CENTURY SOLUTIONS

February 6, 2012

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

Re: ENSC 440 Functional Specification for *Fall Assist:* a device to detect elderly people who have fallen

Dear Dr. Rawicz:

The enclosed document from *Century Solutions* is the functional specification for our product *Fall Assist*. This product is in correspondence with the ENSC 440 project. *Fall Assist* will allow at risk of falling seniors to keep their independence of living alone by contacting the appropriate assistance when it is needed.

The functional specification outlines the high-level functional requirements for the proof-of-concept and final product. Furthermore, this document provides standards and the system test plan that will be used by all members of the team during the development and testing stages.

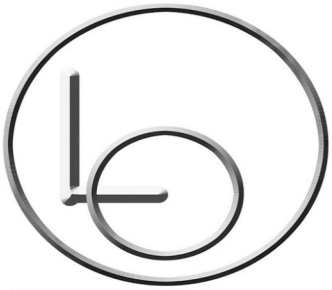
Our company, *Century Solutions*, consists of five senior engineering students: Ashish Agarwal, Richard Cho, Mahsa Dabirvaziri, Paven Loodu, and Alysha Sue. If you have any questions or inquiries about our functional specification please feel free to contact our designated contact person Alysha Sue by phone at (778) 688-7412 or by email at ams34@sfu.ca

Sincerely,

Ashish Agarwal

Ashish Agarwal
Chief Executive Officer
Century Solutions

Enclosure: Functional Specification for *Fall Assist*



Functional Specification for Fall Assist: a device to detect elderly people who have fallen

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ISSUED DATE
February 6, 2012

Executive Summary

Falls are a major concern for elderly people living on their own. Statistics show that approximately one in every three adults 65 years old or older fall each year and 30% of the falls result in serious injury [1]. The United Nations predicts that by 2035, 25% of the world population will be aged 65 years or older as the baby boomers age [2]. Quick detection of a fall can lower the rate of mortality and increase the chances of survival.

Our objective is to design and develop a device that will monitor and determine when someone has fallen. *Fall Assist* is a device that is designed to work independently, without the necessity of user control. This will ensure that every age group that is prone to falling will be able to use the product. The proof-of-concept model will demonstrate following features:

- Automatically detect a fall
- Eliminate false positives
- Send a signal to a web application using Wi-Fi
- Notify an emergency contact that their assistance is needed immediately

The application provided to notify the emergency contact will connect the device with any computer the user may have via Wi-Fi. The application will send a text message to the designated emergency contact person once a fall has been detected and confirmed. The application will be user friendly and will make it easy to change the emergency contact or their information. The features that have been mentioned for the proof-of-concept model will be ready by April 2012.

This document is to serve as a guideline of the features that are implemented in our proof-of-concept model. The proof-of-concept model is not the product's final form and may lack some features designated to the final form only. Such features that will only exist for the final form will be clearly stated in the document.

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Glossary

A Fall	When an elderly person has somehow ended up on the floor and is unable to get up on their own without assistance
ANSI	American National Standards Institute
CSA	Canadian Standards Association
PCB	Printed Circuit Board
TUV	Technischer Überwachungsverein
UL	Underwriters Laboratories

1. Introduction

Fall Assist will give seniors back their independence and ability to live alone by eliminating the fear of falling. It will automatically detect when a fall has occurred and alert an emergency contact via text message that their assistance is needed immediately reducing the time spent waiting for help to arrive. Consequently, *Fall Assist* will lessen the severity of injuries sustained during the fall and will ensure that help is brought to those in need when they are unable to call for it themselves.

1.1 Scope

This document states the functional requirements that *Fall Assist* must meet. These requirements fully describe the functions of our proof-of-concept model and partially those of the final product. These requirements will guide the design of *Fall Assist* and will be referenced in future documents.

1.2 Intended Audience

This functional specification is to be used by all members of *Century Solutions* during the design, development and testing stages of *Fall Assist*. This document will be used to solve design and functionality issues during development. Also, progress will be measured against this document during the testing stages.

1.3 Classification

The following convention is used throughout the document to represent the functional requirements:

[R#-p]

where # is the requirement number, and p is the priority of the requirement. Furthermore, p is represented by one of the following:

- **I** The requirement applies only to the proof-of-concept model.
- **II** The requirement applies to both the proof-of-concept model and the final product.
- **III** The requirement applies only to the final product.

2. System Requirements

2.1 System Overview

The user's activities such as walking, sitting, climbing stairs, etc. will generate readings in the accelerometer. These readings will be in analog format originally and will be converted to digital by the analog to digital converter that is attached to the accelerometer. The converter will also be attached to the microprocessor that will constantly analyze the signal. If the microcontroller determines that the person has fallen and needs assistance, it will connect to the Wi-Fi connection in the user's house and send a text message to the emergency contact.

Fall Assist at its highest level can be seen below in the figure 2.1.

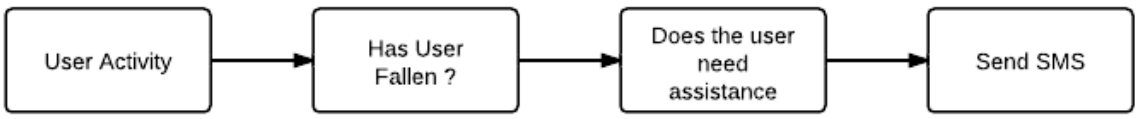

Figure 2.1: Flowchart for *Fall Assist*

The device consists of three different units which work together.

The first unit is the fall detection system. The device will be worn as a leather belt and consists of an accelerometer and a microcontroller. This will detect whether the person has fallen or not.

The second unit is the Wi-Fi transceiver. This will connect the leather belt to the Wi-Fi connection in the user's home. The user will need some technical assistance in setting up the Wi-Fi connection on the belt.

The third unit is the web application which will send a text message to the emergency contact. This will have an intuitive interface and is where the user enters the information of their emergency contact. This will send a text message to the emergency contact once the system determines that the person has fallen and needs assistance.

The proof of concept model will be an operational product and will be powered by two AAA batteries. These batteries will be easily replaced when worn out. The user will be able to "wear" the device and it will be able to do their daily activities without any hindrance. The model will be bulkier than the final product since an entire development board is being used for the project. However, the final product will be small enough to fit inside a leather belt.

2.2 General Requirements

[R1-II] The proof of concept model will cost under $600 CDN

[R2-III] The retail price of the final product must be under $100 CDN

[R3-III] It must be easy to use

[R4-III] Set up must be easy even for a non-technical person

[R5-II] It must be able to access the Internet without glitches

[R6-II] It must detect a fall accurately

2.3 Physical Requirements

[R7-III] It must have a rigid case and be attached to a belt

[R8-III] The weight should be light enough for everyday use (less than 2lbs.)

[R9-III] The size must be small enough for everyday use

[R10-III] It must not interfere with everyday life

2.4 Electrical Requirements

[R11-III] The battery life must be long

[R12-III] The battery should be rechargeable

[R13-III] It must be waterproof

[R14-II] The voltage must be low to prevent any potential electrical shock

[R15-III] The battery should have an indicator showing when it's low and the charging status

[R16-II] The internal electronics must be carefully shielded from short circuits due to drops

[R17-II] The false alarm rate must be VERY low

[R18-III] It must not interfere with other electronic devices

2.5 Mechanical Requirements

[R19-III] All parts must be protected using appropriate tools

[R20-III] The case must be made of non-rusting, waterproof materials to prevent rusting and electric shock

2.6 Environment Requirements

[R21-II] It must work under normal temperatures (0 – 40° C)

[R22-III] It must work in water (i.e. while taking a shower)

[R23-III] It must be durable enough to withstand many drops

2.7 Standards

[R24-III] It should meet ANSI standards for national, regional, and international standards

[R25-III] It should meet CSA requirements for electrical devices

[R26-III] It must meet UL standards for public safety

[R27-III] The electronic components should be TUV compliant

[R28-III] It must be an environmentally friendly device

[R29-III] The plastic components should be biodegradable

[R30-III] The PCB should be biodegradable

2.8 Reliability and Durability

[R31-III] It must be able to withstand a drop from a height of 2m

[R32-III] It must continue its usability and functionality for a minimum of 5 years

[R33-III] The system must function continuously 24 hours a day, 7 days a week

[R34-III] Trained technicians should be available to service the system

[R35-III] It should be water resistance and cleanable

2.9 Safety Requirements

[R36-II] It must not cause bodily harm to the user

[R37-II] It must not overheat causing damage to the device

[R38-II] It must not cause interference to other devices

[R39-III] The electronic components and circuitry must be enclosed

2.10 Performance Requirements

[R40-II] The response time must be low (no more than 2 minutes)

[R41-III] It must not heat up and cause discomfort

2.11 Usability Requirements

[R42-II] The user must have a computer and a Wi-Fi connection

[R43-III] The battery must indicate when it is low

[R44-II] It will detect the fall and send a signal to an application on the user's computer. Then the application will send a message for help automatically

[R45-II] It must not interfere with the user's normal everyday life

[R46-II] Other than the initial set up, action is not required from the user

[R47-II] A button will exist for the user to signal for help when a fall has not occurred

[R48-III] The belt must be adjustable so that it fits the user comfortably

[R49-III] Materials used in the device should not cause the user to have an allergic reaction

2.12 Luxury Requirements

[R50-III] Fall Assist can have flashing lights and siren to help finding the user

[R51-III] Fall Assist can be connected to a hospital to send the ambulance directly

[R52-III] The user can choose between different materials for the belt (such as leather or other more vegan friendly options)

[R53-III] The belt will be available in different colors

3. Belt Requirements

The Fall Assist device is inserted onto a belt and is intended to be worn around the waist of the user. Since we are using a 3-axial accelerometer it is beneficial for it to be aligned correctly with the spine when measuring orientation and acceleration thus the device will be inserted at the front buckle of the belt. By placing the *Fall Assist* device around the waist on a belt, the sampling rate is reduced to within a 100-150 kHz range. This is due to the fact that the movement of the waist is slow as opposed to the arm, leg, or wrist where a higher sampling rate is required from the accelerometer.

The device on the belt will consist of a microcontroller, an analog to digital converter, a 3-axial accelerometer, a Wi-Fi transmitter, and a battery.

3.1 General Requirements

[R54-III] The belt must be able to fit around various waist sizes

[R55-III] It must be easy to put on and take off

[R56-III] The belt will be available in multiple colors and materials

[R57-III] It must not cause allergic reactions

[R58-II] The belt must be comfortable to wear

[R59-II] It must not have any sharp edges

3.2 Physical Requirements

[R60-II] The buckle of the device should be no larger than 10 cm by 10 cm by 3cm

[R61-II] The belt should weigh no more than two pounds

3.3 Reliability and Durability

[R62-III] The belt must be durable and resistant to wear and tear

[R63-III] It must be waterproof along with the device

4. Microcontroller Requirements

The microcontroller will be used to receive data from the accelerometer and using an algorithm will analyze the data to determine whether a fall has occurred or not. If a fall has been detected the microcontroller will send a signal to the Wi-Fi chip to send a signal to the web application to alert the emergency contact.

4.1 General Requirements

[R64-II**]** The microcontroller must have a USB, SPI, TWI, I2C and RS232 interfaces

[R65-II**]** It should have the ability to use internal interrupts to read available sensor Data

[R66-II**]** The microcontroller must have a large enough serial flash to store the sensor data

[R67-II**]** It must be able to communicate with the Wi-Fi chip

[R68-II**]** It must be able to be powered by a Lithium-Polymer Battery

[R69-II**]** The microcontroller must have connector pins for a battery to be attached

5. Web Application Requirements

Using Google's App Engine we will run a web application on Google's infrastructure. Google's App Engine has no servers to maintain allowing the App Engine application to easily be built, maintained and scaled as traffic and data storage needs to grow.

Google App Engine supports applications written in various programming languages. With Java runtime environment applications can be built using standard Java technologies such as the Java programming language, JavaScript, or Ruby. The App Engine also supports Python and Go runtime environments.

There are no set-up costs and no recurring fees. The amount of resources our application uses such as storage and bandwidth are measured by the gigabyte and billed at set rates. The maximum amount of resources the application uses are controlled by the user so it always stays within budget. The App Engine costs nothing to get started and all applications can use up to 1 GB of storage for free [3].

5.1 General Requirements

[R70-II**]** The application must only need to be set up once

[R71-II**]** It must be user friendly and easy to set up

[R72-II**]** Emergency contact numbers must be easy to program and change

[R73-II**]** The application must be able to send a text message

[R74-II**]** The text message must be easy to customize

5.2 Performance Requirements

[R75-III**]** The application must be continuously running

[R76-II**]** The application must not use more than 1GB of storage

5.3 Reliability and Durability

[R77-III] The application must issue a response within 60 seconds when called to service a web request

6. System Test Plan

The test procedure will be divided into three sub categories: correctly detecting a fall, sending a signal to the web app, and miscellaneous testing. Correctly detecting the fall will need vigorous testing and is also the most crucial part of our design. It will be given the greatest priority.

To correctly detect a fall, we need to calibrate the accelerometer such that all false readings are omitted. This will be achieved through the following test plan:

- Fall Testing: Wear the concept model and mimic a fall from standing position. This will give us a sense of typical G forces that occur during a fall. The tester will not receive external forces when falling (i.e. pushing, shoving).

- Steady State Testing: Wear the concept model and sit down or lie down naturally. The data samples acquired from this testing will give a range of G forces that are to be considered false falling and be omitted.

- Everyday Testing: Wear the concept model for a full day and make sure the device only reacts to the range of G forces collected during fall testing.

Once the detection testing is completed, we will test our web application that will send out a text message to signal a fall. Components such as the Wi-Fi transmitter on the device and the web application will be tested for any bugs.

- Wi-Fi Testing: Test the Wi-Fi radio on the device to ensure that there is a connection accomplished between the device and the test computer. The connection should remain unless terminated by a failure. Also, make sure that data packets are sent and received correctly.

- Software Debugging: This test will ensure that the computer application is error free and works according to the specifications.

When the two major features are tested and verified, we will then test the minor features such as battery life, comfortableness, waterproof ability, and other miscellaneous features.

- Battery Life Testing: Optimize the device so that longer battery life is achieved.

- Comfortableness Testing: Make sure that the belt is comfortable and is durable.

- Waterproof Ability Testing: Test for waterproof ability, and make sure the device can also work under minor steams and drips of water. The device will be put under situational tests such as showers and accidental everyday water spills and splashes.

- Miscellaneous Testing: Test other minor features such as: device termination testing, manual activation testing and device/software installation testing. These are considered as miscellaneous because the device is designed to work without user action.

Upon completion of the above testing, we will conduct user testing to ensure other unmet needs are covered.

7. Conclusion

The functional specification details all the requirements, functions, and safety standards of *Fall Assist*. Development of our design will be divided into two distinctive stages: a proof-of-concept model and the final product. The proof-of-concept model satisfying all requirements with priority marked I or II is in the process of the design, development, and testing stages. This model is expected to be delivered by the second week of April 2012.

8. Sources and References

[1] "Falls Among Older Adults: An Overview" Internet: http://www.cdc.gov/homeandrecreationalsafety/falls/adultfalls.html, Sept. 16, 2011 [Feb 2, 2012]

[2] Israel Gannot, Ramat-HaSharon, Dimitry Litvak, Tel-Aviv, Yaniv Zigel. "System for Automatic Fall detection For elderly People". U.S. Patent 0224925, September 10, 2009

[3] "Google App Engine." Internet: http://code.google.com/appengine/, [February 3, 2012]