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October 19, 2015

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

Re: Functional Specification for Fall Emergency Distress System

Dear Dr. Rawicz,

The document attached is the functional specification for our product, Fall Emergency Distress System (FEDS). Our optimum goal is to design and implement a wearable device that detects dangerous falls and sends a distress call to a 24/7 services system. In addition, the device will include an emergency button that sends a distress signal for cases where the user needs medical assistance.

The functional specification will discuss the high-level functionality of FEDS including various stages of development. In addition, the document will cover the following: process details, engineering standards, and sustainability/safety for our product.

4Life Technology Services consist of six highly motivated and talented fourth year engineering students: Yuvn Ng, Cyrus Chan, Benjamin Sia, Janet Mardjuki, WelsonYim and Daniel Lei. If you have any questions or concerns about our functional specification, please feel free to contact me by phone at 6044466738 or by email at cyrusc@sfu.ca.

Sincerely,

Cyrus Chan
CEO
4Life Technology Services

ENCLOSED: Functional Specification for Fall Emergency Distress System



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Fall Emergency Distress System

Functional Specifications

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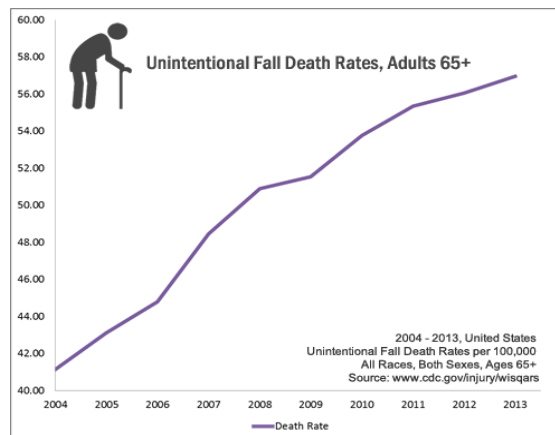
Executive Summary

As we age, our bodies gradually become weaker and less responsive. Senior citizens tend to have difficulty controlling their body movements. At the start of the 20th century, it was estimated that there were at least 2.6 million fall related injuries in the US alone in which 10300 were fatal [1]. Figure 1 shows the severity of this issue depicting a graph of death rates of people who succumb to their fall injuries at the age of 65 and over. Omar Aziz, a PhD graduate of SFU Engineering Science and a researcher in injury prevention to the elderly, stated that the most common causes of falls involving the elderly is due to an incorrect shift in body weight. In many cases, falls are unavoidable but we want medical assistance to arrive as soon as possible.

To solve these problems, our company is designing and developing a system called the Fall Emergency Distress System (FEDS), which responds to the falling motion of the user. When the user has a sudden downward acceleration, the system will detect this motion and emit a buzzer alarm. This informs the user that a distress call will be sent to the service center if it is not deactivated within a period of time. The device will also include an emergency button that can be pressed at any time and it will notify the system of the user's needs for medical assistance. When a distress call is received on our servers, the service team will locate the user through GPS and send the information to a medical response team.

The following document will cover all the functional aspects of FEDS. This includes the systematic requirements of the device, engineering standards in regards to the device, and analysis of the sustainability and safety issue of the device. These sections will present the various aspects the system and the requirements that it must meet before it comes commercialized.

The overall development process of FEDS can be broken down into three stages: the ongoing proof-of-concept design, prototyping, and the final consumer product. Each stage will be organized by importance and subsequent function or designs will be layered on top of the previous one as the project progresses.



Graph 1: Death rate of unintentional falls for seniors age 65+ [2]



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Glossary

ABS	Acrylonitrile butadiene styrene
FEDS	Fall Emergency Distress System
CE	ConformitéEuropéenne; product met the health, safety, and environmental requirements
Cradle-to-Cradle	Efficient production that is waste free, either by reusing or recycling
GPS	Global Positioning System
IEC	International Electrotechnical Commission
ISO	International Organization for Standarization
PCB	Printed Circuit Board
ROHS	Restriction of Hazardous Substances Directive; product does not contain hazardous material, for example use of lead free solder



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1. Introduction

FEDS is a fall detection system that will notify the operator whenever a falls detected or help button is pressed and will call for help if necessary. The system can be broken down into two smaller systems, the first is the wearable device that will be used to detect the fall, and second is the server that will receive data from device and notify the operators at hand. With the help of this system, people who have a higher risk of falling can be more independent. The users who utilize the system and fellow family members will have peace of mind knowing that the system will call for help if the user falls. This system is designed to cater to people who need continuous surveillance such as older people and people with disabilities but can also be used for people who are frequent fainters or have epilepsy.

1.1 Scope

This documentation will provide the functional specification and requirement on FEDS; this includes the wearable device, the sensors, the remote server, and the communication between the device and the remote server. Moreover, this document will cover the engineering standards that apply to FEDS, and the sustainability/safety of the system.

1.2 Intended Audience

This document will guide 4Life's members through the different development phases of FEDS. Engineers should refer to this document to conform to the requirements for FEDS.

1.3 Classification

The following convention will be used throughout the functional spec document:

[Rn-p]

In this convention, n is the requirement number and p is the priority number that will represent the following alphabet:

- A – Proof of concept
- B – Prototype
- C – Consumer product

2. System Requirements

The following section will go into detail pertaining to the general system requirements for the FEDS.

2.1 System Overview

The system can be separated into two distinct parts; the embedded system and the server as shown in Figure 1.

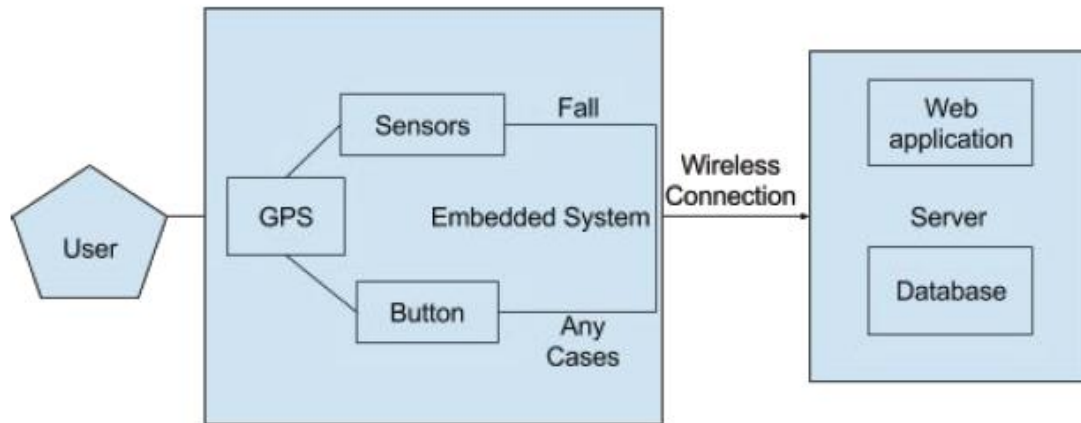


Figure 1: FEDS' subsystems

FEDS is designed to provide an emergency response service when the user falls or decides to manually call for assistance. The Fall Emergency Distress System (FEDS) is a wearable device which is designed to be worn around the user's waist. The device will only be activated after the user registers the device and sets up their medical record. The medical record will then be uploaded with the specific device ID and sent to the server's database. The following are two scenarios that would cause the device to send a distress response:

1. The first scenario occurs when the on board sensors detect the fall of the user. When the user falls, FEDS's on board speaker will give the user a countdown before the service operator calls for help. If the fall was a false alarm or the fall was not serious, the user can push the button on the device to cancel the countdown. However, if the user decides he or she is in need of assistance or has passed out, the service operators will call for an emergency response action after the countdown. A medical response team will be informed of the patient's location through the GPS of the device.
2. The second scenario occurs when the user is conscious and decides he or she needs emergency assistance. In this case, the user can press the button on the device which will activate the distress signal and instantly call for assistance.

In both cases, the FEDS's operator will be notified by the distress signal in the web application page and the medical response team will be requested to the user location. Table 1 shows the sensors that the FEDS contain and a description of what it is used for.



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Table 1: The sensors that is included in the device

Sensor	Description	Number of sensors
Accelerometer (included in the prototype)	The accelerometer is used to detect when a person has a sudden downward acceleration which may be a fall	1
GPS (included in the prototype)	The GPS is used to detect the location of the user when a distress signal is sent out	1
Shock Pulse Sensor (production model only)	Shock Pulse sensor is used to add accuracy in sensing when a person falls as the impact to the ground would cause a shock	1
Heart rate monitor (production model only)	Heart rate monitor is included to give the operator extra information to tell the paramedics when calling for assistance	1

2.2 General Requirements

[R1-B]	The device will be intuitive to use with a low learning curve
[R2-C]	The final product will be visually appealing
[R3-C]	The final product will cost less than \$150 CAD
[R4-C]	The final product will be easy to wear
[R5-C]	The final product will be portable
[R6-C]	The final product will be water resistant
[R7-C]	The final product will tolerate a 3 meter drop
[R8-B]	The device will be able to communicate with the server
[R9-C]	The final product will use a mobile network to communicate with the FEDS's server

2.3 Physical Requirements

[R10-C]	The final product will not exceed the total weight of 250g
[R11-C]	The final product will not exceed the dimension of 10 cm x 6 cm x 2 cm
[R12-B]	The device will have a casing to protect the user from the electrical components

2.4 Electrical Requirements

[R13-B]	The devicefinal product will have a battery as the power source
[R14-C]	The final product will not expose any electrical components
[R15-C]	Device will be insulated to avoid electrical discharge



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2.5 Performance Requirements

[R16-A]	The device will send a signal immediately when an emergency happens
[R17-A]	The device will detect a fall in 1 second

2.6 Standards and Safety Requirements

[R18-C]	The final products package should follow ECOPACK® standard Section ECOPACK® [3]
[R19-A]	All component should be RoHS compliant [4]

2.7 Environmental Requirements

[R20-A]	Device will utilize a wireless connection
[R21-B]	Device is designed to operate in between the temperature range of (-10°C and 60°C)
[R22-C]	The Device will function in both outdoor and indoor situations

3. Device Sensor Requirements

The FEDS's device will include sensor components to assist in detecting and responding to the user's fall. When a fall occurs, the accelerator will detect a sharp spike in acceleration and request to verify if the user fell with the assistance of a shock sensor. After the fall, a distress signal will be sent with the user GPS location and heart rate information to the server. The sensors will be enclosed in a case to prevent direct contact with the user.

3.1 General Requirements

[R23-A]	The cost of accelerometer should not exceed \$30
[R24-A]	The cost of GPS should not exceed \$100
[R25-A]	The cost of heart rate sensor not exceed \$10
[R26-A]	The cost of shock sensor should below \$10
[R27-B]	The accelerator should be able measure 6G or above
[R28-B]	The GPS should be able to send the location of the user when an emergency occurs
[R29-B]	The heart rate sensor should be able to measure the heart rate in 1 minutes to 2 minutes
[R30-C]	The shock sensor will be able to measure the shock in 1 sec

3.2 Electrical Requirements

[R31-B]	The sensors will run at a voltage value of 5V or lower
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3.3 Physical Requirements

[R32-B]	The components should function in indoor or outdoor environments
[R33-B]	All components should be in protected and mounted inside the case
[R34-C]	All components should be conformal coated to protect from water

4. User Interface

To avoid complicated user interface, the FEDS's device will have a light source to indicate whether the device is currently is on, off, in warning mode, or in emergency mode. The device will have two buttons and one switch which are distinct in shape and colour to provide easy recognition of functionality for the user. Figure 3 shows conceptual design for the production model.

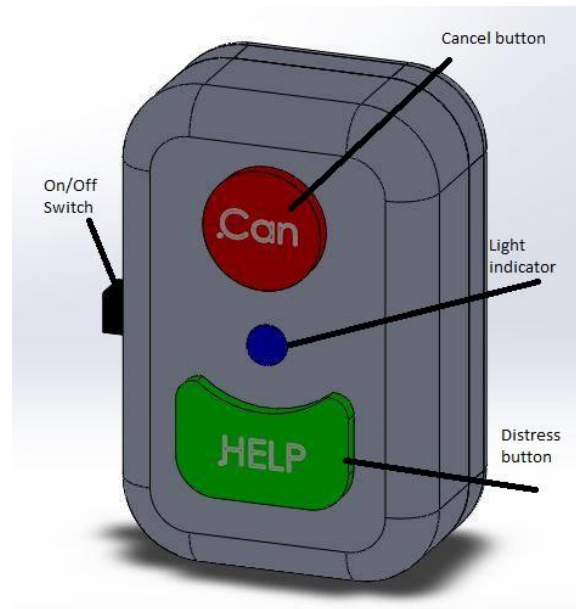


Figure 2: Conceptual design for the production model

4.1 General Requirements

[R35-B]	The device will have a light source to show the status of the device
[R36-B]	The device will have a help button
[R37-B]	The device will have a cancel button
[R38-B]	The device will have an on/off switch
[R39-B]	The device will have a buzzer to notify user when a fall has been detected
[R40-B]	The device buzzer will continuously beep until a distress signal is sent
[R41-B]	Device will send the distress signal to the operator in 15 seconds if the user does not deactivate the countdown



4.2 Performance Requirements

[R42 -A]	The light source, power switch, and button will have a response time of less than 1 second
[R43-A]	The help button will have the function of sending out a distress signal at any time
[R44-A]	The cancel button will cancel the distress call after a fall has been detected

5. Device Mount/Casing

The FEDS's device will come in a case which will be safe and easy to wear. This device is designed to be worn around the waist where less movement occurs to provide improved accuracy for fall detection. In addition, the casing will not have any sharp edges to prevent the user from being injured by the device while falling.

5.1 General Requirements

[R45-A]	Device is designed to be worn around the waist
[R46-A]	Device should be adjustable for various waist sizes
[R47-C]	The final product will have rounded edges
[R48-C]	The device mount should be non-obtrusive
[R49-C]	The device mount should be easy to put on

5.2 Safety Requirements

[R50-C]	The final product will not have any sharp edges which may injure the user during a fall
[R51-C]	
[R52-C]	The final product will be easy to take off
[R53-B]	Device will be insulated to avoid electrical discharge
	The on/off switch will be easily accessible in case the device malfunctions

6. Power Supply Requirements

The device is required to be on all the times and that entails the use of a battery. The battery act as the power supply for the device and will be easy to recharge or replace.



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6.1 General Requirements

[R54-A]	The cost of the battery must be below \$30 CAD
[R55-C]	The battery will be replaceable
[R56-C]	Battery will be rechargeable
[R57-B]	The prototype product should consume between 4 to 8Watts [5]

6.4 Performance Requirements

[R58-B]	A 5V DC USB charger will be used to charge the battery
[R59-B]	The battery will supply 5V of power
[R60-C]	Battery will allow the device to operate for up to 6 hours

6.5 Standard and Safety Requirements

[R61-C]	The battery will be enclosed in a plastic cover to avoid punctures from external sources
[R62-C]	The adaptor will follow the North American wall plug standard [6]

7. Operator Interface and Server Requirements

The FEDS's server will be used as a platform for storing user information and status. The information on the server will only be accessible by 4Life Technology's operators. This is to ensure that the information stored in the server will remain private under the personal information protection act. Only in an emergency will the medical response team be notified of user's information.

7.1 General Requirements

[R63-B]	The information accessible by the operator will not be accessible for the user
[R64-B]	The server will run continuously unless maintenance is being done

7.2 Functional Requirements

[R65-B]	The server will require the operator to login to access or change information on the database
[R66-B]	The operator will have a function to add and remove users
[R67-C]	The operator will have a function to search for users
[R68-B]	The server will be show the location of the device when a distress call is received
[R69-B]	The server will be able store the device ID
[R70 -B]	The server will store the status of the device and location of the device
[R71 -B]	The server will store the user's information such as: name, telephone number,



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[R72-B]	emergency number, address, and medical history FEDS's operators will be able to modify the user's information through the back end of the server's database
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7.3 Standards and Safety Requirements

[R73-C]	The server's information will not be available to the general public as according to the "Personal Information Protection Act" [SBC 2003] (Use of Personal Information)[7]
[R74-C]	The server shall conform ISO/IEC 17799:2005[8]

8. User Manual Requirements

The user manual will come in both electronic and physical copy during purchase of FEDS's device. The user manual will assist the user in understanding how to properly use the device and provide details on the functionality of device

8.1 General Requirements

[R75-A]	The user manual will describe how to use the device
[R76-A]	The user manual will describe how to safely wear the device
[R77-A]	The user manual will explanation the function and purpose of the buttons and switch
[R78-C]	The user manual will be easy to follow with clear images
[R79-A]	The user manual will contain a troubleshooting guide and contact information

8.2 Usability Requirements

[R80-C]	The user manual will be available as a physical printed copy
[R81-C]	The user manual will be available as an electronically downloadable copy

9. Sustainability/Safety

4Life is committed to designing products that are safe and sustainable for both the user and the environment. By following the 'Cradle-to-Cradle' concept we plan on optimizing the entire life cycle of the product [9]. In the following section, the design's safety and sustainability of both the prototype and final product will be analyzed.

9.1 Prototype

The prototype is designed around the Raspberry Pi. This multipurpose computer allows 4Life to build custom programs and perform the initial testing phase. After the design and testing of the prototype is complete, the Raspberry Pi can be recycled for use in future projects. The



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Raspberry Pi itself is a ROHS and CE compliant product which means that it does not contain any hazardous material and that it is safe for consumers. [10]

Likewise, the accelerometer, shock sensor, and GPS will also be chosen from ROHS compliant components. Just like the Raspberry Pi discussed above, these components can be recycled into future prototypes due to their versatility.

To protect the Raspberry Pi and the other components, a 3D printed case will be made using ABS. ABS is a recyclable and environmentally friendly plastic that is inexpensive and durable. [11]

9.2 Final Product

The final product will be built on a PCB that has the following components: processor, circuit, network card, accelerometer, shock sensor and GPS. The case will be made through injection moulding with ABS plastic like the prototype but it will be more streamlined and smaller than the prototype counterpart. 4Life will ensure that the components used fall under ROHS and that the end product is CE compliant.

10. Conclusion

The functional specification of FEDs clearly defines the functionality and requirement of 4Life's FEDs. The requirements in each section are categorized under A, proof of concept, B, prototype, and C, consumer production. FEDs will be built under the completion of each category starting from A to B. The order allows the device to meet all underlying requirements as the final product is built up for commercial use.



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