F.A.M.

Simon Fraser University
School of Engineering Science
ENSC 305/440- Capstone Project

Group Members:

Behdad Jamshidi

Eric Swanlund

Ted Lee

Zack Frehlick

Nastaran Naghshineh

April 10, 2012

Objectives

- Team Members
- Motivation
- Business Case
  - Competition
  - Market Potential & Difficulties
- System Overview
- System Design
  - Portable Device Hardware
  - Fall Detection Software
  - Central Device Hardware & Software
- Project Details
  - Timeline
  - Budget
  - Team Dynamics
- Conclusion & Summary
- Acknowledgments and References
- Questions

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Individual Roles

- **Behdad Jamshidi, Team Leader**
  - Hardware and software of central box
  - Implementing text messaging
  - Programming LCD
  - Ordering and delivering parts
  - Schedule meetings & keeping team on track

- **Ted Lee**
  - Hardware and software of central box
  - Implementing text messaging
  - Programming LCD
  - Ordering and deciding on the parts

Individual Roles Cont'd

- **Zack Frehlick**
  - Developing fall algorithm
  - Hardware and software of portable accelerometer device
  - RF communication between devices
  - Ordering and deciding on the parts
- **Eric Swanlund**
  - Hardware and software of portable accelerometer device
  - RF communication between devices
  - Developing fall algorithm
  - Ordering and deciding on the parts
- **Nastaran Naghshineh**
  - Helping both sub-groups
  - Ordering and deciding on the parts
  - Funding

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Motivation

- More than one-third of adults 65 and older fall each year.
- The risk of falling and fall-related problems rises with age.
- Over 19700 elderly adults died from falling in 2008.
- People are more likely to return to independent living after a fall if help comes quickly

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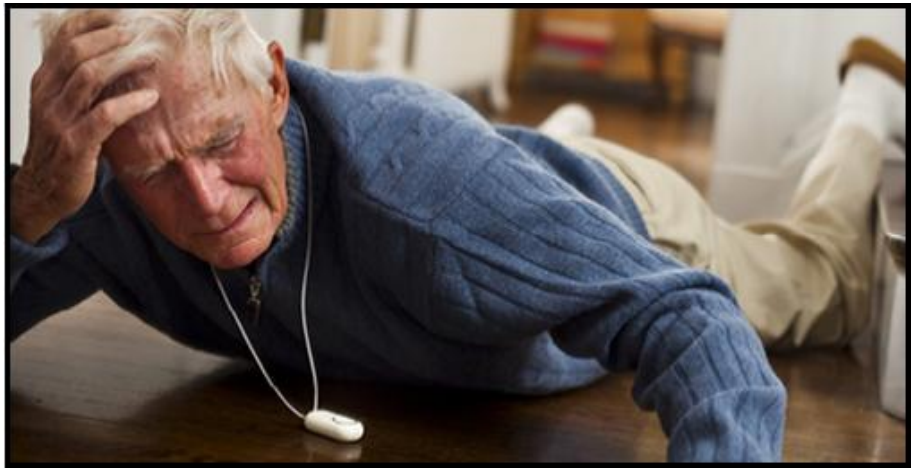
Competition



Life Alert

Philips Lifeline with AutoAlert

Brickhouse Alert Fall Detector

Market Potential

- In 2000, total medical expenses for fall injuries were $19.3 billion dollars.
- Walgreen's Ready Response system generated 9.5 million in second quarter revenue in 2008.

Difficulties in Industry

- Many elderly feel stigmatized by wearing monitoring devices.
- Families want security, but elderly folk want independence.

What is the solution?

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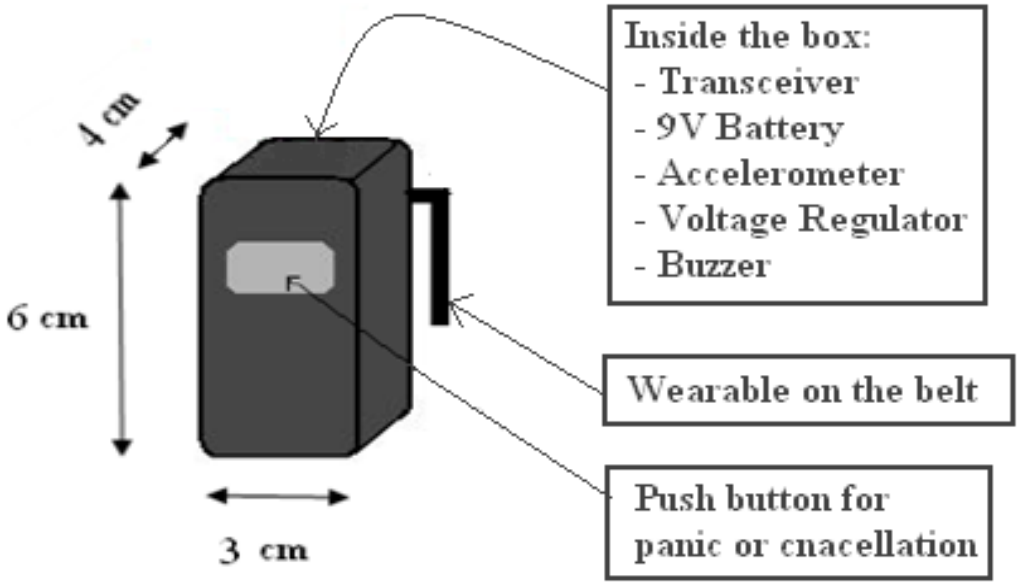
System Overview

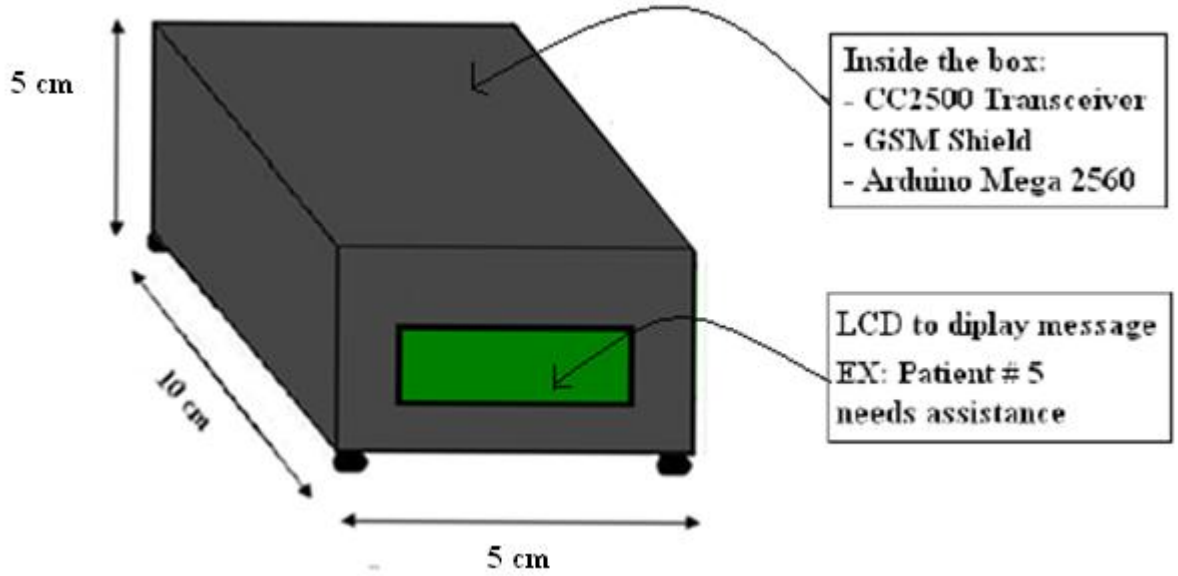
Portable Device



- Detects a proper fall
- Sends a signal to the central device

System Overview

Central Device



- Receives signals from portable device
- Sends text messages
- Displays which portable device has sent a signal on LCD

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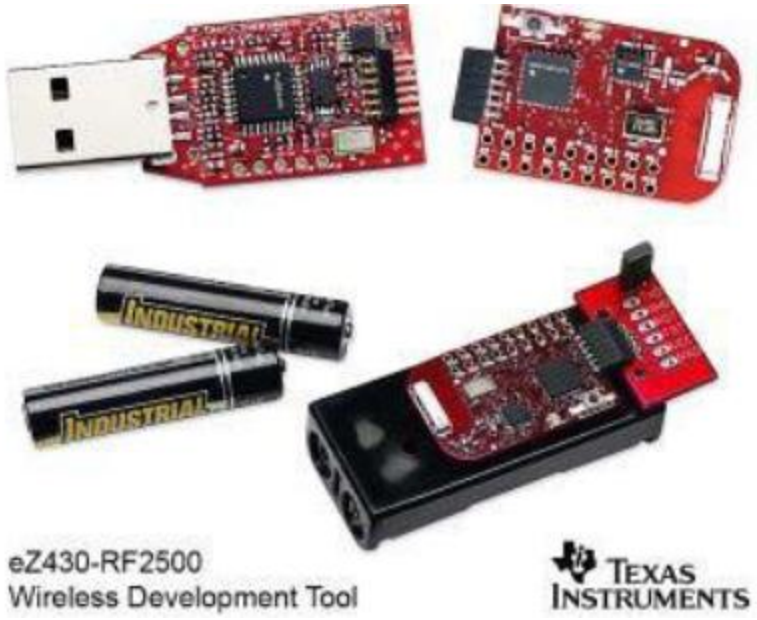
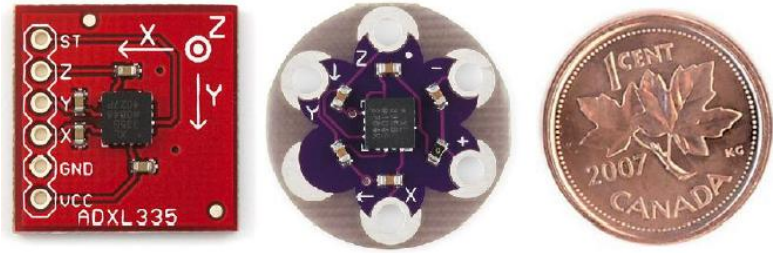
Portable Device Hardware

- eZ430-RF2500 Development Kit
  - Contains MSP430F2274 microcontroller and CC2500 2.4 GHz wireless transceiver

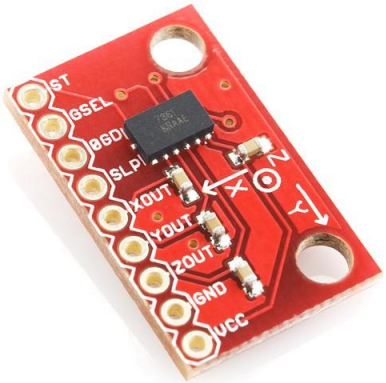


Portable Device Hardware

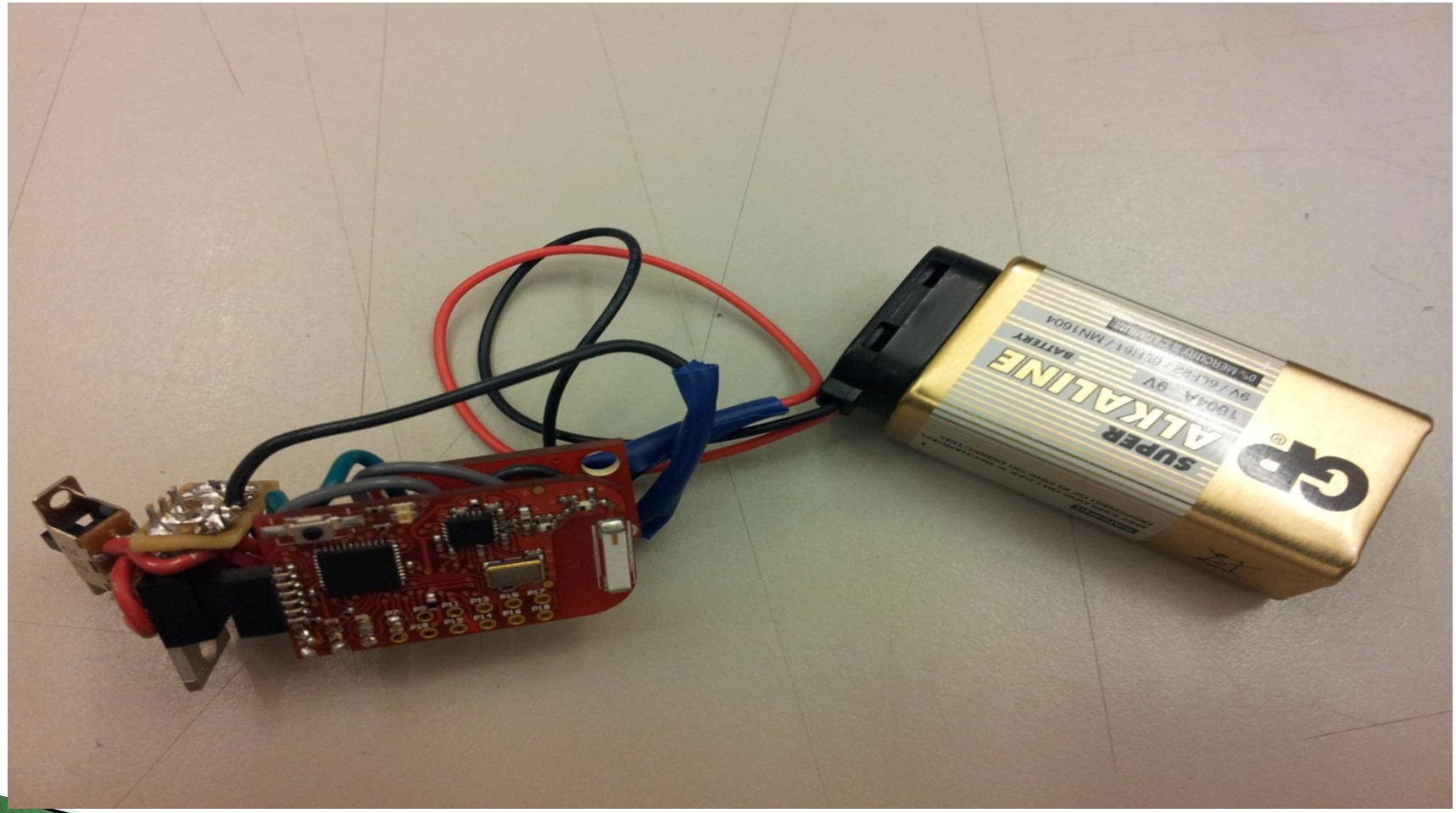
- ADXL335 Accelerometer: 3g (not adequate)



- MMA7361 Accelerometer: 6g (adequate)



Portable Device Hardware



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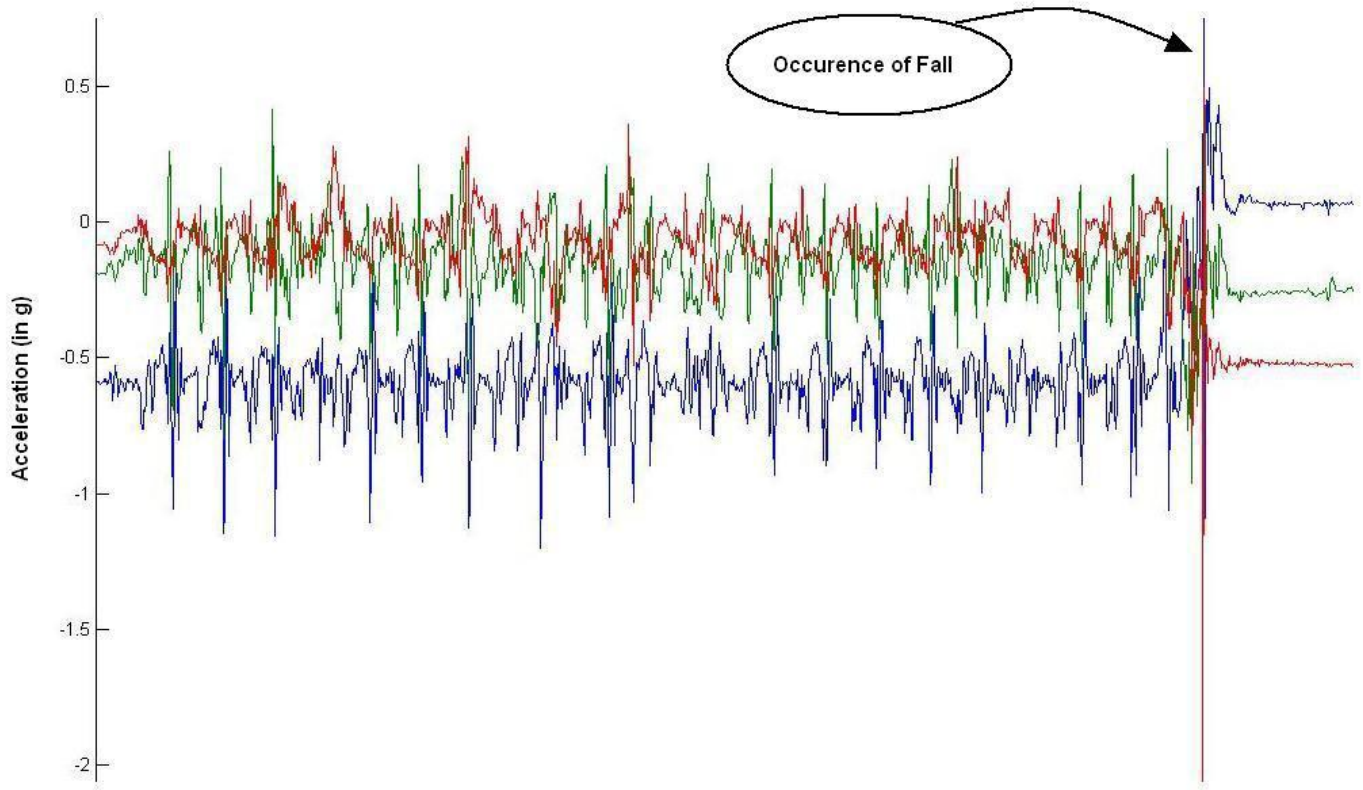
Fall Detection Software



Fall Detection Software

- Final Fall Algorithm:
  - Step 1) $$Magnitude = \sqrt{Acc_X^2 + Acc_Y^2 + Acc_Z^2}$$
  - Step 2) Acceleration Peak:

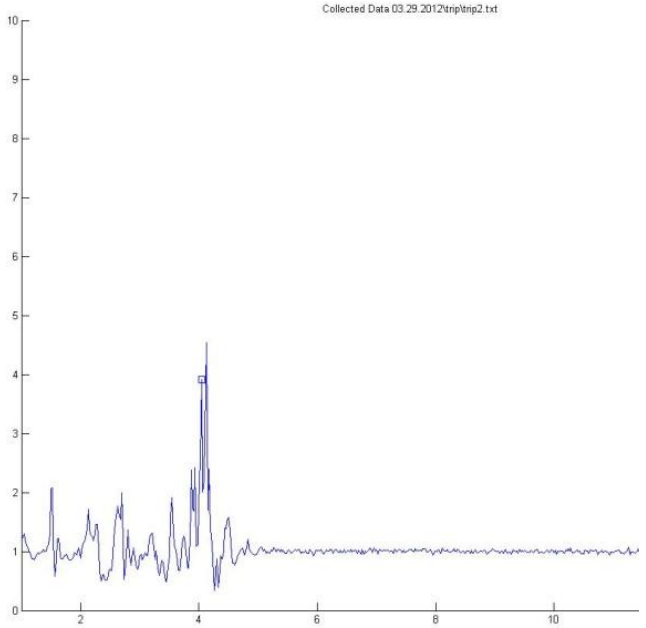
$$Magnitude > 2.5$$

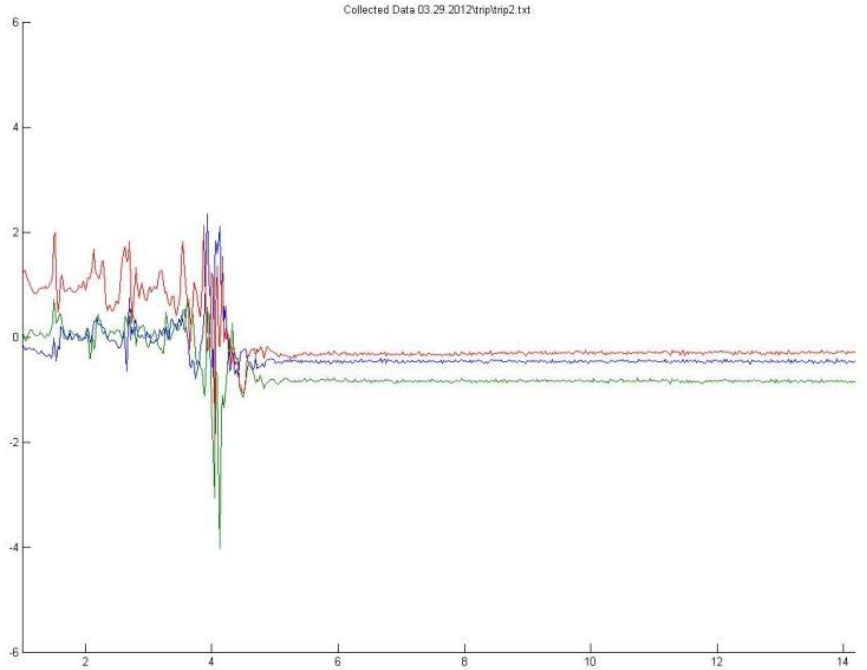
  - Step 3) Compare orientation 1 second before and 1 second after peak

Fall Detection Software

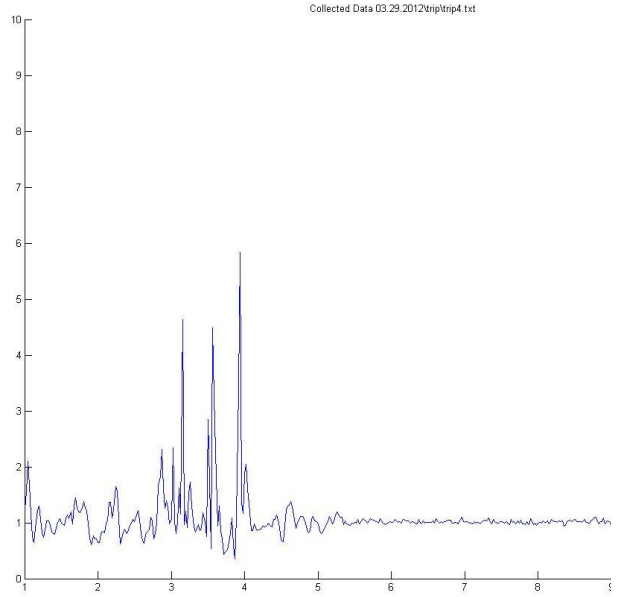
- Test Cases:
  - Common Types of Falls (trips, slips, etc.)
  - Loss and Recovery of Balance (near falls)
  - Activities of Daily Living (ADLs)

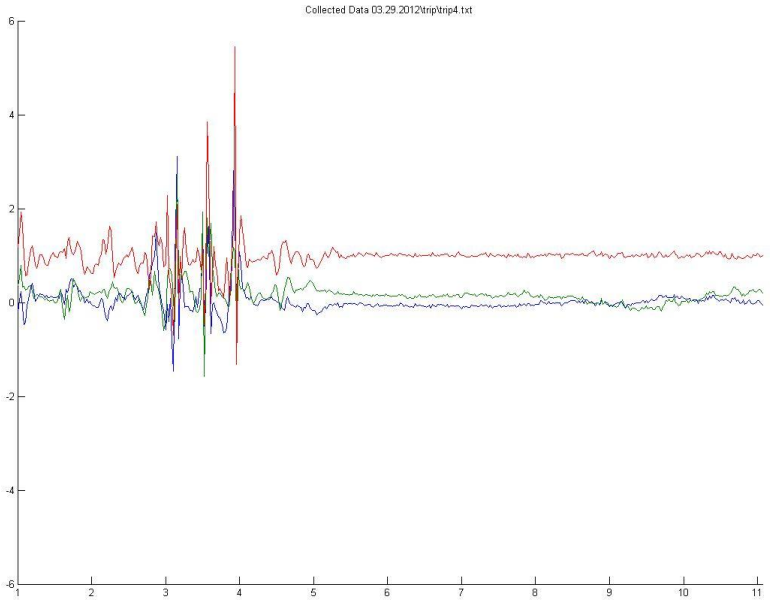
Fall Type – Trip



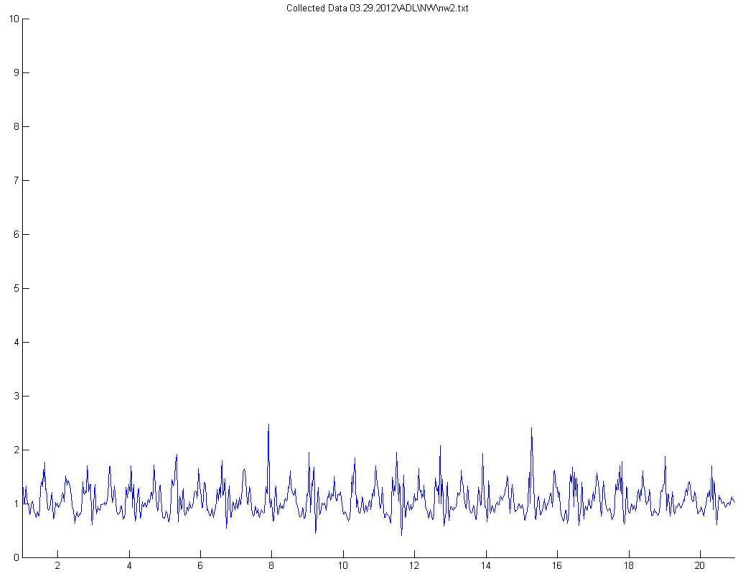


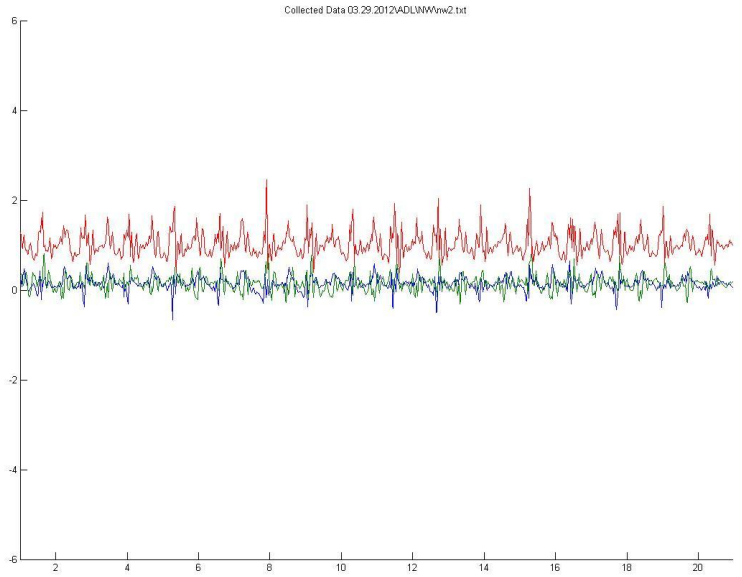
Near-Fall – Trip



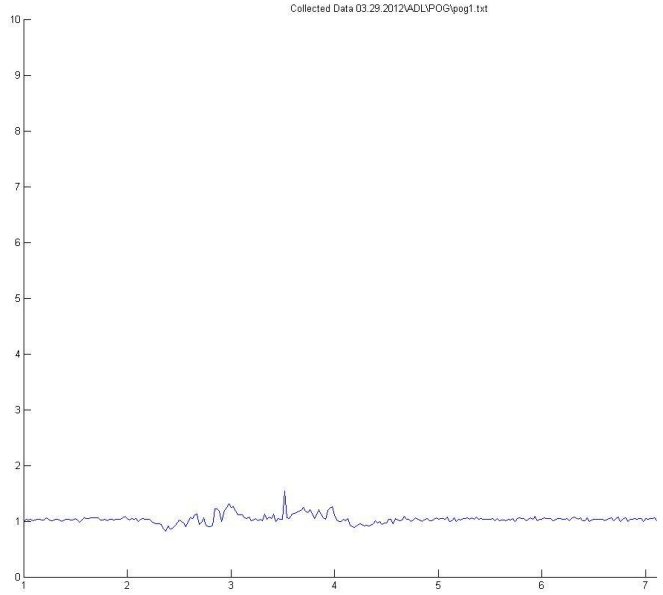


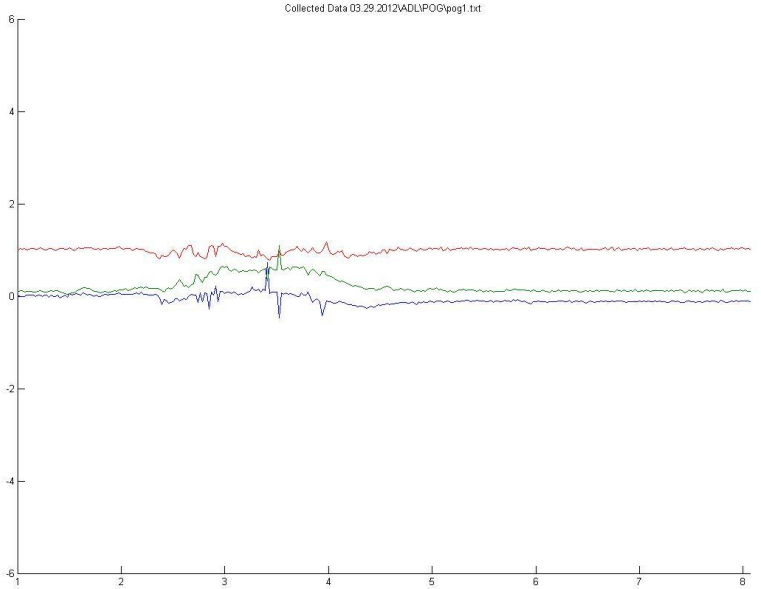
ADL – Walking


Collected Data 03.29.2012\ADL\NW\nw2.txt
10
9
8
7
6
5
4
3
2
1
0
2
4
6
8
10
12
14
16
18
20


Collected Data 03.29.2012\ADL\NW\nw2.txt
6
4
2
0
-2
-4
-6
2
4
6
8
10
12
14
16
18
20

ADL – Pick Up Off Ground





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Central Device Hardware

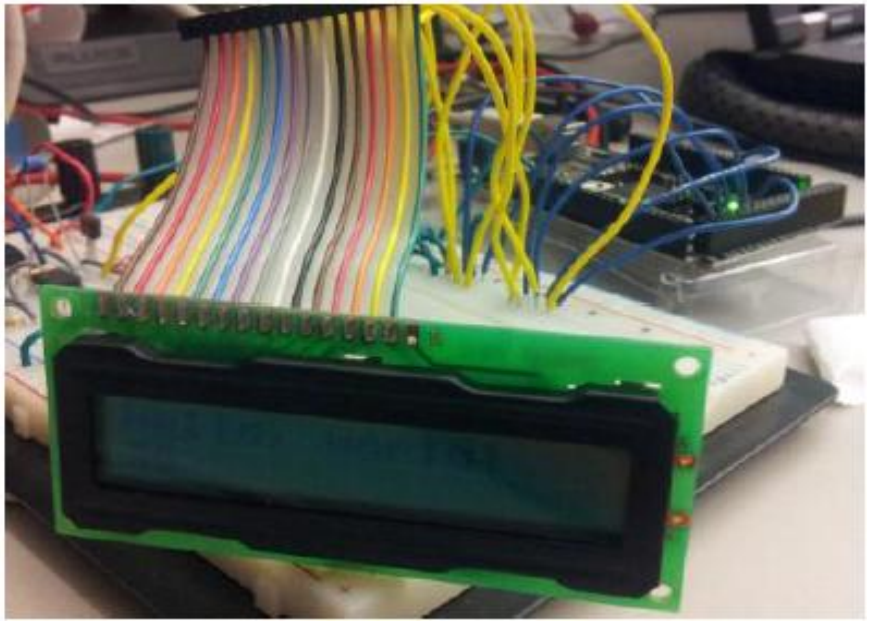
- Arduino Mega 2560
  - Easy to work with microcontroller with fast learning curve
  - Controls the texting and display modules of the central device
  - Powered by 5V and 3A regulator

Central Device Hardware

- GSM shield Module
  - Has the ability to do everything a cell phone can
  - Controlled by AT-commands

Central Device Hardware

- LCD Display (model TM162ADA7-2)
  - Displays the state of the portable device
  - Controlled by Arduino



Central Device Software

- Arduino Software (C++)
  - Texting
    - Receives a radio frequency signal from Portable device wirelessly and triggers the GSM shield module to send text messages to loved ones.
  - LCD
    - When a radio frequency signal is received from the Portable device, it shows which device has fallen and displays the device name on the screen.

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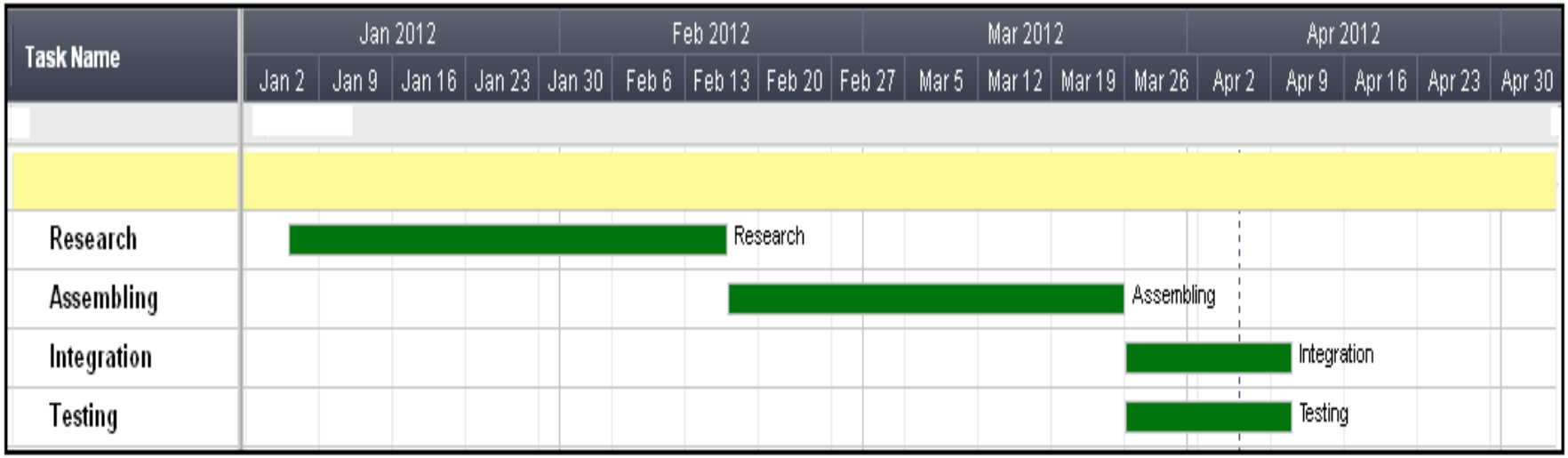
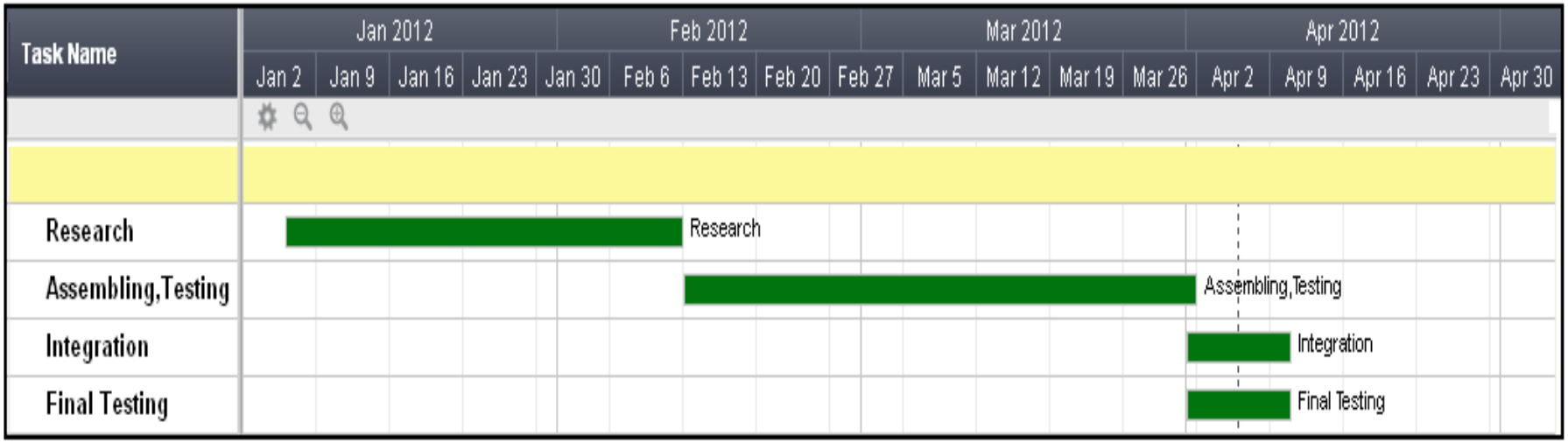
Timeline: Expected



Timeline: Actual



Budget: Expected

Component	Price
LED light	$ 10
Accelerometer	$ 150
Wireless Transmitter Receiver	$ 300
Microcontroller	$ 50
Other Costs	$ 100

TOTAL : $ 610

Budget: Actual

Component	Price
Development Boards & kits	$ 151.65
Triple Axis Accelerometer	$ 39.04
GSM Shield	$ 126.70
Cellular Shield (Arduino Board)	$ 117.91
Material for outside box	$ 35.12
Other costs	$ 115.09
Unused components	$149.87
Broken Components	$ 151.65

TOTAL : $ 886.98

Team Dynamics

- The project has been divided into sub-groups.
- Helped each other when problems occurred.
- Every one did the best to bring the project to success.

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What We Learned – Central

- How to work with Arduino board, GSM shield module, and LCD
- Soldering skills and techniques
- Teamwork and organization
- Creating and sticking to timelines and weekly goals

What We Learned – Portable

- Working with microcontrollers, RF communication, accelerometers, and debugger
- There will always be unforeseen problems
- Be persistent and creative in addressing problems
- Attention to detail

Future Developments

- Add keyboard for entering phone numbers and clearing the display
- Implement portable device on a single chip
- Create smaller and more attractive device case
- Improve RF communication system

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Portable Device Problem

- We have experienced significant problems with development kit, having to buy 2 replacement kits.
- CC2500 transceiver module becomes unresponsive and fails to initialize or communicate. All three kits we purchased eventually failed in the same way.
- In our demo, we can show the two system parts working independently, and we have implemented a short-term RF communication solution.
- We also have video footage of our device functioning properly, prior to development kit failure.

Acknowledgments

Thanks to:

- Dr. Stephen Robinovitch and graduate student Omar Aziz for guidance in fall testing and allowing us to borrow their data

- ENSC 305/440 Instructors and TAs:

  Dr. Andrew Rawicz, Steve Whitmore, Lukas-Karim Mehri, Shaghayegh Hosseinpour , Ali Ostadfar

- Engineering Science Student Endowment Fund (ESSEF) for funding the project

References

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Questions

Project Demonstrations