Team E7: Body Buddy

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Use Case

- Problem
  - Falls can cause serious injuries for elders
  - Fear of falling can also limit their activities / social engagements
- How can we promptly handle the emergency situations caused by falls?
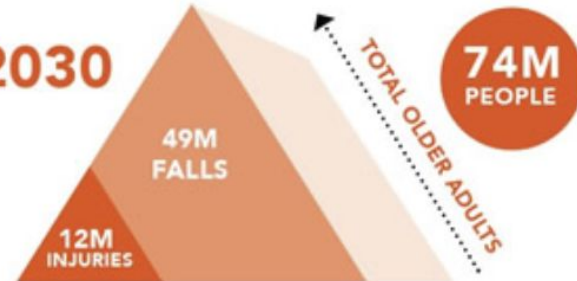

OLDER ADULT FALLS
A Growing Burden

STEADI Stopping Elderly Accidents, Deaths & Injuries

2014
29M FALLS
7M INJURIES
TOTAL OLDER ADULTS
46M PEOPLE

2030
49M FALLS
12M INJURIES
TOTAL OLDER ADULTS
74M PEOPLE

Use Case

- Proposal: An attachable device connected to a mobile app that detects a fall and sends alerts to the first responders
- Covered Areas:
  - Software
  - Hardware

Coming Soon ·······

Requirements: Fall Detection

- Detect a fall with 90% accuracy
- Should not detect ordinary behaviors as a fall (running, sitting down, jumping)
- Should not miss a fall
- Process data and output result within 2 seconds

Requirements: Hardware Platform

- Battery Life - needs to last a full day on a charge (at least 10h)
- Weight - under 10oz.
- Enclosure - Weatherproof, drop-safe, and somehow wearable
  - Easily accessible
  - Need to determine size & impact of location on accuracy first
  - Actual form factor TBD

Requirements: App

- Connections with the mobile app
    - Hardware System (Bluetooth)
    - Sendinding an alert to first responders
- Location tracking
    - In a human-readable format, not coordinates
- Cancelling an alert by a user for unintentional falls or false alarms
- Store contacts of the first responders

Technical Challenges

- Detection of a fall using IMU data
- Location of the sensors for collecting the most precise data
- Accuracy of the fall detection algorithm
- Possible false alarms due to user's movement
- Latency of sending sensor data through bluetooth
- Easy-to-carry / easy-to-attach design
- Intuitive app UI for elderly

Solution Approach: Hardware

Hardware Platform: Raspberry Pi
- Fast to set up, Bluetooth included
- IMU add-on boards available
    - Would still want separate boards with a custom PCB to vary placement
- Prioritize small size & low power

Enclosure: Off the shelf enclosure
- Don't need any I/O buttons or cables other than power
    - Can use a less-than-weatherproof enclosure and modify
- Prioritize size & weight

Solution Approach: Software

- Fall Detection
  - Machine Learning
    - Use SVM to classify IMU data into two categories (fall/normal)
    - Collect user's dataset
  - Improve Data Accuracy
    - Measure time after detecting falls
    - Combine sensor data with phone's IMU data
    - iOS Core Motion framework
- iOS App
  - Google Maps API for location / GPS
  - Connection with hardware through Bluetooth
  - Alerts through an app notification / email / text message
  - Alerts can be cancelled on the app to prevent false alarms

Testing / Verification / Metrics

- Fall Detection
    - Obtain data from different numbers and positions of IMU devices
    - Test on people with different heights / weights
    - >90% accuracy of the algorithm
- Latency
    - Sending IMU data through bluetooth
    - Running ML algorithm to detect the fall using IMU data
    - Sending an alert to first responders
    - ➡ total time should sum up to < 3s

Testing / Verification / Metrics

- Battery Life
    - Determine battery life by logging connectivity on phone / measuring power consumed
    - Estimate from battery pack size
    - Should last at least 10h without charging
- Location Tracking
    - Location accuracy
- Enclosure
    - Waterproof
    - Fall Resistant
    - Total weight < 10oz

Tasks and Division of Labor

Milestones		Proposal				Design Present	Design Doc				Interim Demo					Final
List of tasks	1/27	2/3		2/10	2/17	2/24	3/2	3/9	3/16	3/23	3/30	4/6	4/13	4/20	4/27	
Proposal																
SW Architecture																
HW Architecture																
Fall Detection Algorithm																Sojeong
App Barebone																Nick
HW Architecture (Devices)																Max
Parts Selection																Whole Team
Design Presentation / Document																
Order Parts																
Test alorithm on app with phone IMU data																
GPS location system																
SW Bringup (Embedded System																
Sending notification																
Spring Break																
Integrate / Test IMU sensor data																
SW HW Integration																
SW HW Integration																
IMU data connection to app																
SW Bringup (IMUs) / HW Bringup																
Slack																
Test Latency																
Test and Improve fall detection																
Iterate on IMU configuration																
Test & collect data																
Improve UI/UX																
Slack / Testing																
Final Presentation Prep																
Demo																