optical cameras, accelerometers, and a mobile app. Due to the large range of features included in the project, there is a risk of not being able to successfully integrate one or more components into the system. Factors which may cause the incompletion of a component include timeline constraints, miscalculations due to real world factors, and incompatibility of the technologies used to design each component. Our group plans to combat this risk by prioritizing and deciding which components are most important to the core idea of our project. This allows us remove components which may not greatly impact the overall concept of Home Attender if they are too much of a challenge to implement. This is made possible due to the scalability of our project design.

Timeline and Budget

Aside from product quality, another risk which may arise during the development of the Home Attender is the acquisition of the materials required. There are a lot of different components in our product which complicates the gathering of parts. Not only does our group have to ensure that the units will be compatible with each other, we also have to consider potential errors in our budget and the time it takes to ship the parts. To mitigate this risk, careful research should be done beforehand to properly integrate the different pieces of hardware. Good timeline planning will eliminate any issue regarding the arrival of the parts. Our group has agreed to collectively subsidize any costs that exceed the budget.

In general, the risks involved with the development of the Home Attender can be mitigated through extended research and planning of the topics involved. As each group member is focusing on a separate feature of the product, team communication will be key to ensure the that the project is completed on time and within our standards. Reduction of the aforementioned risks will result in a functional and reliable Home Attender.

Benefits

Variety

The Home Attender gives our customer a safer home by providing a variety of functionalities, including detection of fires, home intrusion, and wild animal attacks. Additionally, the Home Attender will store recorded footage into a local server as backup. It will also allow the user to check the security status of their home in real-time through a mobile application.

Accuracy

In addition to the traditional way of using video recordings for security, our company decided to add a thermal imaging camera for detecting threats. We also plan to use accelerometers to detect the exact position of a moving object near your home. These features allow us to detect the movement of creatures not only during daytime, but also at night when visibility is low. Additionally, the components will increase the accuracy of the alerts.

Convenience

The Home Attender comes hardware sensors, a local server, and a free mobile software. Our product's real-time control system with notification functionalities will be connected to a network which will let the user know when suspicious action is detected on the property. By using the app, user can set toggle alerts and connect to the camera to see what is happening in real time. The user will have a very convenient control of the Home Attender and can be ensured of their home's safety at all times.

Scalability

What the Home Attender gives our customers is not just a security system with sensors. Our company is trying to provide the user with a security package that not only has basic hardware components, but also a server and software support. The Home Attender is an extremely diverse product. The prototype is targeted towards the common household, but depending on the user's demand, the magnitude and the number of functionalities could be expanded. For example, more sensors can be added to make the Home Attender compatible with a larger building because the software logic of our product doesn't need to be changed.

Product Analysis

Market

Our company believes the Home Attender will perform well in the market since there is no existing security system in the market which can compete with it in terms of convenience and accuracy. Given multiple cameras and fire detection capabilities, along with networking, a mobile app, and other useful functionalities, one can only imagine how much our product is needed in the market.

Target Customer

As shown in Figure 1, there is a huge increasing demand in the market for smart home security technologies. It is the most important aspect people want for their smart home system after automation. For us, we believe our product could suit anyone who want to experience a smart security system for either their home. The Home Attender could replace the traditional intrusion and fire alarm system.

Market Share

Our company has found that there is no single home security company which currently possess all the elements that the Home Attender has. Currently, a lot of security systems have the drawback of consuming lots of data and bandwidth. For example, Shaw requires user to subscribe to a plan where the equipment isn't owned by them, and ADT requires users to also subscribe to a plan. In comparison, our system stores video and data locally on a local server inside the house. Bandwidth is only consumed when the user plans to view images and videos through the mobile app. As a result, there will be minimal follow-up charges incurred by the Home Attender. Additionally, the scope of our security system could be scaled depending on the user's demand. Thus, the price can also be changed depending on that. One of our company's goals is to help our customers to decrease the cost of a smart home security system. Letting them know what they need so they only pay for what they use.
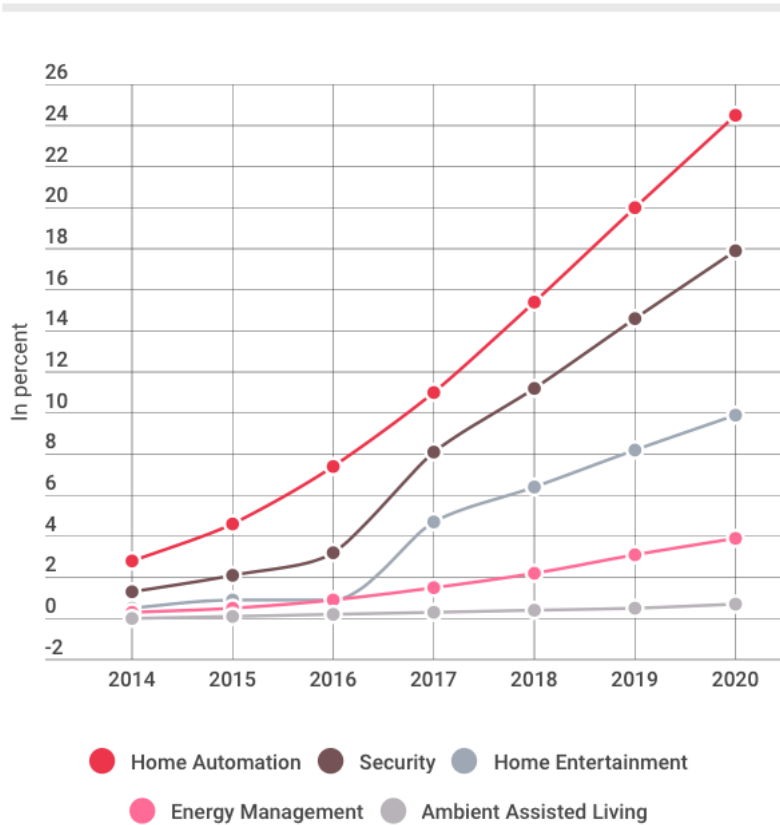
"Smart Home" demand, U.S. market

Figure 1: Smart Home demand in US market [2]

Competition

There are currently no companies providing the Home Attender 's specific set of configurations and components. However, a number of competitors to our product have similar features.

Shaw Cable offers IP cameras installed at your home, with a minimum monthly subscription of $30.00/month [3]. Shaw indicates that the price is for a complete package, including internet, camera, and cloud storage. The cameras also include thermal readings for office traffic tracking. They are not designed or manufactured by Shaw. Axis and Pelco offers a variety of security camera and servers for storing footage, neither of which offers the capability to track the high core temperatures of fire [4] [5]. Home Attender offers the ability to suppress fires in a specific location, limiting the amount of overall water damage commonly found in many post-fire homes. The benefit of using the Home Attender's security system versus any of the cheap camera systems available on amazon.ca, Best Buy, or Home

Depot, is heavily based on the sophistication of the machine learning capability in our camera software, and the system networking. Conventional home security systems rely on the bandwidth and data of your home internet whether you use it for television, streaming Netflix, or browsing the internet. High speed internet nowadays has upper limits on how much data may be used each month before a surcharge is added to you bill.

Many home conventional home security systems tend to consume a lot of bandwidth and data for your home internet. They commonly require homeowners to purchase a separate dryline to supplement their new security system. This is because the footage streamed by the cameras are sent either to local data storage or the cloud, both via internet. Apps that allow users to view footage are streamed directly from the camera to the phone. Home Attender allows the user the opportunity to only consume bandwidth and data when it is needed. Our design eliminates any data being passed through the internet unless it is requested by the user. Images and footage are sent from the camera to the computer via ethernet to the local data storage which our company uses a cheap off the shelf computer. Footage is stored locally on a continuous ring buffer, with triggered events going into a separate folder. The computer is connected to internet at all times, and old footage can be retrieved from your phone using remote applications such as Teamviewer or VNC. Real-time streaming is also available through our smartphone application. Although internet is still used, bandwidth and data will only be consumed when activated by the user.
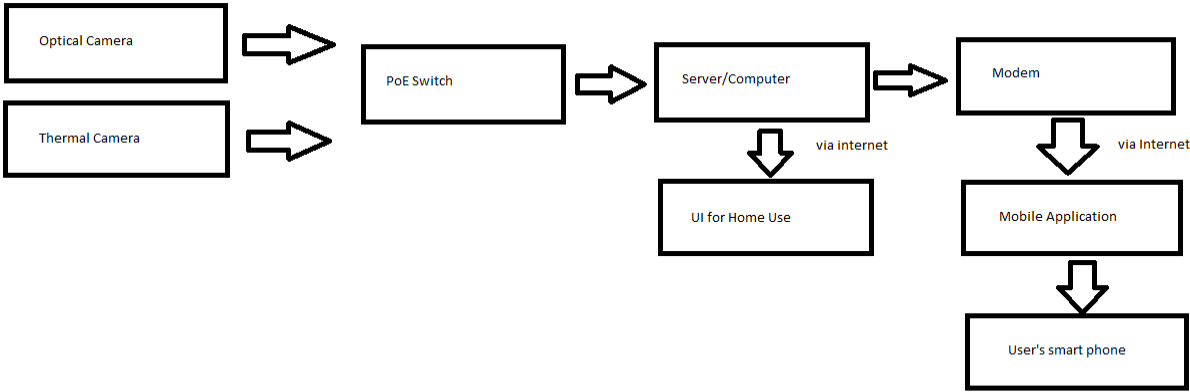

Figure 2: Network Diagram of Home Attender Security System

Kinemetrics Inc. is an American company based out of Pasadena, CA. The company specializes in industrial and commercial seismic monitoring equipment [6]. Their catalog equipment includes free-balance accelerometers and seismometer for vibration detection, and digitizers for data recording and computation. However, equipment price for a common triaxial accelerometer ranges between $2,000 to $5,000 a piece, while digitizers can range from $75,000 to $120,000. The company

has an annual maintenance plan for approximately $1,000 per year. For a typical homeowner, equipment at this level of sophistication is unnecessary. Another company based out of the US is Trimble Inc., also specializing in seismic monitoring service and GPS tracking [7]. Similar to Kinemetrics, equipment is primarily centered in commercial and industrial settings, specifically for seismic related activities. Geosig is a Swiss based company specializing in strong and weak motion detection [7]. The company offers customers (primarily oil giants and government agencies located on seismic hot spots) the opportunity to join their strong motion network. Data used for a strong motion network would help the local government agencies gather forensic data on shake intensities for analyzing important rescue and evacuation structures (i.e. bridges, hospitals, etc.). Weir-Jones Ltd., located in Vancouver, specialized in monitoring instrumentation primarily for pipelines, but have also engaged in structural health monitoring and George Massey Tunnel's Early Earthquake Warning System [7]. Again, Weir-Jones Ltd. primarily services commercial and industrial customers. Analyzing the four companies listed above, we are able to conclude that although they pose insignificant damage to market share, as each of these companies specializes in highly sophisticated accelerometers and vibration detection. Home Attender specializes in home security, with accelerometers being a supplemental application to our product, where we tradeoff of using multiple cheap accelerometers to create a network, rather than using a single high-quality sensor.

ADT, a popular home alarm company in metro Vancouver, specializes in home reporting based on motion triggered when the house is armed. Home Attender does not have a reporting function to the police or fire department, however this portion is scalable. The currently design of the system will report directly to the homeowner's phone via our in-house mobile application. This allows the homeowner to choose whether or not to report, eliminating monthly surcharge to the police departments to have an active reporting line, and confirming false alarms with true alarms. Our company not only has detection software, but fire suppression system.

Overall the Home Attender security system offers a wide variety to consumers to choose from and components design for redundancy. Our product currently does not exist in the market; however, many companies offer a specified portion of our product. The advantage of our product is the diversity of components for enhanced monitoring, tracking, and reporting. Unlike our potential competitors that may pursue this market, our product does not possess the traits of a "one-skew-pony".

Company Details

Isaac Qiao - CEO (Chief Executive Officer)

Isaac is a 4th Year Computer Engineering student at Simon Fraser University. His previous work experience including Database Developer at MENRVA Research Group SFU and Full-Stack Developer at EYEXPO Technology Corp. His interest includes Image Processing, machine learning, and digital system design. Isaac is our company's CEO, in charge of planning, implementing, and integrating the strategic direction of Home Attender

Tommy Li - CTO (Chief Technical Officer)

Mr. Tommy Li is a 5th Year Computer Engineering student at Simon Fraser University. His previous work experience includes a year of QA work at Global Relay Communications, ranging from performing automation to user-level testing on various databases and applications. His interests include programming, digital systems design, and testing. Tommy is our company's incumbent CTO and is in charge of evaluating the company's system and infrastructure and ensuring its quality.

Christopher Chiu - COO (Chief Operating Officer)

Mr. Christopher Chiu is a 4th Year Systems Engineering student at Simon Fraser University. His previous work experience including Embedded System Engineer and Silicon Validation Engineer at Intel. His interest includes FPGAs, programming, and embedded design. Christopher is our company's COO, in charge of overseeing operations of the company and promoting the company's culture and vision.

Benjamin Ng - CFO (Chief Financial Officer)

Mr. Benjamin Ng is a 4th Year Systems Engineering student at Simon Fraser University. His previous work experience including Electrical Equipment and Reliability Engineering at Syncrude Canada, and Seismic Monitoring Instrumentation at the BC Ministry of Transportation and Infrastructure. His interest includes embedded design, electronics, and circuitry. Benjamin is our company's incumbent CFO, in charge of managing and projecting financial assets, investments, and return.

Ruisi Wang - CPO (Chief Product Officer)

Mr. Ruisi Wang is a 4th year Computer Engineering student at Simon Fraser University. His previous work experience including website design and implementation, and an 8 - months Co-op experience as a mobile application developer at Gala Technology Ltd. His interest includes network traffic analysis, APP development, and programming. Ruisi (Sam) is our company's CPO, in charge of product timelines, quality assures, and project communication.

Project Planning

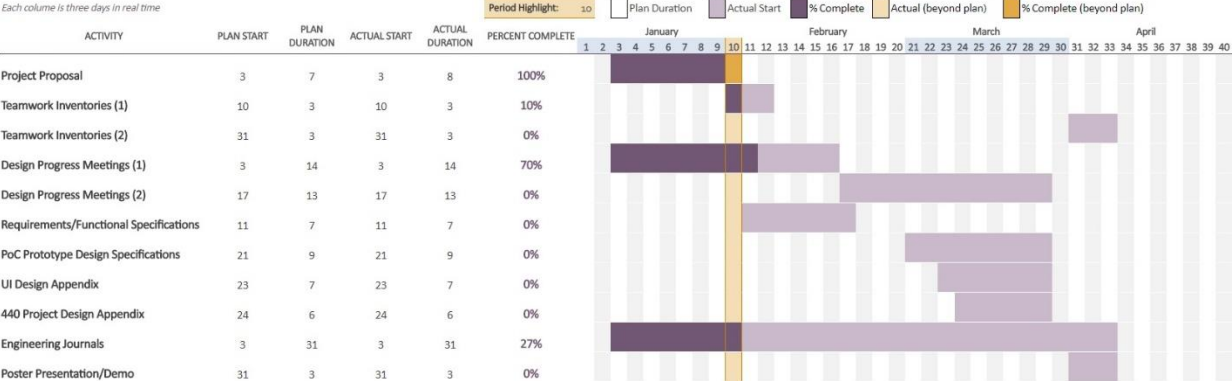## Project Timeline: Documentation Phase ENSC 405w

Figure 3: Project Timeline: Documentation Phase
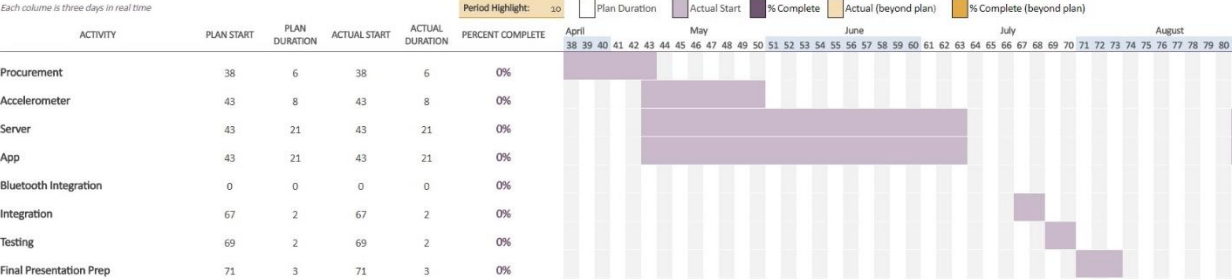
Project Timeline: Implementation Phase ENSC 440

Figure 4: Project Timeline: Implementation Phase

Cost Considerations

Budget and Estimate Cost

Item	Cost	Quantity	Sub Total	Comments
Thermal camera	40.40	1	51	Cost taken from highest costing thermal camera
Optical Camera Module	40.96	1	52	Cost taken from highest costing thermal camera
Arduino Servo	6.40	1	9	
Bluetooth Module HM-10 for Arduino	23.06	1	29	
Arduino Kit	42.99	1	54	Accelerometer and general parts
Computer	200	1	250	
Accelerometer + gyroscope	9.99	10	125	3 accelerometers + 3 gyroscopes per pack
Grand Total	570			

Table 1: Table of estimated cost of parts

The table above outlines the estimate prices based off a higher end costing for a more flexible budget. An overestimation by 25% due to taxes, shipping, and changes in the Canadian currency for the sub total cost rounded up.
Grand Total:

Funding

By recommendation from our colleagues with experience in ENSC 405W, it is best to apply for NSERC and ESSS project grants during the latter half of the capstone project; during the start of ENSC 440.

The members of the group are willing the share the outstanding cost of any items we may be missing.

Conclusion

The Home Attender home security system is a new generation alert system that can help Canadian homes to become some of the safest homes worldwide. It uses multi-camera detection to prevent false alerts, giving users a more accurate alert system so they can avoid false alert fees and benefit the city's emergency recourses. Our home security system will be connected to the network and server, which allows users to access the camera, past intrusions, and send commands to the system in real time.

As a succeed product, our risk and benefit analysis show us with promising market value. Although our company may have some variety and experience issue, our strength in convenience and accuracy gives us an edge in the competition. Furthermore, with our talent team member and our detailed planning schedule, we have minimized our unknown factor of the project, plus a passion at the topic.

The level of integration and new functionalities of Home Attender is unique to the presently available home security systems. This provides a promising risk and benefit analysis our product in the current market, which leads our group to believe that this could be the future of the security system landscape.

References

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