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Project Proposal Rough Draft
November 9th, 2017

1. A Statement of the Problem:

Due to modern medicine, people are living longer than before. Which has resulted in a drastic increase in the senior citizen population. There exists a considerable population of senior citizens who have dementia or some other disease that affects their balance and coherence. If these senior citizens fall then they may need medical attention, as such it becomes necessary for them to be able to contact help. Several systems exist today that allow a fallen senior citizen to contact assistance. However, several of these citizens also have conditions, which make them unaware of their surroundings, and therefore they may be incapable of contacting help. Additionally, there is substantial evidence suggesting the longer a senior citizen is left unaided after a fall, their injuries will become more severe. As such, it becomes necessary to design systems that can detect when someone falls, and automatically contacts assistance, therefore minimizing their time left unaided.

2. Significance of the Problem:

Falls present a very serious issue for senior citizens with one fifth of all falls causing a serious injury. These injuries cost a large amount of both time and money. Annually 2.8 million people are seen in the emergency room for falls; 800,000 of them will need to be hospitalized for injuries received from that fall. These falls cost 31 billion dollars annually. Additionally, these falls cause serious injuries to senior citizens as 95 percent of hip fractures are caused from falling. These falls could also cause some sort of traumatic brain injury[1]. Furthermore, one in three seniors has alzheimer's disease or some other form of dementia at the time of their death. There are more than 5 million Americans currently living with alzheimer's and this number is projected to approach 16 million by 2050. These dementia patients are just as susceptible to falling as any other senior [2]. Medical devices such as life alert naturally assumes the user knows that they are wearing the device, and hence have the ability to interact with it. In the case of dementia patients, this assumption fails. Medical devices have been developed to contact assistance for fallen seniors, but these devices provide no post processing. Our ultimate objective is to add diagnostic capabilities to an autonomous fall detection algorithm. In doing so, we believe that we may significantly lower the amount of time, and money that society spends treating falls.

3. Objective:

Our objective is to develop an autonomous fall detection device targeted at senior citizens with dementia, however; the applications of the product reach far beyond the target market. This device will detect if the one wearing the device has fallen without need for user intervention. The device will then go through a list of contacts that the user specified when the device was purchased. A text message notification will be sent to each contact on the list. The device will continue sending messages until one of the contacts replies that they are available to help the fallen person. The device will also record the data immediately before the fall of the one wearing the device. This data will be analyzed and compared to hundreds of other samples of data for walking, running, etc. These samples will be from both high-fall risk and low-fall risk individuals. The significant differences in movement between the intended user, and the individuals who are not fall risks will then be evaluated. The results will then be sent to a designated healthcare professional. This will allow healthcare professionals to target specifically to what the user needs to improve on to greatly reduce their risk of falling. In addition, to providing the healthcare professionals access to unique movements of the user, artificial neural networks will be utilized to discover what the user was doing immediately before falling. This data will tell the healthcare professionals exactly what movements that the user is not performing optimally.

4. Project Plan:

To accomplish our objectives, we intend to design software drivers that will constantly record the user's movement data. This data will then be recorded if the user's movement data is consistent with a fall. Some of this data will be stored for later comparison and data analysis, otherwise the data will be overwritten. For a fall to be recognized initially the acceleration of the user must be both near the gravitational acceleration constant, as well as decreasing suddenly [1] then the device will assume that the user has fallen. The device will then use a Google account to send texts to the user's designated contacts. Once the device is capable of these functionalities, we will first distribute a prototype of the device to fall risk volunteers. These prototypes will be fully operational,however; they will also transmit the anonymized data immediately preceding the fall for statistical analysis. The data will then be analyzed by an artificial neural network. Additionally, several volunteers who are not at a risk of falling will be given the device. This must be done to establish a baseline muscle usage for low-fall risk individuals. Their movement data will be recorded, and the movements will be decomposed into individual muscle movements. Coefficients will then be calculated showing how each muscle is used in movement. After a typical range of these coefficients is developed, the device will start calculating the same coefficients for the fall risk patients. If the coefficient of muscle use, appears to be a statistical outlier, then is very likely that muscle is not performing optimally.

4.1 Timeline of Deliverables:

The table below shows a tentative schedule of assignments and milestones that need to be accomplished throughout this semester for the Self-Activating Fall Alert project. The table is currently just due dates that are pulled from the Electrical Engineering 497/498/499 course syllabus as well as completion dates for the project. The table can be found on the next page.

Table 1-1 Due Dates for Assignments and Milestones

Due Dates	Assignments/Milestones
November 9th, 2017	Rough Draft of Project Proposal
November 15th, 2017	Device Ready for Data Collection
November 16th, 2017	Rough Draft of Project Presentation
November 28th, 2017	Final Draft of Project Proposal
November 30th, 2017	Final Draft of Project Presentation
December 7th, 2017	Project Website with Deliverables
January 31st, 2018	Data Collection Started, if not earlier
February 15th, 2018	Midpoint Project Progress Self-Check
March 9th, 2018	Student Expo Registration
March 20th, 2018	ANN and Coefficients Tested
March 29th, 2018	Final Report
March 30th, 2018	Student Expo Abstract
April 5th, 2018	Poster Print
April 10th, 2018	Expo Poster Setup
April 12th, 2018	Expo Poster Judging
April 13th, 2018	Award Ceremony
April 17th, 2018	Final Presentation
April 26th, 2018	Class Picture
April 27th, 2018	IAB Poster Session
April 28th, 2018	Senior Project Conference and Reception?
May 1st, 2018	All Deliverables Completed and Uploaded to Website

5. Personnel and Resources:

Presently, the team has access to the full range of the Bradley University Electrical Engineering Department. This includes the primary advisor for this project Dr. Mohammad Imtiaz. Dr. Imtiaz is an Electrical Engineer specializing in the biomedical applications of artificial neural networks. The primary students assigned to the projects are Hayley Langley and Sean M. Miller. Sean Miller is a senior electrical engineering student who specializes in the biomedical applications control systems and signal processing. Hayley Langley is a senior level electrical engineering student who specializes in the biomedical engineering applications of robotics.

6. Current Progress:

Currently, the team is preparing the data collection device, so that we may begin the data analytics necessary for this project. This device will be the chosen prototype that is distributed to volunteers so that we may begin to establish typical ranges for muscle usage. At this time our device is made up of a 9DOF Razor IMU, a Bluetooth Mate Gold module, a 400mAh Lithium-Ion Battery, and a JST Connector (Male-to-Male).

7. Conclusion:

Ultimately this device could improve the treatment of falls; by giving the causes of the falls to health care professionals. This allows falls to be treated at the source. This could reduce the amount of falls, and therefore reduce the amount of effort society must spend on falls.

8. References

[1] https://www.cdc.gov/homeandrecreationalsafety/falls/adultfalls.html
[2] **https://www.alz.org/facts/**

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[1] A person suddenly ceasing to accelerate would be consistent with an impact. In this case we are assuming it means that the wearer has impacted with the ground.