Simon Fraser University
8888 University Dr.
Burnaby, BC, Canada

January 16, 2012

Dr. Andrew Rawicz
Simon Fraser University
8888 University Drive
Burnaby, B.C. V5A 1S6

Re: ENSC 440 Project Proposal for a Fall Detection System for Seniors

Dear Dr. Rawicz:

Enclosed is a document, *Proposal for a Fall Detection System for Seniors*, which describes our prospective project for ENSC 440 (Capstone Engineering Science Project). We intend to design and implement a system that recognizes when its elderly user has fallen and sends an alert. In this way, the user will quickly receive any necessary assistance or medical attention. The system will consist of a portable accelerometer-based device and central base unit.

This document will provide a general overview of the intended functionality and design of our proposed product. In addition, it will examine current technologies on the market with which our product would compete and considerations of budgeting and funding for our project. Finally, the document will provide information about knowledge resources we will use and our expected scheduling and distribution of time.

Our group, Fall Alert Mechanism (F.A.M.) Incorporated, consists of five skilled and enthusiastic engineering students: Behdad Jamshidi, Eric Swanlund, Nastaran Naghshineh, Ted Lee, and Zack Frehlick. Farid Najafi of Xyfon Solutions will act as a business consultant.

If you have any questions or concerns about our proposal, please contact our designated spokesman, Zack Frehlick, by phone at (778)385-3590 or by e-mail at zfa2@sfu.ca.

Sincerely,

Nastaran Naghshineh

Nastaran Naghshineh

Proposal for a Fall Detection System for Seniors

Project Team:	BehdadJamshidi Eric Swanlund NastaranNaghshineh Ted Lee Zack Frehlick	**Submitted to:**	Dr Andrew Rawics Steve Whitmore School of Engineering Science Simon Fraser University
Contact Person:	Zack Frehlick	**Date issued**	January 16, 2012

Executive Summary

Each year millions of elderly individuals worldwide are seriously injured in simple falling accidents. It is difficult to prevent these falls, as they occur unexpectedly and in normally harmless situations. However, it is possible to improve the quality and speed of care that seniors receive after a fall.

F.A.M. is a new company providing an intelligent fall detecting mechanism to clients who are elderly or disabled. Our purpose is to provide a device for assisted-living facilities that ensures resident safety by immediately informing the staff of any falls. By targeting these facilities with a device specifically tailored to their needs, we believe this product will find a very receptive market. Home care is a growing sector of the health care industry because of the value that families place in ensuring the well being and safety of their elders. This is the driving factor in the need for a product like ours.

Our device will harness wireless communications and accelerometer technology. A small pager-like device will be on the client. If there is a sudden abnormal change in motion with the device, such as "free falling", the device will recognize a fall. A central "command center" device will be notified and will relay the "fall alert" message to the nurse and/or aide of the specific client. As noted, the F.A.M device will initially be used in home care centers by staff nurses. Using our device, the nurse will be very quickly alerted that the patient has fallen. The immediate alert allows help to arrive within minutes.

The F.A.M team consists of Behdad Jamshidi, Nastaran Naghshineh, Ted Lee, Zack Frehlick, and Eric Swanlund, in partnership with Farid Najafi of Xyfon. F.A.M. consists of technically skilled individuals possessing a mixture of computer and electronic knowledge. The team's engineering aptitudes involve software and hardware development. Development of this product will officially begin on Jan 15, 2012.

F.A.M. will plan a schedule which involves further research and expected dates of completion of specific components. Over the next few months, an enormous amount of time and effort will be put into the development and production of the F.A.M device. Meeting deadlines and staying on budget will be crucial if we are to deliver a product in the expected time frame. In the end, our hope is that we will produce a device that not only can succeed on the home care market, but also ensure that our elders of our society are always safe.

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1. Introduction

The complete life, the perfect pattern, includes old age as well as youth and maturity. The beauty of the morning and the radiance of noon are good, but it would be a very silly person who drew the curtains and turned on the light in order to shut out the tranquillity of the evening. Old age has its pleasures, which, though different, are not less than the pleasures of youth.

– W. Somerset Maugham

As noted by the author W. Somerset Maugham, life may change as one gets older, but the quality of its pleasures should not decrease. Old age is a part of life which we all will eventually encounter. In fact, our population is aging must faster than most people realize. It is projected that by 2026 a full 20% of Canadians will be aged 65 or older [1]. With an aging population, the question of how to ensure the health and prosperity of our seniors is becoming increasingly important. As we age, commonplace activities like climbing stairs, caring for oneself, and living independently can become troublesome and even dangerous. The quality of life of a senior depends of the ability to carry out these daily tasks safely and with confidence. For many seniors, falling down during their daily routine is of particular concern. A slip or a fall for a young adult is usually harmless, but for the elderly this is often not the case.

Studies have determined that each year one out of three adults above the age of 65 suffers a fall. The diminished health of the elderly and the frequency of occurrence of falls make falling the leading cause of injury and death among seniors. Each year in the United States, about 2.2 million falls are treated by emergency departments and more than a quarter of those patients spend time in the hospital. Common injuries sustained include lacerations, hip fractures, and head trauma. Injuries such as these can drastically affect the life of a senior, destroying their ability to live be independent. Most concerning of all is the fact that, in 2008 alone, over 19700 elderly adults died from accidental falling [2].

Although a fall could cause instant death, many deaths occur due to medical help being too slow to arrive or not being notified at all. It is likely that earlier detection of falls would save lives and improve treatment outcomes. To that end, our group has created the F.A.M. (fall alert mechanism) project to create a small portable device that will detect the fall of its wearer and trigger an alert to call for help. There are some products on the market that serve a similar function, such as those allow an elderly person to call for help by pushing a button. However, each of the available products has its own set of drawbacks. It is our hope that we can create a design that improves upon existing issues the highest quality care.

Our system will be geared towards assisted-living facilities where seniors live semi-

independently but medical help is on staff. The device we will design will have an accelerometer and a transmitter that sits on your belt like a pager. This portable component will communicate with a central unit which has a receiver. When the user falls, the accelerometer will recognize the motion profile of the fall and cause the transmitter to send an alert to the receiver. The receiver will wait 15 seconds before it notifies medical staff that assistance is required. There will be a button on the device to enable canceling the alert within the 15 second window, but also call for help in non-fall-related emergencies. This feature will greatly diversify the applications for this device.

The remainder of this document will explain our proposed design in greater detail. It will also provide further information about competing technologies on the market. Finally, it will outline how we intend to handle certain important aspects of project development such as financing, time scheduling, and the sources of information on which we will rely.

2. System Overview

Figures 2.1 and 2.2 below illustrate the general function of our product. The first image shows the sequence of events that is triggered by a fall. The device accelerometer unit detects the fall and sends a signal to the central unit. The central system then notifies help staff, such as a nurse, so that the patient quickly receives any necessary assistance.

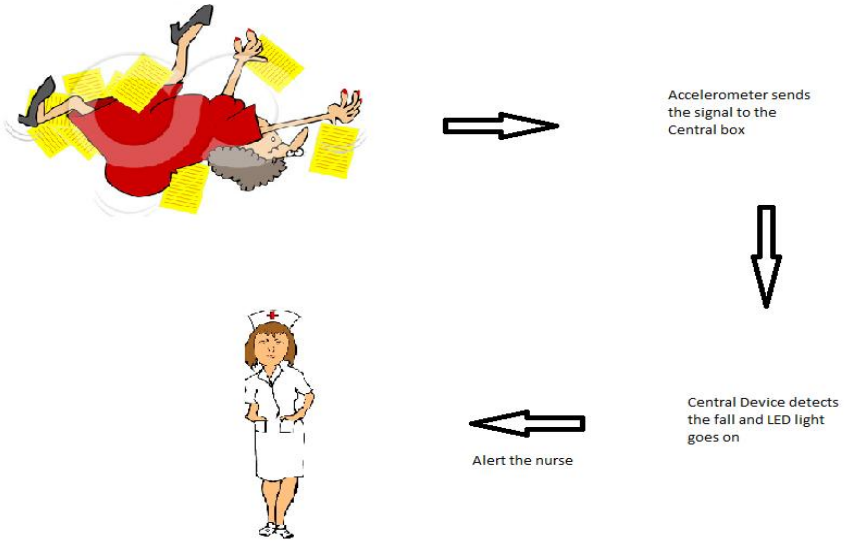

Figure 2.1 – Conceptual Illustration of F.A.M.

Figure 2.2 shows the flow of information within the system. In the idle state, the accelerometer unit is monitoring user movement and looking for a fall. When a fall is detected, two courses of action can occur. If the user does not require assistance, the alert can be cancelled and the system will return to idle state. Otherwise, the sequence of events described by Figure 2.1 will be initiated.

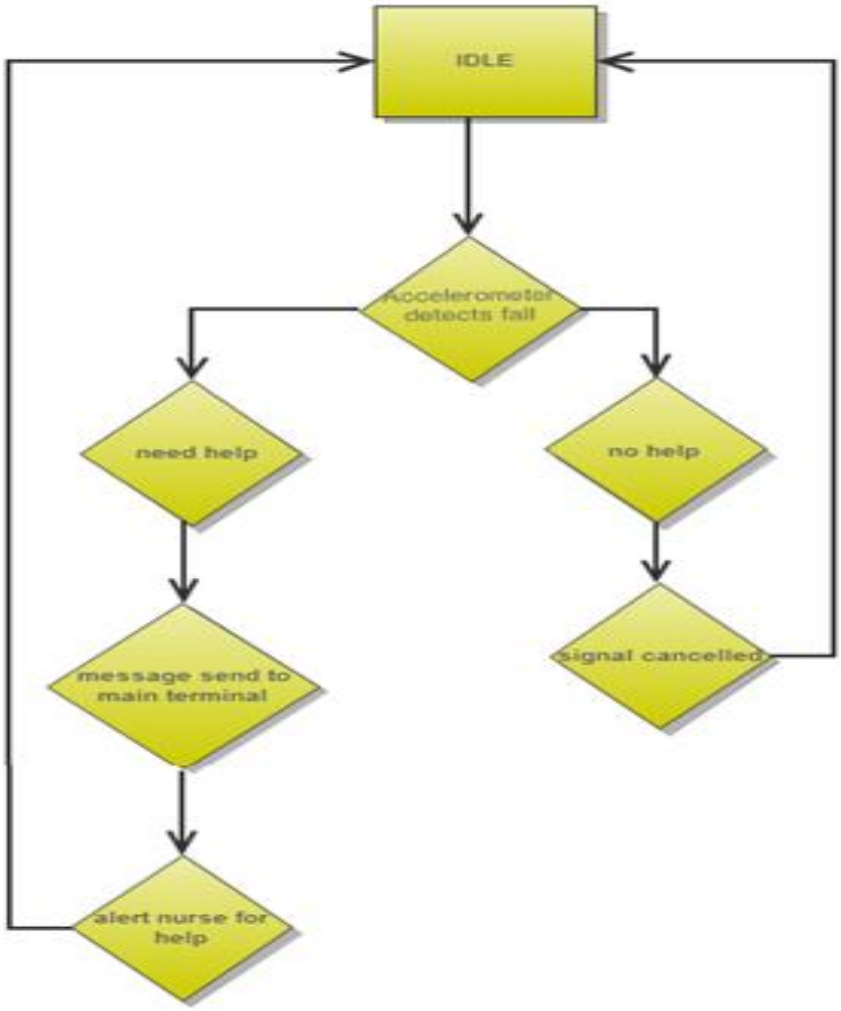

Figure 2.2 – Flow Chart of System Operation

3. Existing Technologies

Given the frequency of falls among the elderly and the potential danger involved, it is unsurprising that in recent years an industry has sprung up with the idea of improving the situation. Clearly, one of the major issues for this industry to address is the need for technology to detect the occurrence of falls and thus provide earlier care and treatment. This is especially important for those seniors who live alone or with little supervision. For these individuals, there is a chance that a fall or emergency could go undetected for several hours or even days. To assist these individuals, there are currently multiple companies marketing products which allow the user to notify someone of their fall or other medical emergency and receive help. These products typically fall into two categories.

The first category involves products such as that marketed by Medical Guardian [3]. The wears a pendant-style push-button device at all times. In the event of a fall or other emergency, the user will push the button and be connected to a monitoring service where an operator can determine the problem and the appropriate course of action. There are two issues with this approach. First, it is possible that the user will be incapacitated after the fall and unable to push the button. Second, many seniors feel embarrassed after a fall and choose not to alert anyone. One British study suggested that, even when a pendant button is worn, 80% of falls still go unreported due to the user being unwilling or unable to use the device [4]. The solution to this issue is to design a device that independently detects the fall and calls for help. This can be done by incorporating accelerometer technology into the push-button device. While such products are on the market, they are much less common.

The second category includes more comprehensive and multi-faceted systems. For example, Brickhouse Alert markets a system where the user is equipped with a push-button pendant and a separate accelerometer-based fall detector. Additionally, the user's home is outfitted with an array of motion sensors that track daily movement patterns. If the user strays from their typical routine, an operator comes on-line to ensure everything is alright [5]. While such an involved system is undoubtedly effective, there remain some drawbacks. The use of multiple devices may lead to the elderly individual being overwhelmed. Rigid monitoring could produce a feeling of discomfort and stigmatization in the home. There are surely situations where this technology is desirable, but in the general case a simpler and less intrusive solution is likely preferable.

4. Proposed Solution

Our desire is to design a product that incorporates a few novel features with certain positive aspects of existing technologies to provide an easy-to-use, non-intrusive solution to fall detection. The product will be a small portable device, attachable to the belt of the wearer, which is equipped with accelerometers and a push button. The device accelerometers will track user movement levels and monitor for falls based on acceleration magnitude and device orientation. The precise algorithms will be worked out as the project progresses. When a fall is detected, the portable device will interface with a central unit in the home to trigger an alert. However, if it is a false alarm or if help is already present, the user will be able to cancel the alert by pushing the button. Otherwise, if a fall has not been detected, pushing the button will serve its original purpose of triggering an alert. In this way, the device can also be used for medical emergencies other than falls.

Initially, our marketing strategy will target assisted-care living facilities and senior's communities. As such, when a fall occurs, the alert can take the form of a signal light or alarm within the facility's staff office. Over time, our alert system may evolve to include text or voice communication, but at present this simple alarm serves to limit device complexity while still providing adequate protection and assurance to the user. It is our hope that a combination of minimal device size and minimal presence in the home, coupled with an alert system that notifies staff whom the user knows and is comfortable with, will lead to a high degree of user comfort and satisfaction.

5. Sources of Information

Over the course of this project, there will be instances where the expertise of our group members is insufficient and we will require some additional knowledge or advice. When this occurs, there are several resources upon which we will be able to draw. The internet is a very valuable and broad source of information which can provide information about issues such as the types of parts to order. Our group has already researched and ordered certain parts for the project over the internet. When the information about parts provided on the internet is unclear, it will

also be possible to contact companies directly to clarify. Library resources and old course text books will also be of use in refreshing any necessary skills.

In addition, as our entire group members are upper level students, over time each of us has developed a relationship with certain professors. Some of these professors are experts in areas related to our project and we will consult them if necessary. For example, for advice on the electronics of our system we could consult Dr. Ash Parameswaran or for advice on device communications we could talk to Dr. Shawn Stapleton. Finally, we will be able to draw from the experiences of Dr. Andrew Rawicz in the biomedical device industry. Also, Mr. Steve Whitmore can advise us on business plans, time management, and report style.

6. Financial Considerations

6.1 – Budget

Table 6.1 below provides a general overview of the components our Fall Alert Mechanism device will require and their estimated costs. Only the most important and expensive components are given a separate listing. These include the accelerometer unit, the microcontroller to monitor acceleration levels and send an alert when a fall has occurred, and a transceiver to receive the alert signal. All other costs such as external hardware components for the device, the push-button on the device, and any unexpected expenses are grouped together into the other costs section. In order to reduce the price of development, we intend to borrow the microcontroller board from Simon Fraser University.

Components	Price
Accelerometer	$150
Transceiver	$300
LED Light	$10
Microcontroller	$50
Other Costs	$100
Total Cost	$610

Table 6.1 – Estimated Cost of FAM Project

6.2 – Funding

In order to cover the high costs of certain system components for the project, we have applied for funding from the Engineering Science Student Endowment Fund (ESSEF) and we will also be applying to the Wighton Fund. If our expenses are greater than expected and exceed what we receive from these two sources, we will also be approaching Xyfon for extra funding. If the funding from these aforementioned sources is still insufficient, costs will be distributed equally among the members of our group.

6.3 – Future Growth

As shown by the products on the market, there are many different ways to implement a fall detection system. In the future, if our group intends to continue with the product and attempt to market it, we the design of the device may be changed or expanded. For example, instead of being limited to assisted-living facilities due to its simple alert system, the product may evolve to either message or call a second party when the user falls. This second party could be a family member or the emergency department. The device could also evolve so that the central unit is portable like a cell phone. Clearly, these changes would increase the development budget and require more funding and time to implement. If our project proceeds faster than expected, we may attempt to implement some of these features which would cause our projected budget to be inaccurate.

7. Project Schedule

Table 7.1 below is the Gantt Chart for our project, which illustrates the amount of time expect to spend on each phase of development. Meanwhile, Figure 7.1 shows the expected completion dates for various aspects of the project.

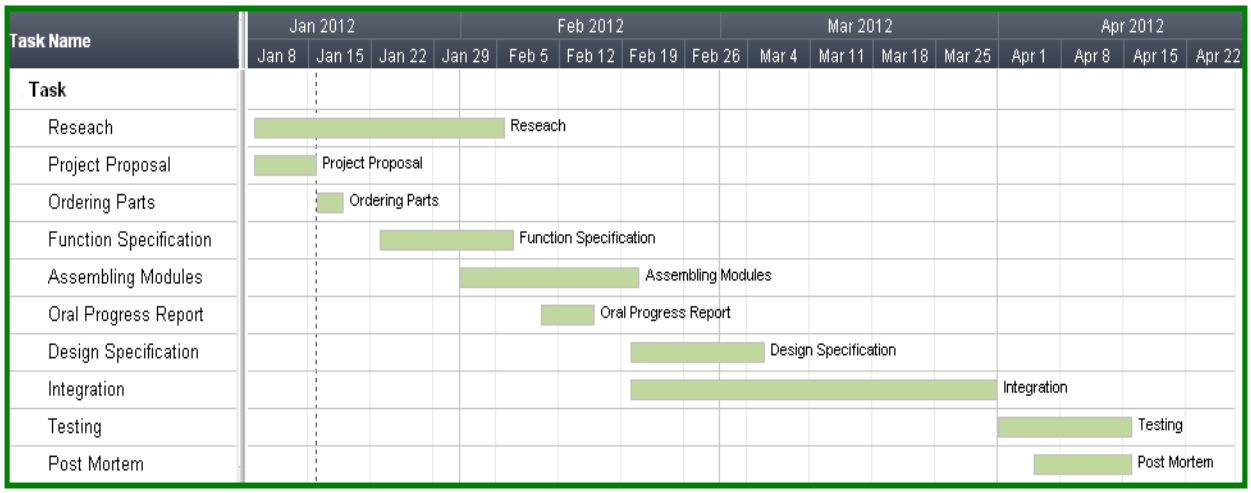

Table 7.1 – Gantt Chart

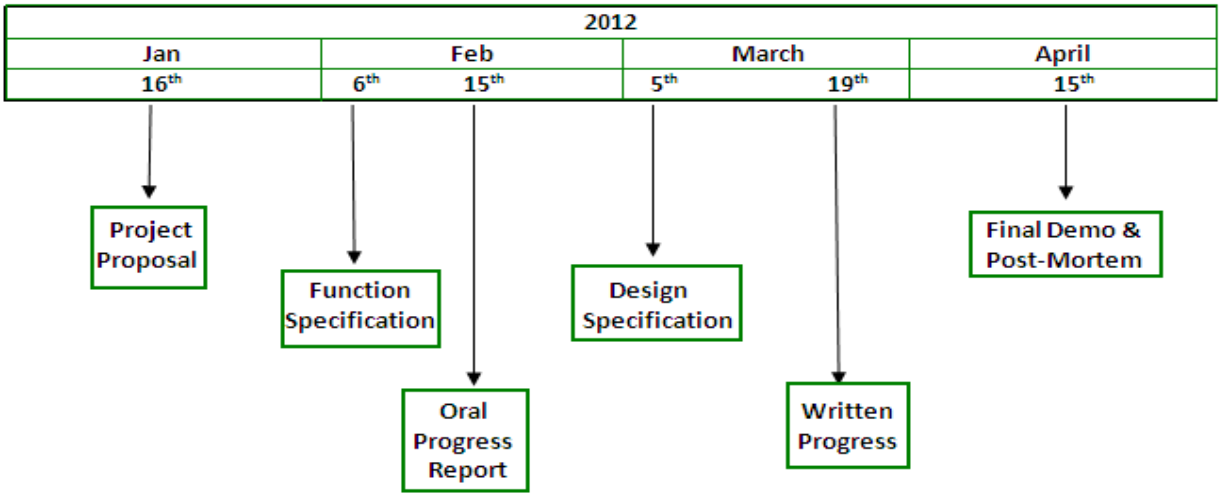

Figure 7.1 – Milestone Diagram

8. Team Organization

The F.A.M. team is composed of five motivated and talented Engineering Science undergraduate students: Behdad Jamshidi, Eric Swanlund, Nastaran Naghshineh, Ted Lee, and Zack Frehlick. Collectively, the team possesses a wealth of electronic, computer, and biomedical knowledge and skills. In the "Company Profile" section below, a detailed description of each team member can be found. Each member has unique attributes and experiences, which will reflect on their roles in the project.

Behdad Jamshidi will act as CFO, overseeing the project budget and ensuring that milestones are being hit. He will mostly work on the central transceiver unit of our system because he has experience with communications and microcontrollers. Eric Swanlund is the President of Operations and is in charge of various technical and design aspects of the project. He will also employ his programming skills in a variety of areas. Ted Lee is CTO (Chief Technical Officer) and will chiefly work on the accelerometer unit of the project. Nastaran Naghshineh is CPO (Chief Product Officer) and will be responsible for overseeing the assembly of hardware modules, integration, and testing. In addition, she will write the minutes after each meeting and make it viewable to other team members. Zack Frehlick act as CMO (Chief Medical Officer) and will oversee the biomedical aspects of the project. He will employ his previous experience with accelerometers for the purpose of fall detection algorithm development and will work on various other software aspects. It is important to note that at this early juncture roles in the company are not yet fully developed and may evolve over the course of the semester.

Each week, the F.A.M members will hold a meeting to discuss any matters at hand. These weekly meetings are also crucial for synchronization of project development and are an easy way to manage project tasks. Our meeting structure is "open"; everyone has equal speaking rights and everyone needs to be heard. The team will agree on a time schedule and goals to accomplish for each meeting. Team members that are late for meetings will receive extra work, measured by working hours, to be do.

9. Company Profile

Behdad Jamshidi

I am a fifth year engineering student finishing my last year at Simon Fraser University with this semester being the last academic one. I have worked at Shaw technical systems and Wireless Wave so I am familiar with the communications aspect of the project. I have taken a variety of classes such as ENSC 451 (advanced digital systems) which have given me experience with finishing big projects on time. I have many skills, both programming and hardware, that will help with this project. Having taken many upper level classes, I have close relationship with my professors for help. As I have taken ENSC 426, I am familiar with signals and how they work in general and will be able to apply them to our current project. Also, having completed ENSC 425, I am familiar with the lab equipment and complex circuits which will be required for our project given the ICs that we need to use.

Nastaran Naghshineh

I am a fifth year Electronics engineering student, completing my last semester at Simon Fraser University. I have done two co-op terms at Top Producer LTD where I was responsible for testing various software products using software testing tools and ensuring the accuracy of data by checking against a database. This position required me to learn XML. My last co-op was done at MENRVA lab in Simon Fraser University under supervision of Dr. Carlo Menon. As a result of taking electronics courses, I am familiar with functionality of various electronics laboratory equipment and components. In addition, I have worked in optics, robotics, and physics lab which demonstrate my strong 'hands-on' ability.\I also have some programming experience with C++, Matlab, VHDL, and the Linux operating system.

Eric Swanlund

Currently, I'm a third year Computer Engineering Science student. I have completed my full 3 terms of co-operative work at Ericsson, where I worked on their Line Card Software Development team. On this team I was responsible for testing and debugging their current products' software, as well as design and develop features for their product which they sell today. One of the main features I developed was the automated detection of transceivers. This was done by calculating the wavelength tolerance of the laser inside of the transceiver, which is unique to each transceiver type, and then can be compared to various thresholds. This position required me to learn C but also drastically improved my problem solving and software development skills. My programming experience involves the following languages: C, C++, Java, JavaScript, Python, and VHDL.

Ted Lee

I am a fourth year Electronics engineering student at Simon Fraser University. After this semester I only have five more courses left plus a term of co-op until graduation. I have worked at Safeway IT in a Quality Assurance team testing their Point of Sale equipment. This position taught me how to test functionalities step by step in a professional way. I have taken many courses that require software and hardware skills. For software, I am familiar with C++, C, VHDL and Java. I am also currently taking a fourth year microelectronics courses which will help for this project when building hardware components using a variety of lab equipment.

Zack Frehlick

I am a fifth student at Simon Fraser University majoring in Biomedical Engineering. To date, I have completed two co-op terms. The first was for the SFU Dead Reckoning Project, headed by Dr. Craig Scratchley. My main task was developing Matlab algorithms to process data from accelerometers and angular rate sensors to be used in personal tracking. This experience will be useful for this project as we develop an algorithm to detect falls. My second co-op was as a software developer at BC Cancer Research Center. This position greatly strengthened my C++ programming skills and also gave me some hands-on experience with lab equipment. Given my major, I also have more knowledge of kinesiology and of medical device development standards than the average student. Since is in the biomedical sphere, this will undoubtedly be important.

10. Conclusion

F.A.M Inc. is motivated to bring a technically advanced product to the health care industry. Our goals will reflect the interest of any client part of a home care center, and also their respective families. F.A.M Inc. promises to provide a top quality device, making use of high end technology to ensure the safety of the elderly.

Our goals will be accomplished with our simple design and affordability. The accelerometer feature makes our device automated, compared to the push-button devices on the market. There is the possibility of situations where a patient can be physically incapacitated or the button could be obstructed and therefore we feel that our automated system is essential.

The Gantt and milestone diagrams show our dedication to the project and that it can be completed in a timely manner. Our research and sources of information have already been discussed, Plans for budgeting and funding were also outlined. We have received financial support from ESSEF. Our objective and strategy have been identified; the next step is to begin development.

11. References

[1] Government of Canada, "Canada's Aging Population". Internet: http://publications.gc.ca/collections/Collection/H39-608-2002E.pdf [Jan 15, 2012].

[2] Centers for Disease Control and Prevention, "Falls Among Older Adults: An Overview". Internet: http://www.cdc.gov/homeandrecreationalsafety/falls/adultfalls.html [Jan 10, 2012].

[3] Medical Guardian, Internet: http://www.medicalguardian.com [Jan 13, 2012].

[4] Money Magazine, "Keeping your aging parents safe at home". Internet: http://money.cnn.com/2011/05/25/retirement/keeping-parents-safe.moneymag/#TOP?iid=EL {Jan 15, 2012].

[5] Brickhouse Alert, Internet: http://www.brickhousealert.com [Jan 13, 2012]