ENSC 405W Grading Rubric for Design Specification

Criteria	Details	Marks
Introduction/Background	Introduces basic purpose of the project.	**/05%**
Content	Document explains the design specifications with appropriate justification for the design approach chosen. Includes descriptions of the physics (or chemistry, biology, geology, meteorology, etc.) underlying the choices.	**/20%**
Technical Correctness	Ideas presented represent design specifications that are expected to be met. Specifications are presented using tables, graphs, and figures where possible (rather than over-reliance upon text). Equations and graphs are used to back up/illustrate the science/engineering underlying the design.	**/25%**
Process Details	Specification distinguishes between design details for present project version and later stages of project (i.e., proof-of-concept, prototype, and production versions). Numbering of design specs matches up with numbering for requirements specs (as necessary and possible).	**/15%**
Test Plan Appendix	Provides a test plan outlining the requirements for the final project version. Project success for ENSC 405W will be measured against this test plan.	**/10%**
User Interface Appendix	Summarizes requirements for the User Interface (based upon the lectures and the concepts outlined in the Donald Norman textbook).	**Graded Separately**
440 Plan Appendix	Analyses progress in 405W and outlines development plans for 440. Includes an updated timeline, budget, market analysis, and changes in scope. Analyses ongoing problems and proposes solutions.	**Graded Separately**
Conclusion/References	Summarizes functionality. Includes references for information sources.	**/05%**
Presentation/Organization	Document looks like a professional specification. Ideas follow logically.	**/05%**
Format/Correctness/Style	Includes letter of transmittal, title page, abstract, table of contents, list of figures and tables, glossary, and references. Pages are numbered, figures and tables are introduced, headings are numbered, etc. References and citations are properly formatted. Correct spelling, grammar, and punctuation. Style is clear, concise, and coherent. Uses passive voice judiciously.	**/15%**
Comments		

March 31, 2018
Andrew H. Rawicz
School of Engineering Science
Simon Fraser University
Burnaby, British Columbia
V5A 1S6

Re: ENSC 405W/440 Design Specification for **Home Security System** by **Home Attender**

Dear Dr. Rawicz,

Enclosed is the design specification for Home Attender, part of the curriculum for ENSC 405W/440. Our group is aiming to design a cost-effective home security system which uses a thermal and optical camera module along with accelerometers to detect intruders and fires.

This document will outline the high-level design, showing which requirements our system will need to meet. It includes the system overview, system requirements, test appendix, user interface appendix, and 440 plan appendices for both the proof-of-concept and later stages of the Home Attender. The specifications outlined in this document will serve as a guide throughout the design for our project.

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 requirement specification. Please feel free to contact our Chief Executive Officer, Isaac Qiao, by email or phone at bqiao@sfu.ca or (778) 927-4893 if you have any questions or concerns.

Sincerely,
Isaac Qiao
Chief Executive Officer
Home Attender

HA HOME ATTENDER

Design Specifications for Home Security System

Project Team:
Isaac Qiao
Christopher Chiu
Ruisi Wang
Benjamin Ng
Tommy Li

Contact Person:
Isaac Qiao
bqiao@sfu.ca

Submitted to:
Dr. Andrew Rawicz – ENSC 440
Steve Whitmore – ENSC 405w
School of Engineering Science
Simon Fraser University

Issue Date:
March 31, 2018

Version:
1.0

Abstract

The Home Attender home security system is a scalable, multi-purpose intruder and fire detection system designed to be compatible with a variety of markets. The product's overall specifications can be separated into system overview and specification for each component in the system. The high-level requirements for these functionalities will be analyzed for the proof-of-concept, prototype, and production stages of development. Additionally, development of the product must take into account engineering standards, environmental impact, and safety concerns. User and technical analysis must also be performed during the design process. All of the aforementioned aspects must be taken into consideration for the upcoming development of the Home Attender

Contents

List of Figures and Tables

1. Introduction

The Home Attender is designed to integrate various components dedicated to specific optimized tasks in order to provide a sophisticated home security system. The system will be thrifty and efficient in terms of the cost-to-performance ratio in order to appeal to a wider market. The Home Attender will be scalable, allowing deployment in varying home layouts with the eventual goal being expansion into other markets, such as government surveillance.

This document will provide an in-depth analysis of the design specifications of the Home Attender, along with the user interface design, test appendix, and action outline of our group's next steps in ENSC 440. The design specifications will detail the overall layout of the product, supported by calculations and diagrams.

The user interface design focuses on how the consumer will interact with our product, providing a detailed analysis on the expected workflow of the average user. The test appendix outlines the necessary steps to ensure that Home Attender's product meets government regulation and also our company's own standards. Testing will be broken up into three parts: proof-of-concept, prototype, and production, applied to all of hardware, software, and networking. The action outline will involve a rundown of how the Home Attender team plans to tackle many of the aspects required to produce a functioning prototype during ENSC 440.

2. System Overview

The Home Attender's objective is to create a cost efficient and sophisticated home security system that has a level of technology which is scalable to the commercial, industrial, and military industries, but at the same time utilizing low cost consumer-grade equipment.

The current market of home monitoring is heavily divided between militarized grade homes with blast resistant doors and searchlights for those who are financially competent, and low-quality surveillance cameras for the average consumer. Both systems are heavily user driven, requiring the customer to directly report intrusions to the appropriate authorities. Our company believes that this process can be completely automated. Another issue the Home Attender aims to combat relates to the increasing popularity of smart homes. The market is flooded with various electronic devices installed around your home to invoke convenience for the user. But what happens when a fire erupts inside your home? Current sprinkler systems, when initiated, results in a large discharge of water that is expected to cover every inch of your house with little regard for the exact location of the fire. This is extremely problematic as a small house fire can result in major water damage to the home due to the sprinkler system. Additionally, a common practice for firefighters after rescuing small fires in Canada is to open up sections of the home's walls to extinguish any hidden fires lurking inside walls. These are major questions that have facilitated the design of the Home Attender. The Home Attender system is fully automated and a one-stop-shop product that provides various security and smart utility features to protect your house.

The protection Home Attender system provides begins on the outside of the customer's house. Thermal and optical cameras are place at a high vantage point on your house and sit on top of a small controller capable of pivotal movement. The user's lawn is then instrumented with an array structure of vibration and force sensors underneath their lawn. The buried sensors prevent accidental clipping from surface activity, vandalism, theft, and provides better aesthetic. The overall layout can be observed in Figure 2-1.

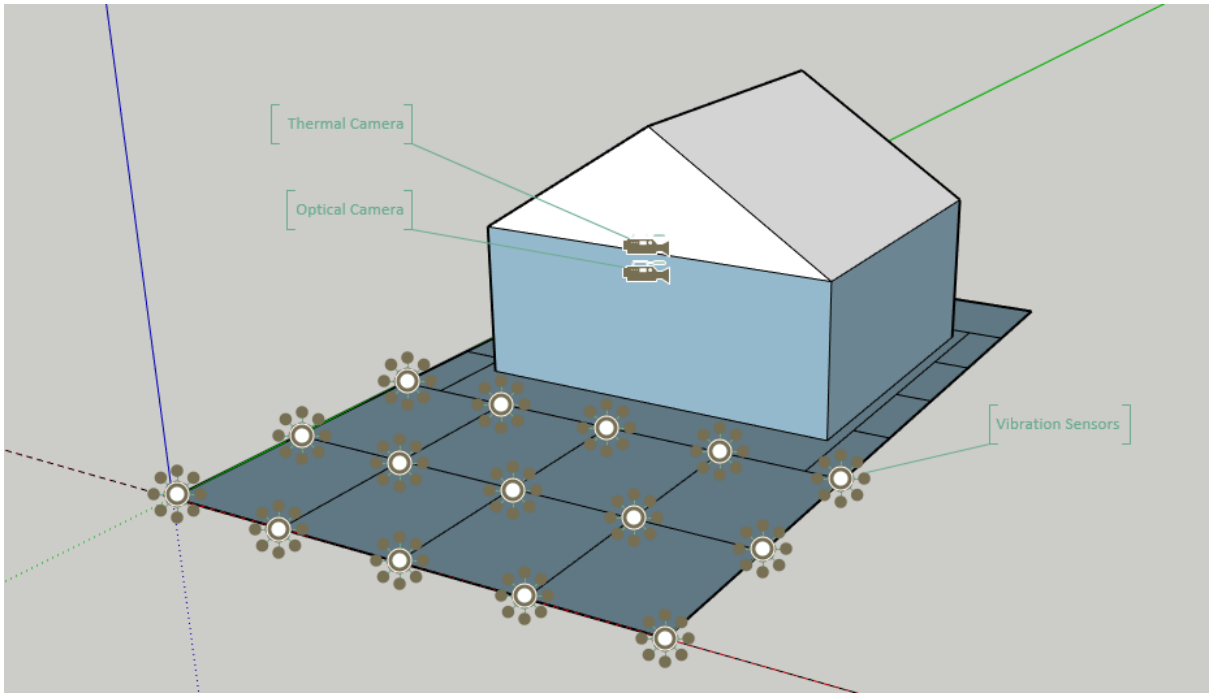

Figure 2-1: Home Attender Layout Diagram

The Home Attender system's intruder detection is first triggered by the thermal imaging camera, which picks up high heat signature readings that stand out from the static environment. Figure 2-2 displays the control diagram of the outdoor component of the Home Attender. This will be recalibrated between seasons or when there are major changes that happen to the house's exterior. A heat signature of 36 degrees Celsius or greater--coinciding with average human internal body temperature of 36 to 38 degree Celsius--is required to trigger the "alert flag" in the system. Afterwards, the sensors on the field will compute the approximate location of the intruder. Since the thermal imaging cameras contain a single lens system; accurate depth perception is a major hurdle. The sensor system is essential in answering the following questions:

1. Is the intruder on or off the user's property?
2. How many intruders are there?
3. If there is more than one intruder, which one should the camera track and record?
4. Does the intruder actually exist?

The design of the system's prototype design is to only track the intruder closest to the house. Although a small sized home property in the Greater Vancouver area has very little use for instrumenting the property with sensors; the scalability of this design is also applicable to owners with large plots of property such as private schools or farms. For the prototype design, the vibration and force sensors will only help determine where and which intruder to track. After both the heat signature and location of the intruder is determined, the optical camera is activated. As both the thermal and optical cameras sit on a small pivotal controller; this controller will be actuated by the thermal imaging camera to be able to continuously follow the heat signature of the intruder, while the optical camera will provide additional visual evidence. Data is recorded and stored in five-minute files for one week on a ring buffer within a integrated home

server. Simultaneously, the security system will notify the home owner through our proprietary smartphone application. The prototype app will be compatible with iOS only.

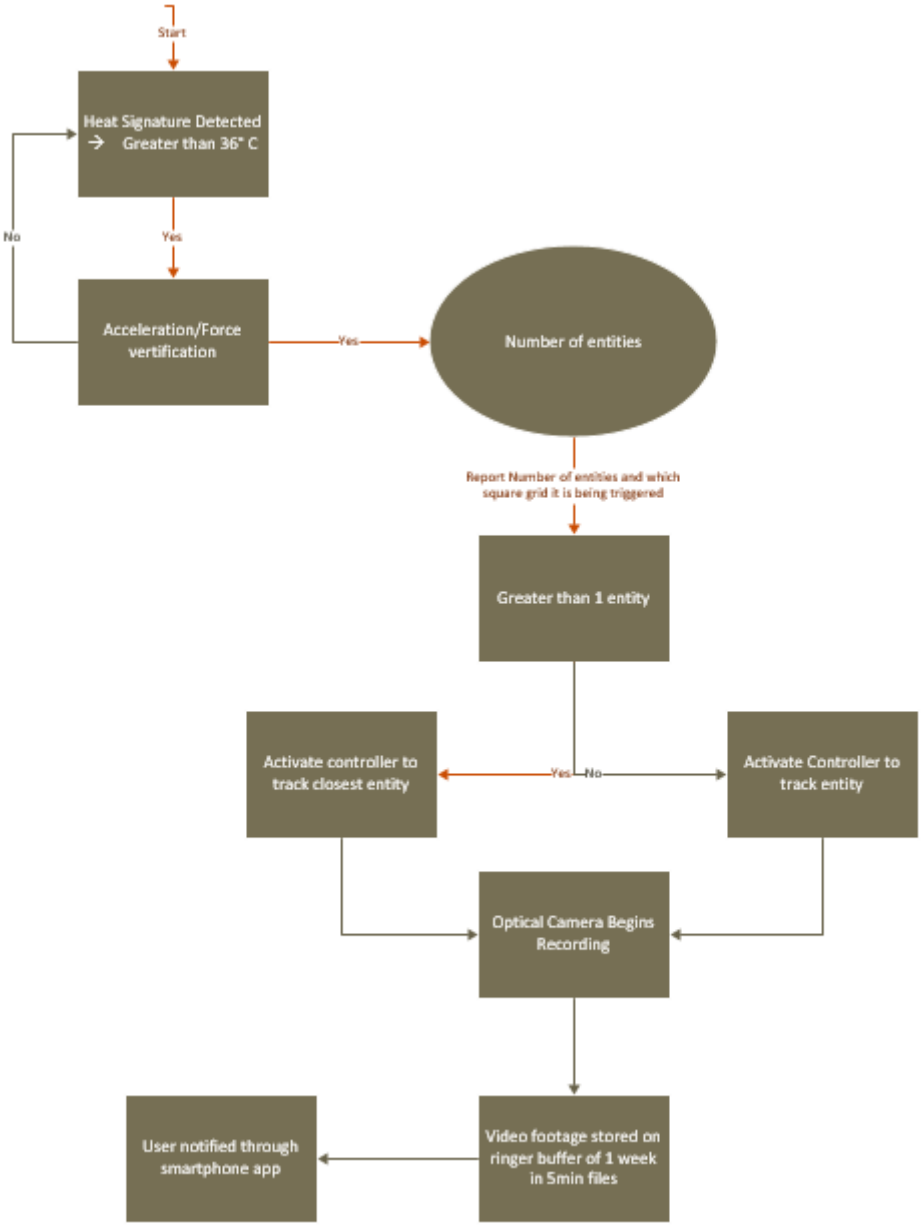

Figure 2-2: Home Attender Control Diagram (Outdoor)

While the outdoor component of the Home Attender focuses on intruder detection, the indoor component focuses on monitoring intrusion and fire suppression. The inside of your house will be instrumented with an identical camera set up as the outdoor component. The only difference is that the camera will be introduced with two different functionalities:

1. Reading internal temperatures in humans (36 to 38 degrees Celsius)
2. Temperature of a red coloured fire (lowest temperature of 600 degrees Celsius)

The thermal imaging camera will run continuously and monitor the heat signatures inside the user's house. In addition, the prototype design will incorporate an additional controller that will actuate the flow of water for fire suppression. The camera will first determine whether or not the heat signature is consistent to that of a human body. If this is the case:

1. Optical camera will be activated and begin recording video
2. Pivotal controller will use the data obtained by the thermal imaging camera to track the heat signatures
3. Data is reported to the server
4. Local authorities will be notified
5. User will receive notification via the proprietary app

If this is not the case, the system will move to the next condition of heat signatures being consistent with typical red-flamed fires. In this case:

1. Optical camera will still be activated, footage is valuable for evidence usable for insurance purposes
2. Pivotal controller will use the data obtained by the thermal imaging camera to track the heat signatures
3. Controller for the fire suppression will shoot water out of a hose to suppress the fire
4. Data is reported to the server
5. Local authorities will be notified
6. User will receive notification via the proprietary app

Complete control diagram of the indoor component can be seen in figure 2-3.

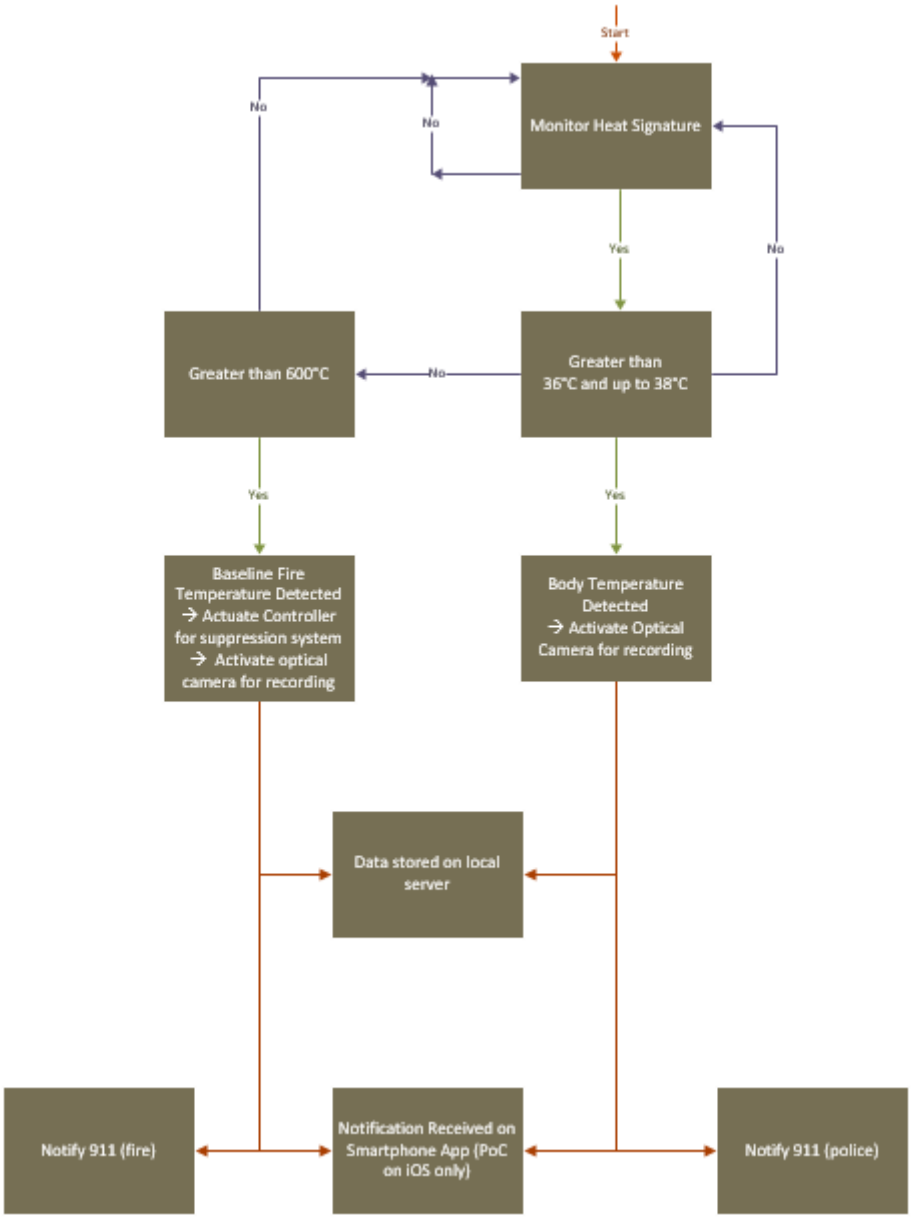

Figure 2-3: Home Attender Control Diagram (Indoor)

A major defining aspect of the Home Attender is its relatively low data usage of the user's home internet. Our company understands that not everyone has unlimited internet data. A common issue with home security systems is that everything is hosted on the cloud. Video footage being uploaded in real time causes major strain on bandwidth and internet data consumption. This is why many home camera systems recommend users to either upgrade their internet package or purchase another dry line. Home Attender's solution to this is simple; make data storage from the cameras local. By introducing a small consumer grade server, we are able to cut down on having footage being continuously uploaded to the internet. Even if the user would like to access this footage remotely, they are only paying for internet during the time they are accessing the computer. Figure 2-4 shows the Home Attender's network diagram.

With the outdoor component, optical and thermal cameras are connected to a PoE (Power over Ethernet) switch and then into the local server. The Accelerometers and force-pads will have the data compiled and computed with a data recorder consisting of either an Arduino or Raspberry Pi and then sent to the local server. This is to compensate for real time computation delays. As image processing requires the majority of threads in the CPU for a consumer grade server, a separate controller can help ease computation speeds.

For the indoor component of the Home Attender, thermal and optical footages follow the same network link to a PoE switch before entering into the local server.

Once data has made its way into the server; the server will begin computation and feed the information into the controllers. The controllers will actuate the pivotal platforms. With the outdoor component it will only pivot the platform, while with the inside component it will also activate the fire suppression water pump.

Next, the server will notify the user through the home Wi-Fi. The notification will make its way into our proprietary app on the user's smartphone. From there the user is able to review what the issues are and access footage and vibration data.

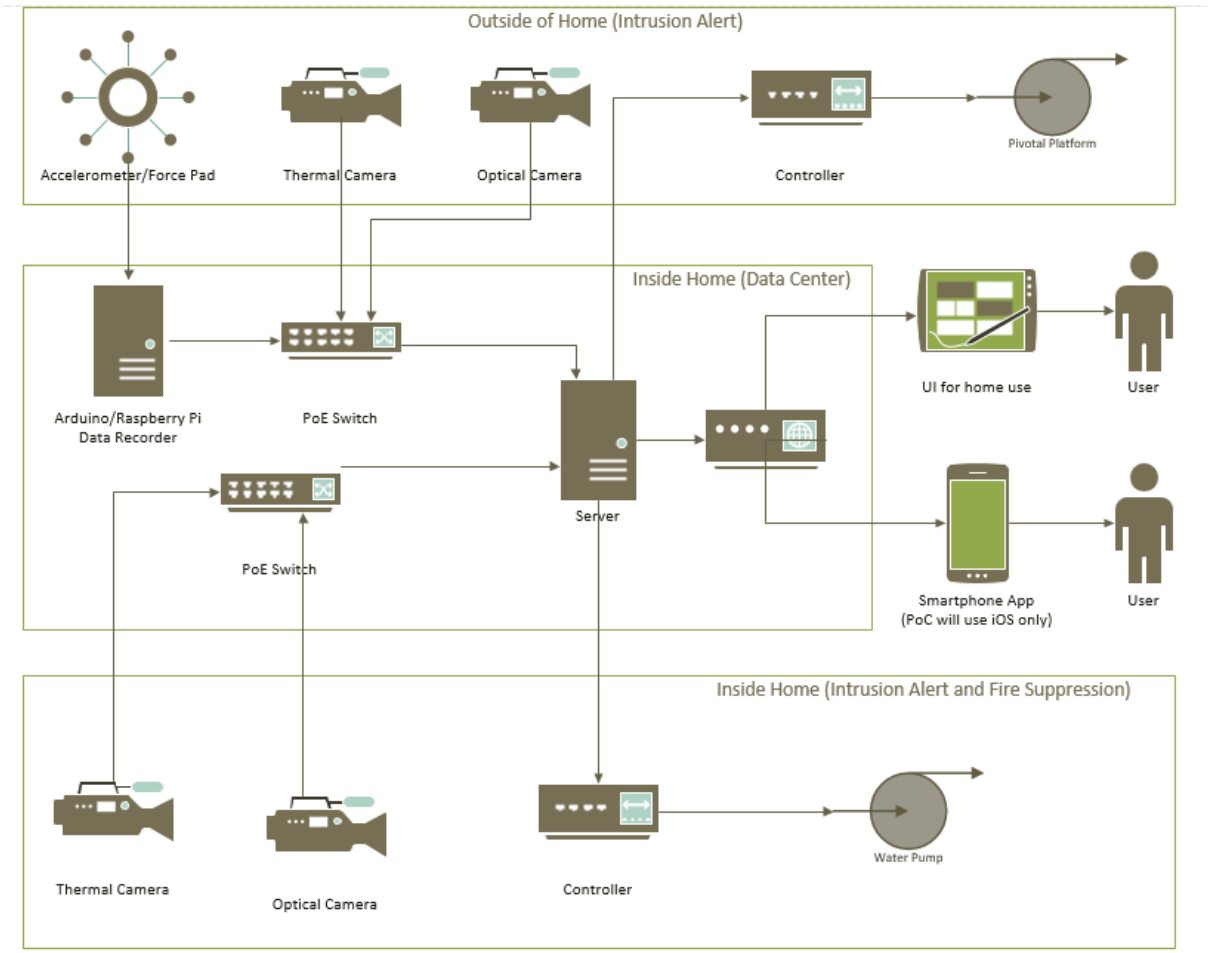

Figure 2-4: Home Attender System Network Diagram

3. System Requirements

3.1 Camera Module

The system will have two camera modules each containing one optical camera and one thermal camera. The two camera modules will have different designs for environmental resistance. One is used for indoor monitoring and fire tracking, while another is used for outdoor intruder tracking and prevention. Based on user's installation environment, the camera modules can be installed on ceilings, walls, or pillars. The recorded video data will be sent to the local server for data analysis.

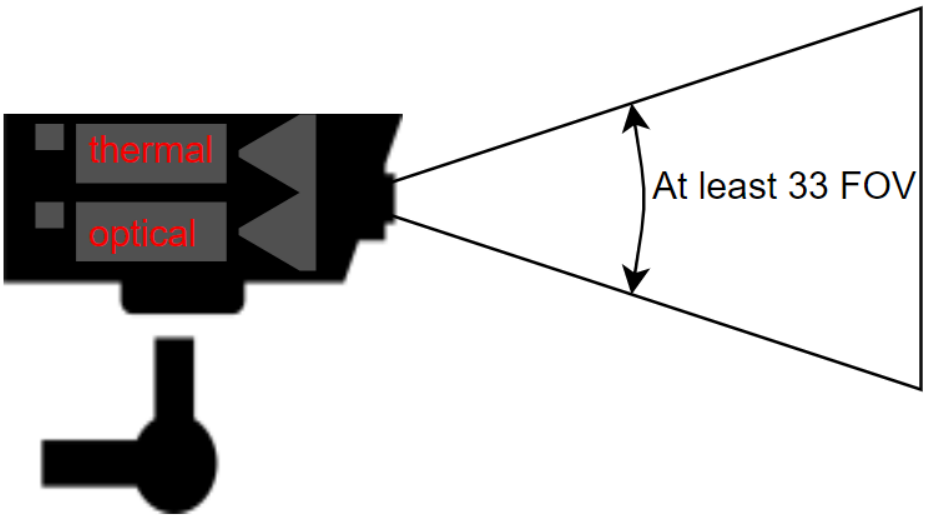

Figure 3-1: Camera Module Diagram

Below are the key specifications for thermal camera [2]

Function	Passive thermal imaging module
Sensor Technology	Uncooled VOx microbolometer
Spectral Range	Longwave infrared, 8 µm to 14 µm
Array Format	80 × 60, progressive scan
Pixel Size	17 µm
Effective Frame Rate	8.6 Hz (exportable)
Thermal Sensitivity	<50 mK (0.050° C)
Temperature Compensation	Output image independent of camera temperature
Non-uniformity Corrections	Automatic (with scene motion)
FOV - Horizontal	51°
FOV - Diagonal	63.5°
Depth of Field	10 cm to infinity
Lens Type	f/1.1 silicon doublet
Output Format	User-selectable 14-bit, 8-bit (AGC applied)

Solar Protection	Integral
Input Clock	25-MHz nominal, CMOS IO Voltage Levels
Video Data Interface	Video over SPI (see VoSPI Channel, page 28)
Control Port	CCI (I2C-like), CMOS IO Voltage Levels
Input Supply Voltage	2.8 V, 1.2 V, 2.5 V to 3.1 V IO
Power Dissipation Nominally	150 mW (operating), 4 mW (standby)
Package Dimensions	8.5 × 11.7 × 5.6 mm (w × l × h) Weight 0.55 grams
Operating Temperature Range	-40 °C to +80 °C
Shock	1500 G @ 0.4 ms

The key specifications for optical camera. [3]

Size	Around 25 × 24 × 9 mm
Weight	3g
Still Resolution	8 Megapixels
Video Modes	1080p30, 720p60 and 640 × 480p60/90
Sensor	Sony IMX219
Sensor Resolution	3280 × 2464 pixels
Sensor Image Area	3.68 x 2.76 mm (4.6 mm diagonal)
Pixel Size	1.12 µm x 1.12 µm
Optical Size	1/4"
Full-frame Lens Equivalent	35 mm
S/N Ratio	36 dB
Dynamic Range	67 dB @ 8x gain
Sensitivity	680 mV/lux-sec
Dark Current	16 mV/sec @ 60 C
Well Capacity	4.3 Ke-
Fixed Focus	1 m to infinity
Focal Length	3.04 mm
Horizontal Field of View	62.2 degrees
Vertical Field of View	48.8 degrees
Focal Ratio (F-Stop)	2.0
Linux Integration	V4L2 driver available
C Programming API	OpenMAX IL and others available

3.1.1 Proof of concept:

In the proof of concept stage, the Home Attender will only need to be able to demonstrate the ability to record thermal and optical video from one camera module and stream video data to the server computer. Video analysis will be done manually on server computer after the streaming is finished.

Requirement Code	Requirement Description
Req 2.1.1-H-PoC	Camera module has at least 33° field of view
Req 2.1.2-H-PoC	Camera requires max input voltage of 5V
Req 2.1.3-H-PoC	Resolution of the camera is at least 720x480 pixels
Req 2.1.4-H-PoC	Thermal Camera can detect heat ranges of the range 0℃ - 80℃

Req 2.1.5-H-PoC	Camera captures in 24 or 30 FPS

Table 3-1: Requirement Code for Camera Module at Proof of Concept

3.1.2 Prototype:

During the prototype stage, we will show two different designs of the camera modules with different environmental resistance. This will demonstrate the outdoor camera module with capability of resisting various weather conditions and the indoor camera module with improved aesthetics. A Servo that moves the camera according to a controller is necessary for human tracking algorithms which are to be implemented. We will continue using the same cameras as in the proof of concept stage for financial purposes.

The prototype model will adhere to all safety principles by IEEE, CEC, and ANSI. However, it will not adhere to all design principles as expected in the production model. The prototype model will strictly adhere to standards that will demonstrate the mainstream ideals of the product.

Requirement Code	Requirement Description
Req 2.1.1-H-PoC	Camera module has at least 33° field of view
Req 2.1.2-H-PoC	Camera requires max input voltage of 5V
Req 2.1.3-H-PoC	Resolution of the camera is at least 720x480 pixels
Req 2.1.4-H-PoC	Thermal Camera can detect heat ranges of the range 0℃ - 80℃
Req 2.1.5-H-PoC	Camera captures in 24 or 30 FPS
Req 2.1.6-H-PROTO	Servo moves the camera according to a controller

Table 3-2: Requirement Code for Camera Module at Prototype

3.1.3 Production:

At the production stage the product will contain an audio recording component to provide more information for the user and enhance its security capabilities. It will also include a sensor to acquire distances.

The production will see the adherence of all design specifications as outline in the "Requirement Specifications" document. All safety principles by IEEE, CEC, and ANSI will be strictly adhered. The shown additional requirement codes in addition to those shown in the prototype are to improve the efficiency and performance of the product.

Requirement Code	Requirement Description
Req 2.1.1-H-PoC	Camera module has at least 33° field of view
Req 2.1.2-H-PoC	Camera requires max input voltage of 5V
Req 2.1.3-H-PoC	Resolution of the camera is at least 720x480 pixels
Req 2.1.4-H-PoC	Thermal Camera can detect heat ranges of the range 0℃ - 80℃
Req 2.1.5-H-PoC	Camera captures in 24 or 30 FPS
Req 2.1.6-H-PROTO	Servo moves the camera according to a controller
Req 2.1.7-L-PROD	Camera module can perform audio recording with a minimum range of three meters
Req 2.1.8-L-PROD	Camera module has an ultrasound sensor to acquire distances of at least three meters

Table 3-3: Requirement Code for Camera Module at Production

3.2 Accelerometer

As shown above in Figure 2-1, the accelerometers in the system will be laid beneath the surface of the property, providing an instrumented area that will track the position of the intruder and report the information back to the server.

A microcontroller is used for collecting the analog signals from the accelerometer. We will be using a KUMAN UNO R3 which is a third party (cost efficient) alternative to the ARDUINO UNO R3. This microcontroller will convert the analog signal to a numeric reporting value capable of being used for numeric computation. Specifications of the microcontroller are as follows:

Microcontroller:	KUMAN UNO R3
Operating Voltage:	5V
Input Voltage (recommended):	7-12V
Input Voltage (limit):	6-20V
Digital I/O Pins:	14 (of which 6 provide PWM output)
PWM Digital I/O Pins:	6
Analog Input Pins:	6
DC Current per I/O Pin:	20 mA
DC Current for 3.3V Pin:	50 mA
Flash Memory:	32 KB (0.5 KB used by bootloader)
SRAM:	2 KB
EEPROM:	1 KB
Clock Speed:	16 MHz
LED_BUILTIN:	13
Length:	68.6 mm
Width:	53.4 mm
Weight:	25 g

3.2.1 Proof of concept:

In the proof of concept stage, Home Attender will need to be able to demonstrate the ability to detect vibrations and return to the server a numeric reading. The importance of this numeric reading is to show that the sensor is capable to reporting numerical values, and the server is able to interpret the value. The data will help with positioning calculations for the prototype and production product. We will be attempting the proof of concept stage with the MPU-6050 tri-axial accelerometer and gyroscope.

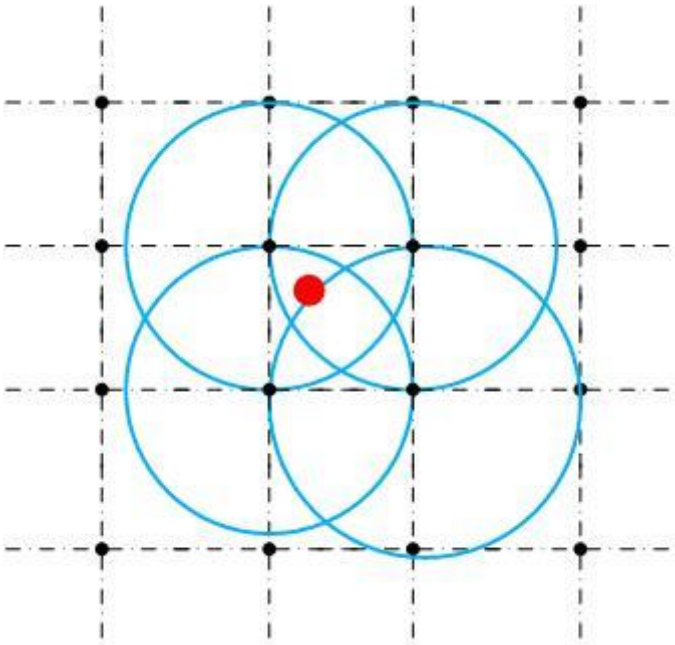

Figure 3-2: Accelerometer Detection Diagram

3.2.2 Prototype:

The prototype version of the Home Attender will utilize multiple accelerometers. This will demonstrate the capability of indicating position using vibration spectral intensities. We will continue using the same model of accelerometer as in the proof of concept stage for financial purposes.

The prototype model will adhere to all safety principles by IEEE, CEC, and ANSI. However, it will not adhere to all design principles as expected in the production model, but rather to standards that will demonstrate the mainstream ideals of the product.

Requirement Code	Requirement Description
Req 2.2.2-L-PoC	Sensors have a voltage input of 3-5 VDC
Req 2.2.4-H-PoC	System can determine which sensor has been activated
Req 2.2.6-H-PROTO	Sensor grid is able to determine location of intruder

Table 3-4: Requirement Code for Accelerometer at Prototype

3.2.3 Production:

The production will see the adherence of all design specifications as outlined in the "Requirement Specifications" document. All safety principles by IEEE, CEC, and ANSI will be strictly adhered. The shown additional requirement codes in addition to those shown in the prototype are to improve the efficiency and performance of the product.

Requirement Code	Requirement Description
Req 2.2.1-L-PoC	Sensors have a voltage input of 3-5 VDC
Req 2.2.2-H-PoC	System can determine which sensor has been activated
Req 2.2.3-M-PoC	Sensor grid measures vibrations within a 40 cm x 40 cm square
Req 2.2.4-H-PROTO	Sensor grid is able to determine location of intruder
Req 2.2.5-H-PROD	Sensors are placed in a grid that covers entire property

Table 3-5: Requirement Code for Accelerometer at Production

3.3 Server

The server in the Smart Home Security system performs all the data processing and acts as an intermediary for transferring alerts to the owner. The image processing algorithms are done using Matlab scripts so the server must have enough processing power to run it. A minimum storage requirement of 2 TB is to allow for enough space for recent videos, with surplus. The server must also have 8 GB system memory to run the processing algorithms. The requirements below exist in the proof of concept stage as they are required to perform other features of the Smart Home Security System.

3.3.1 Proof of concept:

At the prototype stage, we will use one of our teammate's free PC and Arduino/ Raspberry Pi board as the server computer. The PC will used to store video while the Arduino/Raspberry Pi board will be used to config and analysis the recorded data from the cameras and accelerometers. The numeric value from accelerometers will be calculated for the prototype and production product. The video from optical camera will be analysis for showing the ability for tracking moving object. The video from thermal camera will be analysis for showing the ability for tracking high temperature object.

Requirement Code	Requirement Description
Req 2.3.1-H-PoC	Server has x86-64 processor from Intel or AMD

Req 2.3.2-H-PoC	Server has 2 TB storage for media
Req 2.3.3-H-PoC	Server has a minimum of 8 GB RAM
Req 2.3.4-H-PoC	Server consumes a maximum of 600W

Table 3-6: Requirement Code for Server at Proof of Concept

3.3.2 Prototype:

At the prototype stage, the server could receive the video and accelerometers data. The algorithm for tracking intruders and fires will be enhanced. The server computer will also be configured to be able to automatically update stored videos for storage optimization. The server will be connected with the user's mobile application and handles all the alarm notification and remote controlling.

The prototype model will adhere to all safety principles by IEEE, CEC, and ANSI. However, it will not adhere to all design principles as expected in the production model. The prototype model will strictly adhere to standards that will demonstrate the mainstream ideals of the product.

Requirement Code	Requirement Description
Req 2.3.1-H-PoC	Server has x86-64 processor from Intel or AMD
Req 2.3.2-H-PoC	Server has 2 TB storage for media
Req 2.3.3-H-PoC	Server has a minimum of 8 GB RAM
Req 2.3.4-H-PoC	Server consumes a maximum of 600W

Table 3-7: Requirement Code for Server at Prototype

3.3.3 Production:

At the production stage the algorithm will be enhanced to differentiate in house fire with stove.

The production will see the adherence of all design specifications as outline in the "Requirement Specifications" document. All safety principles by IEEE, CEC, and ANSI will be strictly adhered. The shown additional requirement codes in addition to those shown in the prototype are to improve the efficiency and performance of the product.

Requirement Code	Requirement Description
Req 2.3.1-H-PoC	Server has x86-64 processor from Intel or AMD
Req 2.3.2-H-PoC	Server has 2 TB storage for media
Req 2.3.3-H-PoC	Server has a minimum of 8 GB RAM

Req 2.3.4-H-PoC	Server consumes a maximum of 600W
Req 2.3.5-H-PROTO	Server has networking equipment for mobile application connection

Table 3-8: Requirement Code for Server at Production

3.4 Mobile Application

As shown in figure 2-4, the mobile application will be the primary way for the user to control the smart home system. It will accept alert notifications and let user to access the real time camera footage.

Functionalities will include toggling the alerts, getting real time visuals when the alert is received, password encryption, and server access. Currently, the mobile application is planned to only be available on IOS platforms. Specifications of the mobile application are as follows:

Operating Platform	IOS
Recommended Operating Version	IOS 9.0 and up
Recommended Operating Device(s)	iPhone
Registration Method	Ethernet Network
Application Size (approximate)	50 MB

Table 3-9: Application Specifications

3.4.1 Proof of concept:

The role that the mobile application play in our project will be giving the customer the ability to receive alerts and control other functionalities of the system. However, for the proof of concept stage, it will not be prioritized heavily and only a simple shell application will be developed, if time permits.

Figure 2-6 below is shows our prospective layout for the mobile application.

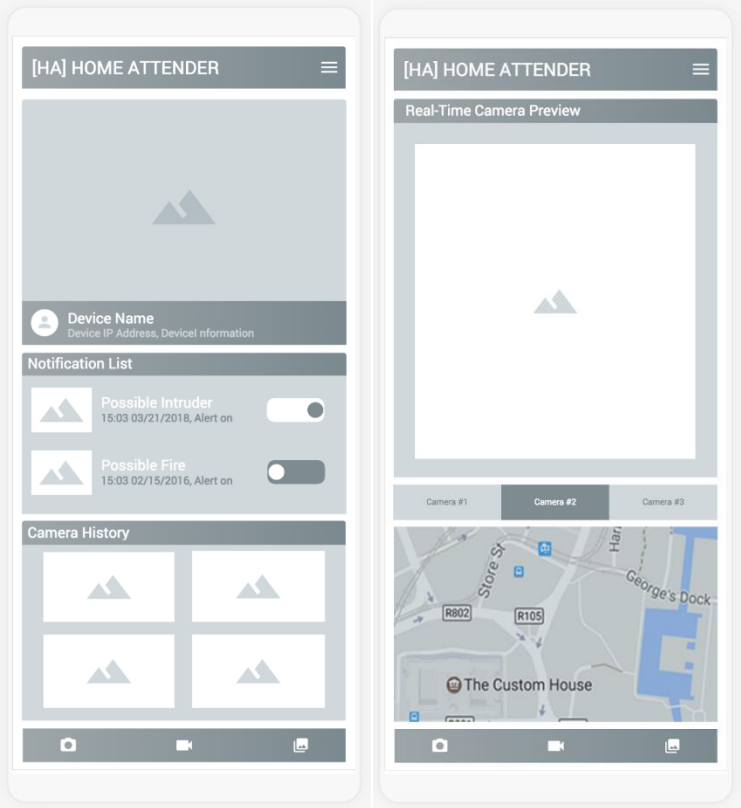

Figure 3-3: Mobile Application UI Diagram

3.4.2 Prototype:

In the stage of prototype, the user will have a certain degree of control over the system through the app. The mobile application will be only operating on IOS platform in this version. It will have the ability to let user register the phone which contains the mobile application on the server. In order to register, the phone and the server have to be under the same network, with the server communicating to the phone as authentication.

After the mobile application and the server is connected, the mobile application will be able to receive alert notifications, toggle alerts, and change other system settings. Below is the list of requirements for the prototype stage of the mobile application.

Requirement Code	Requirement Description
Req 3.2.1-H-PROTO	Application runs on IOS platform
Req 3.2.2-H-PROTO	Application accepts notifications from the local server
Req 3.2.3-M-PROTO	User will be able to modify alert settings with the application
Req 3.2.4-H-PROTO	Application requires password when accessing media
Req 3.2.6-H-PROTO	User will be able to register on the mobile app

Table 3-10: Requirement Code for Mobile Application at Production

3.4.3 Production:

The production stage will see the adherence of all design specifications as outlined below:

Requirement Code	Requirement Description
Req 3.2.1-H-PROTO	Application runs on IOS platform
Req 3.2.2-H-PROTO	Application accepts notifications from the local server
Req 3.2.3-M-PROTO	User will be able to modify alert settings with the application
Req 3.2.4-H-PROTO	Application requires password when accessing media
Req 3.2.5-L-PROD	Application has real time access to the camera
Req 3.2.6-H-PROTO	User will be able to register on the mobile app
Req 3.2.7-H-PROD	On-board processor can communicate with the application
Req 3.2.8-H-PROD	User will be able to modify camera settings with the application
Req 3.2.9-M-PROD	User will be able to manage data and video with the application

Table 3-11: Requirement Code for Mobile Application at Production

3.5 Fire Suppression

The fire suppression system component of the Home Attender will be developed during the prototype stage and beyond as it is having few connections to the intruder and fire detection aspect of the product. The requirements are chosen to ensure that the suppression system performs its duties and minimizes possible water damage compared to when water sprinklers are activated.

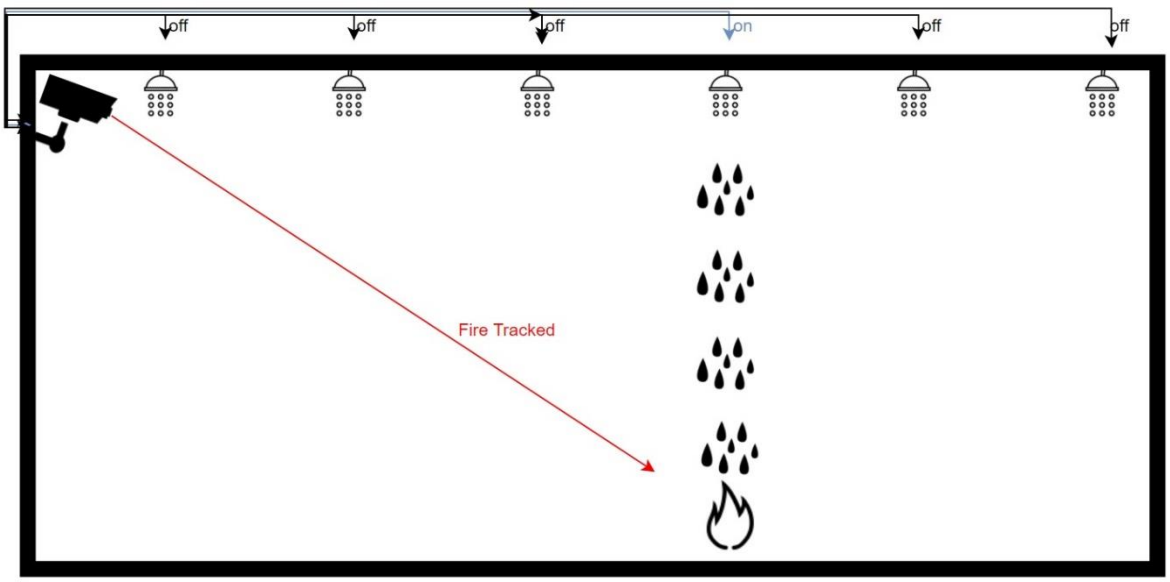

Figure 3-4: Fire Suppression Diagram

3.5.1 Prototype:

At the prototype design, the thermal imaging camera will run continuously and monitor the heat signatures. If the thermal camera determines the heat signature is consistent with typical red-flamed fires, the fire suppression system will activate an additional controller that will actuate the flow of water for fire suppression. The controller for the fire suppression will only allow the sprinklers from the specified room to shoot water out to suppress the fire. Local authorities will be notified and user will receive notification via the proprietary app.

The prototype model will adhere to all safety principles by IEEE, CEC, and ANSI. However, it will not adhere to all design principles as expected in the production model, but rather to standards that will demonstrate the mainstream ideals of the product.

Requirement Code	Requirement Description
Req 2.4.1-M-PROTO	System activates water source to suppress fire
Req 2.4.2-M-PROTO	The water source does not leak

Table 3-12: Requirement Code for Fire Suppression at Prototype

3.5.2 Production:

At the production stage, the suppression system will be enhanced to be able to further minimize water damage. Instead of using sprinklers, the pivotal controller will use the data obtained by the thermal imaging camera to track the

heat signatures. The controller for the fire suppression will shoot water out of a hose to suppress the fire.

The production will see the adherence of all design specifications as outlined in the "Requirement Specifications" document. All safety principles by IEEE, CEC, and ANSI will be strictly adhered. The below requirement codes in addition to those shown in the prototype are to improve the efficiency and performance of the product.

Requirement Code	Requirement Description
Req 2.4.1-M-PROTO	System activates water source to suppress fire
Req 2.4.2-M-PROTO	The water source does not leak
Req 2.4.3-M-PROD	System only activates when fire is detected
Req 2.4.4-M-PROD	System performs localized suppression only
Req 2.4.5-H-PROD	System is able to differentiate cooking heat to uncontrolled fire

Table 3-13: Requirement Code for Fire Suppression at Production

4. Test Plan Appendix

Our product is a system of different parts which can be tested separately.

4.1 Camera Module

Test	Test Description	Outcome	Comments
Video Transfer to Server	Short test video is captured and sent to the server. Afterwards, the video should be viewable from the server		
Optical Camera Resolution	Video viewed from server has a resolution of at least 720x480 pixels and is clear enough for the user to distinguish objects and visually recognize faces		
Thermal Video Transfer to Server	Test video captured by the thermal imaging camera module is able to be sent to the server		
Thermal Camera Module can detect Differences in Temperature	The thermal camera can record a video pointed at a human target and then to an empty space. The heat signature of the human target should be clearly distinguishable		
Servo Movement via Controller	Servo is able to move to certain input angles via commands sent to the controller		
Servo Movement via Algorithm	Servo is able to rotate the camera module to track a moving human		

Table 4-1: Test Plan for Camera Module

4.2 Sensor Grid

Test	Test Description	Outcome	Comments
Sensor Ranged Reading	Sensors are able to sense vibrations created by a human up to 10 centimeters away		

Sensor Grid Reading	Four sensors arranged in a square are able to detect a force applied by a human within the square		
Intruder Tracking - Single Source	Four sensors arranged in a square are able to interpolate the exact location of a force applied by a human within the square		
Intruder Tracking - Multiple Source	Four sensors arranged in a square are able to interpolate the exact location of multiple forces applied by humans within the square. Forces closer to each other will be displayed as a single averaged force while forces distant to each other will result in the closest force to the home being displayed		

Table 4-2: Test Plan for Sensor Grid

4.3 Server

Test	Test Description	Outcome	Comments
Video Storage	Videos are storable on the server. The test includes: 1. Transferring a video onto the server via USB		
Video Receiving from Camera Module	Server has the ability to receive videos directly from the camera module. The test includes: 1. Recording a test video 2. Sending test video to server 3. Server successfully receives the video		
Update Stored Videos	New videos are constantly sent to the server and are timestamped. The test includes: 1. Few test videos are recorded 2. Each test video is time stamped accordingly		
C++ Application Operation	The processing power of the system is able to run C++ applications. The test includes:		

	1. Running a test batch file 2. Batch file handles all the inputs 3. Server runs the C++ application without crashing		
Matlab Script Operation	The processing power of the system is able to run MatLab scripts. The test includes: 1. Running the image processing Matlab script on a test video		
Sensor Data In	Test data is sent to the server from the sensor grid. The test includes: 1. Applying source of vibration within the sensor grid 2. The sensed vibration data is sent to the server		
Password Generation	Server is able to generate a password for security purpose. The test includes: 1. Server generates a password 2. Password allows the Phone to connect to the server		
Phone Pairing	The Mobile Application is able to be paired with the server. The test includes: 1. Requesting pairing from the mobile application to the server 2. Server accepts the pairing 3. Both mobile application and server acknowledges each other		

Table 4-3: Test Plan for Server

4.4 Mobile Application

Test	Test Description	Outcome	Comments
IOS Operation	The app is openable in an Apple Phone device. The test includes:		

	1. Opening the Application in an iPhone		
Server Notification	The server is able to send notifications to the application for the user to view. The test includes: 1. Manually sending notifications from server 2. Receiving the notifications from the server		
Priority Notification Changes	The user can access settings to change the priorities of different types of notifications. The test includes: 1. User changing the notification settings 2. Having the server send that priority setting		
Latest Video are viewable	The latest recorded security videos can be requested access to from the application. The test includes: 1. Recording a test video 2. Viewing the recorded video via the application		
Secure Media Access	The videos are locked behind a password. The test includes: 1. Selecting the video 2. Entering the password 3. Successfully viewing the video		

Table 4-4: Test Plan for Mobile Application

4.5 Fire Suppression

Test	Test Description	Outcome	Comments
Suppression	A controller turns the water source on to spray at a target via sending commands to the controller. The test includes: 1. Lowering the fire detection threshold so we can trigger it 2. The controller turns the water source on		

No water leakage after activation	After turning on the water source, the controller will turn the water source off where water does not leak. The test includes: 1. Turning the hose or water device off 2. Water does not leak out		

Table 4-5: Test Plan for Fire Suppression

4.6 System Level

The system level tests aim to test the functionality of each part as part of an integrated system.

Test	Test Description	Outcome	Comments
Detect Intruder	When an intruder is detected the system must notify the user. The test includes: 1. Enable alert mode of system 2. Team member walks in front of camera module 3. Server will send alert to the phone application		
Sensor Grid + Camera Tracking	The sensor grid helps the camera with tracking when in alert mode. The test includes: 1. Enable alert mode of system 2. Team member taps a location in the sensor grid 3. Servo rotates the camera to look at the tapped location 4. Camera records a test video of the location		
Fire Detection + turn on water source	A lower threshold for fire is used for testing the ability to detect heat source and turning on a water source for suppression. The test includes: 1. Enable Fire debug mode 2. Stand in front of the camera 3. Water source will be turned on 4. Walk away from camera 5. Water source is turned off		

Table 4-6: Test Plan - System Level

ENSC 405W Grading Rubric for User Interface Design
(5-10 Page Appendix in Design Specifications)

Criteria	Details	Marks
Introduction/Background	Appendix introduces the purpose and scope of the User Interface Design.	**/05%**
User Analysis	Outlines the required user knowledge and restrictions with respect to the users' prior experience with similar systems or devices and with their physical abilities to use the proposed system or device.	**/10%**
Technical Analysis	Analysis in the appendix takes into account the "Seven Elements of UI Interaction" (discoverability, feedback, conceptual models, affordances, signifiers, mappings, constraints) outlined in the ENSC 405W lectures and Don Norman's text (*The Design of Everyday Things*). Analysis encompasses both hardware interfaces and software interfaces.	**/20%**
Engineering Standards	Appendix outlines specific engineering standards that apply to the proposed user interfaces for the device or system.	**/10%**
Analytical Usability Testing	Appendix details the analytical usability testing undertaken by the designers.	**/10%**
Empirical Usability Testing	Appendix details completed empirical usability testing with users and/or outlines the methods of testing required for future implementations. Addresses safe and reliable use of the device or system by eliminating or minimizing potential error (slips and mistakes) and enabling error recovery.	**/20%**
Graphical Presentation	Appendix illustrates concepts and proposed designs using graphics.	**/10%**
Correctness/Style	Correct spelling, grammar, and punctuation. Style is clear concise, and coherent. Uses passive voice judiciously.	**/05%**
Conclusion/References	Appendix conclusion succinctly summarizes the current state of the user interfaces and notes what work remains to be undertaken for the prototype. References are provided with respect to standards and other sources of information.	**/10%**
CEAB Outcomes: Below Standards, Marginal, Meets, Exceeds	1.3 Engineering Science Knowledge: 4.1 Requirement and Constraint Identification: 5.4 Documents and Graphic Generation: 8.2 Responsibilities of an Engineer:	

5. User Interface Appendix

5.1 Introduction/Background

This appendix provides a detailed analysis of how the user interface of the Home Attender will be designed and tested. Factors looked at include how the typical user will respond to certain UI elements, what the typical user looks for in a home security system, and various technical aspects such as discoverability, feedback, conceptual models, affordances, signifiers, constraints, and engineering standards. Additionally, the appendix will discuss how various tests, such as analytical usability testing and empirical usability testing will be applied to the Home Attender during various stages of development.

5.2 User Analysis

The target market of the Home Attender includes the average homeowner, so it should be assumed that the user has no knowledge of how to operate a home security system. With that in mind, the Home Attender offers a mobile application which allows the user to access all the features provided on a single convenient platform. The app operates under the reasonable assumption that the average homeowner has access to a device which can download said app and that the user is able to operate their device fluently. The app will include a tutorial which will guide the user on how to access various features provided within it.

Since the Home Attender is a surveillance system, it is expected that users will desire a system which possesses the following traits:

1. contains features which are quick and simple to access
2. able to alert the user in a timely manner when a security threat occurs
3. able to detect security threats reliably
4. requires no extra effort on the user's part in regards to maintenance or attention

The mobile application of the Home Attender will provide quick and simple access every to tasks such as changing the settings of the security system, viewing recorded video for up to two weeks, and viewing live footage through the optical camera module. Effort will be taken to enhance the visual aesthetics of the application, as doing so can increase the perceived usability of the app [1]. The app also allows the user to be alerted immediately through a push notification with optional vibration or sound when an intruder or fire occurs at their home. The user is then able to confirm whether or not a security breach had actually occurred through the live footage, eliminating the risk of a false alarm.

Thanks to the local server of the Home Attender, users do not need to worry about extra internet usage fees that may be incurred by a home security system which uses cloud storage. The user is also not required to know how to install or

remove the home security system, as the company will hire technicians to perform such tasks.

5.3 Technical Analysis

5.3.1 Discoverability

Discoverability relates to the user dependence on allowing the product to function on its own. The user experience is vastly significant for any product to function as intended.

The Home Attender security and fire suppression system requires most of installation be done by the company's technicians. Installation of the cameras, server, and the instrumenting the property will need to be left to professionals.

However, after the installation, the general usability will require user interaction to set up. These tasks have been carefully and meticulously designed to alleviate the user from taking on roles of the developer. The majority of the system is automated and does not require much user interaction upon installation. The team at Home Attender have compiled a list of tasks that the user will need to perform after installation:

1. **User needs to download the mobile application:** The Home Attender Security and Fire Suppression system is heavily app based in terms of controls and settings. The user must be able to use their smartphones to download and install the free application
2. **User's smartphone must be powered on:** As the controls and settings are performed using the application, user must be knowledgeable in how to manage power to their devices
3. **User needs to turn on, off, and restart the server:** The Home Attender is heavily reliant on the local server that is placed inside the user's home. As the operating system is Windows based, it would be subjected to constant updates and will need to know how to let the system restart upon updates.
4. **User needs to use the app:** The user must have basic knowledge or ability to learn basic application functionalities. As the app is the user gateway to the system, it will require user ability to use the app.
5. **User should have mobile data plan:** This step is optional but can maximize the potential and usability of the system. Having a mobile data plan or a convenient and frequent internet connection allows for real time security alerts to be sent to the user. The system and the app constantly communicate with one another, and the alert system is delivered to the server, through the internet and into the app.

5.3.2 Feedback

The importance of feedback is to allow the user to be able to understand the system without having any technical knowledge about the system. Basic

notifications will be able to alert the user on things such as the status of the system. Below is a list of items that the system uses to interact with the user:

1. When an intruder is detected, a notification will be sent to the user through the app
2. When fire or irregular heat signatures are detected, a notification will be sent to the user through the app
3. The user's app will check the status of the cameras that will be displayed in the app by sending a ping to each of the cameras' IPs
4. Upon installation, the user will be introduced to the app through a tutorial to help them set up the elements that are unique to the Home Attender

5.3.3 Conceptual Models

The design of the Home Attender lends itself to help reduce costs of sophisticated home security systems. Users who are familiar with the use of apps to various consumer products will have no difficulty in setting up the Home Attender on their smartphones. The Home Attender's main controls and system settings require the mobile app in order to be accessed. The network diagram of the Home Attender and how each part plays in continuity to the user is shown below.

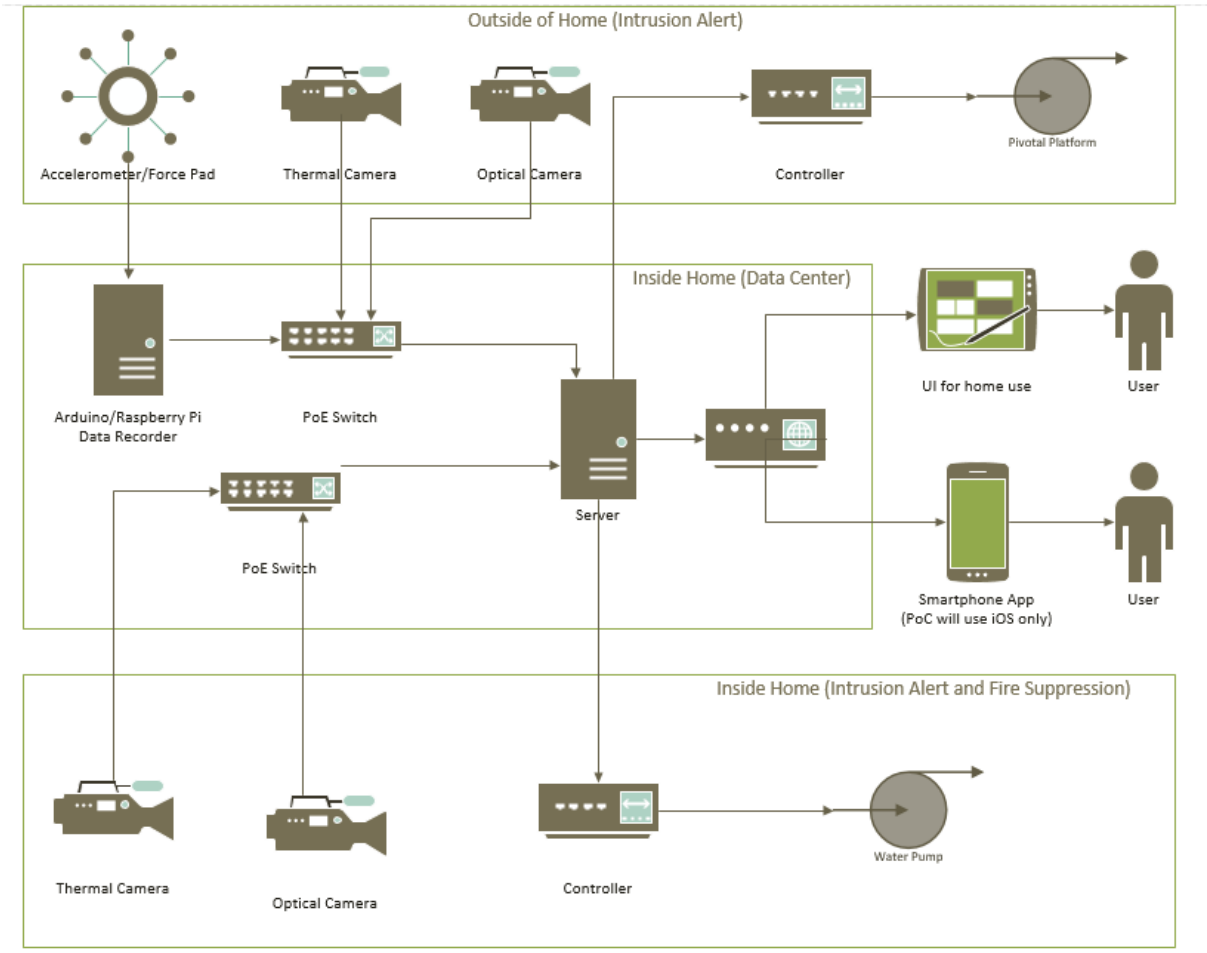

Figure 5-1: Home Attender System Network Diagram

5.3.4 Affordances

The affordance of a product relates to its quality and an environment that enables the user to perform specific abilities or actions pertaining to it. The affordances of the Home Attender are all concentrated into the mobile application, which hosts all of the user settings and controls. The application has been heavily designed to give the user maximum simplicity and the lowest learning curve possible.

5.3.5 Signifiers/Mappings

Signifiers on the Home Attender are located in two places, primary and secondary indications:

Primary - Mobile Application
In the primary signifier, the mobile app provides notifications on different statuses of the overall system. The server is designed to perform regular checks on the various instruments in Home Attender and provide updates for the app. The app will process this information and notify the user if necessary. These notifications include:

1. Connection status of the IP cameras
2. Connection status of the accelerometers
3. Connection status of the raspberry pi and Arduino (microcontroller)
4. Connection status to the servo motor to the fire suppression system

Secondary - System Fail Alert System
In the secondary signifier, there is a separate controller that is dedicated to checking the connection status of the server. As the server is the critical path to the system, the user needs to be notified if it fails. If the app or controller is unable to establish any connection to the server, the user will be notified of the server failure.

5.3.6 Constraints

The constraints to any product is the limiting factor that prohibits it from performing its intended functionality. The Home Attender is significantly dependent on four factors:

1. Mobile Application: The user must have basic understanding on downloading, installing, and general usability knowledge on operating applications.
2. Server: The server handles all the logic, computation, and data storage. Notifications are also handled by the server. As a result, the server has become the critical path for our system, and if it were to fail, the system would become redundant.

3. Internet Access: The Home Attender system requires communication to the application in order to alert the user and for them to view, control, and perform settings remotely.
4. Smartphone: The Home Attender is built with the user possessing a smartphone in mind. Without the smartphone, the user loses the ability to be notified of security issues.

5.4 Engineering Standards

Requirement Code	Requirement Description
IEEE 802.4h [4]	Standards for token bus network
IEEE 802.6 [5]	Standards for information exchange between systems
IEEE 802.15.1 [6]	Standards for WPAN/Bluetooth
IEEE 829 [7]	Standards for Software and System Test Documentation
IEEE 830 [8]	IEEE Recommended Practice for Software Requirements Specifications
IEEE 1016 [9]	Standard for Software Design Description
IEEE 1074.1[10]	IEEE Guide for Software Development Life Cycle
CAN/CSA-C22.2 NO. 60065:16 [11]	Audio, video and similar electronic apparatus - Safety requirements (Adopted IEC 60065:2014, eighth edition, 2014-06, with Canadian deviations)
CAN/CSA-C22.2 NO. 61508-1:17 [11]	Functional safety of electrical/electronic/programmable electronic safety-related systems
CAN/CSA-C22.2 NO. 0-10 [11]	General requirements - Canadian electrical code, part II
CAN/CSA-ISO 14040-06 [12]	Environmental Management - Life Cycle Assessment - Principles and Framework
CSA C22.1-15 PACKAGE - 2015 [13]	Canadian electrical code, part I
IEEE 802.15.4 [14]	Efficient security and privacy protection

Table 5-1: Engineering Standard

5.5 Analytical Usability Testing

Analytical usability testing describes the approach the designers will use to perform heuristic evaluation of the usability of our system. Each designer will

approach the testing without discussing opinions with the others to ensure there are no biases. Our focuses during these tests are the following:

1. Status of security system being enabled or disabled is clearly indicated and easily identified
2. Tabs and other identifiers are labeled sufficiently and minimalistic
3. No technical jargon; everything is described in simple plain language
4. Material is presented in a consistent manner
5. System provides security checks when watching security footage
6. System provides security checks when altering system settings
7. Error messages are expressed clearly
8. Help features are easily found in all interfaces

Once the evaluation of the usability is complete, testers will discuss their findings and opinions of the system together. Actions for improvement will be made and another round testing will be done to evaluate the changes.

5.6 Empirical Usability Testing

Empirical testing will be done as a later part of our development process. In order to receive feedback from users before finalization, it will occur during prototype stage. We believe it is better to provide testers with a complete version of our product. In the POC stage, the overall system is still under design, meaning that conducting a user test at these stages will be less effective as the feedback is limited at that time.

For the proof of concept stage, the aim is to check if the functionalities of the overall system are useful and attractive for the user. The overall system will be shown to a number of individuals. Based on the majority's feedback, functionalities that are not pleasing will be removed or revised.

In the prototype stage, the aim is to design and test if each component will meet the user's expectation. During the testing phase, we will let users try the system and encourage them to interact with all the major components. A documentation that outlines the functionalities and intended usage of each component will be provided. An overview and flowchart of the system will also be available in the documentation to help users understand why and how each key feature is related to one another. During this period of Empirical testing, feedback, suggestions, and errors are to be recorded by us. At the end of the Empirical testing period, a survey will be provided to the user to help further understand their overall experience with the product. Users will be asked to rate the usability of all the features, how likely would they purchase Home Attender, if they would recommend it to others, and any other comments or suggestions they may have. All the collected feedback and suggestions will be reviewed and we will update our design accordingly to produce the final product. We will then run one last iteration of unit and integration testing before releasing the final version of our product.

5.7 Conclusion

Overall, the Home Attender is designed with practicality in mind for the average homeowner. The company has taken into account the proficiency and demands of the target market while providing a thorough technical analysis of the system. By combining the above with a solid strategy for quality control and testing of the Home Attender, our company aims to provide a satisfying experience for the user.

ENSC 405W Grading Rubric for ENSC 440 Planning Appendix

(5-10 Page Appendix in Design Specifications)

Criteria	Details	Marks
Introduction/Background	Introduces basic purpose of the project. Includes clear project background.	**/05%**
Scope/Risks/Benefits	Clearly outlines 440 project scope. Details both potential risks involved in project and potential benefits flowing from it.	**/10%**
Market/Competition/ Research Rationale	Describes the market for the proposed commercial project and details the current competition. For a research project, the need for the proposed system or device is outlined and current solutions are detailed.	**/10%**
Personnel Management	Details which team members will be assigned to the various tasks in ENSC 440. Also specifically details external resources who will be consulted.	**/15%**
Time Management	Details major processes and milestones of the project. Includes both Gantt and Milestone charts and/or PERT charts as necessary for ENSC 440 (MS Project). Includes contingency planning.	**/15%**
Budgetary Management	Includes a realistic estimate of project costs for ENSC 440. Includes potential funding sources. Allows for contingencies.	**/15%**
Conclusion/References	Summarizes project and motivates readers. Includes references for information from other sources.	**/10%**
Rhetorical Issues	Document is persuasive and demonstrates that the project will be on time and within budget. Clearly considers audience expertise and interests.	**/10%**
Format/Correctness/Style	Pages are numbered, figures and tables are introduced, headings are numbered, etc. References and citations are properly formatted. Correct spelling, grammar, and punctuation. Style is clear, concise, and coherent.	**/10%**
Comments:		

6. 440 Planning Appendix

6.1 Introduction

This appendix will detail the teams plan for the upcoming ENSC 440 semester. It will outline the scope, risks, benefits, market analysis, rationale, and personnel involved in developing the prototype of the Home Attender.

6.2 Scope

Home Attender Design Team will spend the next four months implementing research and improve on the proof of concept model to produce a prototype of our product.

Home Attender's prototype will be able to tackle all the fundamental claims to what the production ready product would contain.

6.3 Risk

6.3.1 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.

6.3.2 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.

6.3.3 Timeline

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.

6.4 Benefits

6.4.1 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.

6.4.2 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.

6.4.3 Convenience

The Home Attender comes with 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.

6.4.4 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.

6.5 Market

6.5.1 Market

Our company believes the Home Attender will perform well in the market since it stands out among our competitors 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.

6.5.2 Target Customer

As shown in Figure 6-1, 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.

6.5.3 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, which makes it so that 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.

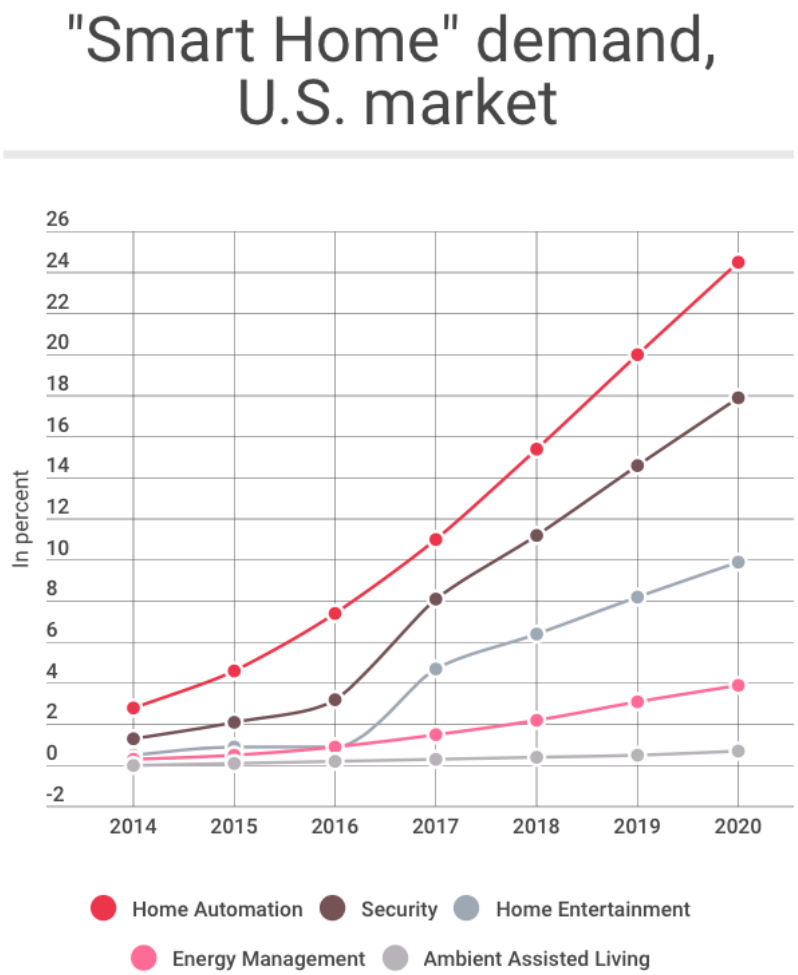

Figure 6-1: Smart Home demand in US market [15]

6.6 Competition and Research Rationale

Many home conventional home security systems tend to consume a lot of bandwidth and data for one's 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.

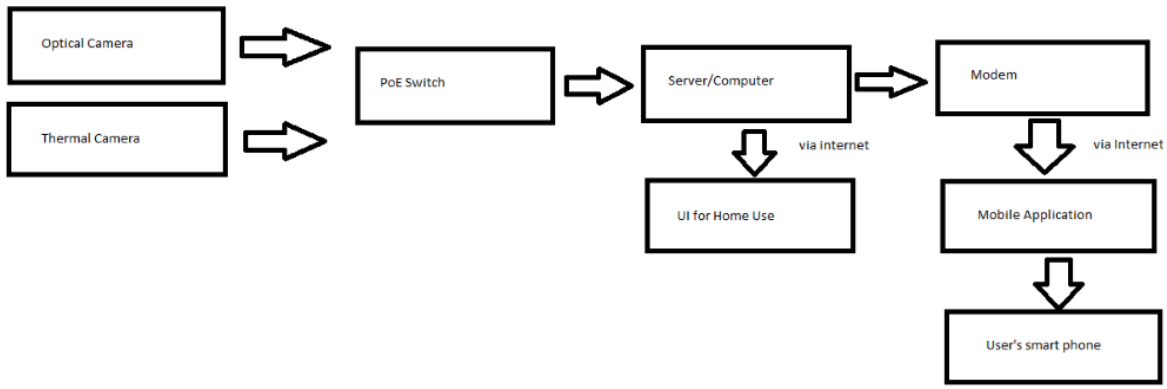

Figure 6-2: Network Diagram of Home Attender Security System

Kinemetrics Inc. is an American company based out of Pasadena, CA. The company specializes in industrial and commercial seismic monitoring equipment [16]. 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 [17]. 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 [17]. 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 Early Earthquake Warning System [17]. 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".

6.7 Personnel Management

6.7.1 In-House Resources

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

From May to August 2018, Isaac will be responsible for overseeing overall project management and the in-depth development of the image processing development for the thermal and optical camera features.

Christopher Chiu
Mr. Christopher Chiu is a 4th Year Systems Engineering student at Simon Fraser University. His previous work experience includes being an Embedded System Engineer and Silicon Validation Engineer at Intel. His interests include 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.

From May to August 2018, Christopher will be responsible for the in-depth development of the image processing development for the thermal and optical camera features, as well as the systems testing to ensure the product is up to par to expectations.

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

From May to August 2018, Ruisi will be responsible for overseeing the development and testing of Home Attender's proprietary app and software security system.

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

From May to August 2018, Benjamin will be responsible for overseeing the overall project finance, intruder detection system with accelerometers, and system networking.

Tommy Li
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.

From May to August 2018. Tommy will be responsible for the software development of the pivoting platform, software and hardware testing, as well as app testing.

6.7.2 External Resources

Aaron Zuo, BSc Interactive Arts and Technology

Mr. Aaron Zuo is the co-founder and CTO for Eyexpo Technology Corporation in downtown Vancouver. He works as a project manager on image processing. He has a background in Interactive Arts and Technology, with a Bachelor of Science in Interactive Arts and Technology, specializing in virtual reality. Mr. Zuo will pay a significant role in providing support on Home Attender's intruder detection with image processing software.

Yavuz Kaya, PhD Earthquake Engineering

Dr. Yavuz Kaya is currently the Senior Seismic and Structural Health Monitoring Engineer for the Ministry of Transportation and Infrastructure. He was previously a Research and Development Engineering for the University of British Columbia and Boğaziçi University. Dr. Kaya's research specialty is in forensic research pertaining to seismic activity to large infrastructures and received his Doctor of Philosophy in Earthquake Engineering from Boğaziçi University. Dr. Kaya will play a significant role in providing support on vibration tracking for Home Attender's intruder tracking with accelerometers over large areas.

6.8 Time management

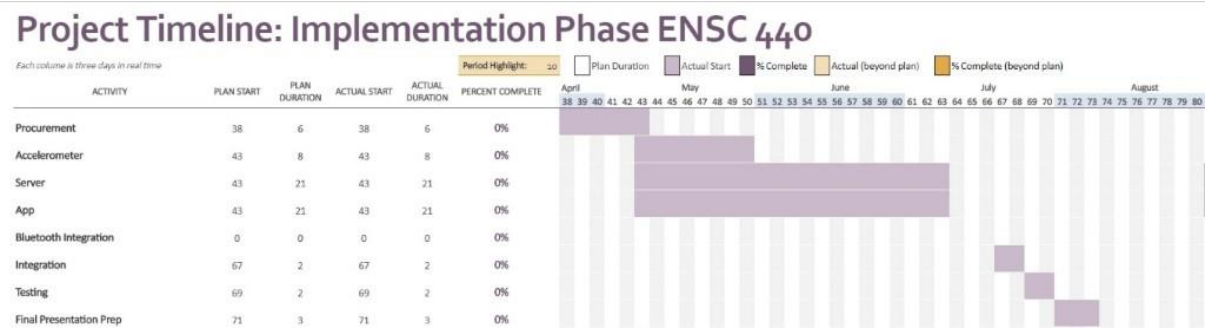

Figure 6-3: Gantt and Milestone Chart for the timeline for ENSC 440

As shown in Figure 6-3, our sensors and accelerometers will be ready for the project in the first month of the term. We will use the next two months to implement the server and mobile application side of the project to ensure acceptable user experience and functionality of our product. Finally, we will use the rest of the time to test all our components and the project as a whole.

In the four-month time of the ENSC 440 course, our group will be holding meetings at least once a week to discuss the project and communicate the progress. We will work around every team member's schedule and make sure everyone is up to date and make sure enough time and effort is put into the project.

6.7 Budgetary managements

Item	Cost	Quantity	Sub Total	Comments
Thermal camera + Breakout Board	335	1	335	
Raspberry Pi Camera Rev 1.3	29.99	1	29.99	
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	799	1	799	May be provided by teammates
Accelerometer + gyroscope	9.99	10	125	3 accelerometers + 3 gyroscopes per pack
Grand Total	1381			

Table 6-1: Budget table

The detail of our budgetary management is shown in the table above.

In regards to funding, our team cannot secure funding from the ESSS since we do not have everyone as a full-time student next semester. We are still trying to find other options for additional funding. To mitigate, we have agreed to increase personal funding to cover for all costs of project.

7. 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 threat detection system so they can avoid false alert fees and benefit the city's emergency resources. The overall 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.

In the aforementioned design specifications, a detailed system overview is given with details on what will entail the proof-of-concept, prototype, and production stages of the Home Attender development process. Components such as the camera module, accelerometer, server, mobile application, and fire suppression are analyzed in detail. The document also includes a test plan appendix with instructions on how to proceed in testing the product during various stages of its design. The user interface appendix will provide insight on how the customer will interact with the Home Attender in order to give key architectural guidelines on how the team should proceed in building the product. Lastly, the 440 Planning Appendix serves as the team’s roadmap for the upcoming ENSC 440 semester, acting as a similar guideline as the "Project Proposal". All of these components are to ensure that the Home Attender team is able to construct a robust, effective, and impressive final product.

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