



Gait Balance Detection and Analysis Using Smart-phone Application



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Abstract

This poster describes the components of a gait analysis framework in a smart-phone App. Gait detection is a major concern problem in the field of biomedical Engineering. This present work deals with gait detection using the help of the following devices: a 3-axial accelerometer sensor, an Arduino uno kit a GPS-GSM module, and a buzzer. The sensor analyzes the data stream coming from a (Microelectromechanical systems) MEMS tri-axial accelerometer to infer fall occurrences and to evaluate the gait quality. With the signals obtained, a new automated approach is developed for classifying (diagnosing) locomotive patients using features that may be extracted from their gait signal. For the analysis of different patterns, we use MATLAB. Arduino uno kit is an open source electronics prototyping platform based on flexible and easy-to-use hardware and software modules. The accelerometer helps in tracking human motion and it plays a vital role in gait detection. On the smart-phone side, the application is made of four major components: Background Service, Classification Engine, Notification System and Graphical User Interface. This is a research work in-progress where we are trying to also analyze and process the gait signals from PhysioNet's Gait in Neurodegenerative disorder public database that includes various kinds of diseases such as Parkinson's disease, Huntington's disease, Amyotrophic Lateral Sclerosis and Healthy control. With the signals obtained, in this study, we try to develop a new automated approach for classifying (diagnosing) locomotive patients using features that may be extracted from their gait signal.

Introduction

- According to the recent study of World Health Organization, approximately 28-35% of people aged 65 and over fall each year, increasing to 32-42% for those over 70 years of age.
- A fall detection system can be defined as an assistive device whose main objective is to alert when a fall event has occurred. Specifically, fall detectors can have a direct impact on the reduction in the fear of falling and the rapid provision of assistance after a fall.
- This work consists of the devices and their working function to detect and calculate the Gait balance which can also be useful for fall detection.
- Gait can be detected through various methods.
- This present work deals with gait detection using the help of these devices. : 3-axial accelerometer sensor, Arduino uno kit , GPS-GSM module, and buzzer .
- In this study, we evaluate different classifiers on the features that are extracted from gait signal of healthy persons and patients with three different movement disorders including Huntington's disease (HD), Parkinson's disease (PD), and Amyotrophic Lateral Sclerosis (ALS).

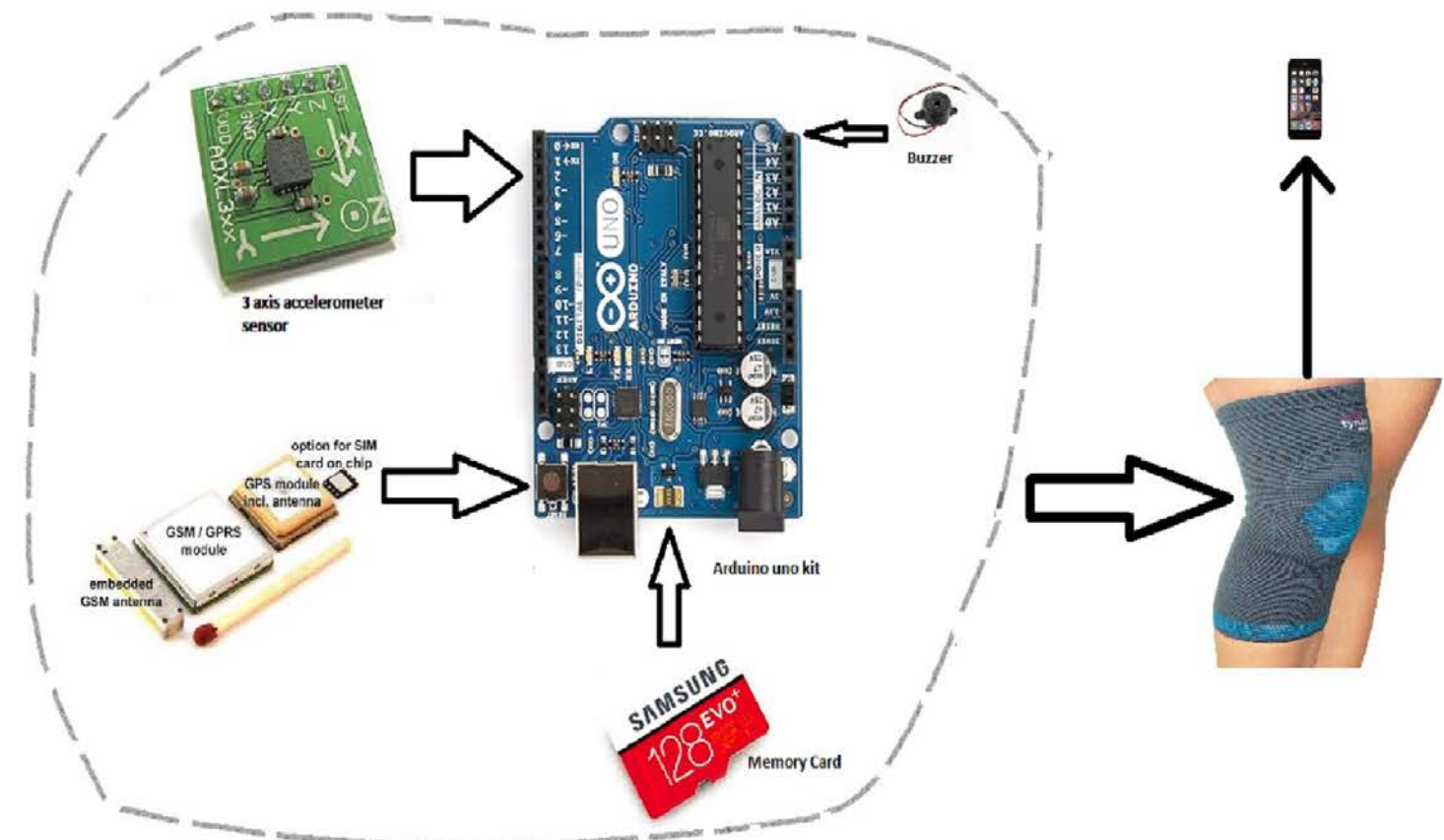


Figure 1: Fall detection prototype

Classification of Fall Detection

Context Aware System

- This type of system uses sensors deployed in the environment to detect the falls.
- Among all the possible types of sensors, the most common are cameras, floor sensors, infrared sensors, microphones and pressure sensors.
- There is a high variability in detection techniques as they are dependent of the type of sensor used. Examples include the ratio of the person's height and weight, the edge points from the silhouette of a person, changes in illumination, the orientation of the main axis of the person, the width, height and depth of the human posture, the skin color to detect the person in the image , etc.
- The features are then compared and classified to distinguish normal activities from real falls using different techniques.

Advantages

The main advantage of the above systems is that the person does not need to wear any special device. Another is that there is a privacy option when the video based sensors are used.

Disadvantages

The accuracy in detecting the fall is still low when compared with wearable devices. There is no standardized context-aware technique that was widely accepted by the research community in this field.

Wearable Devices

- Wearable devices can be defined as miniature electronic sensor-based devices that are worn by the bearer under, with or on top of clothing. Accelerometer is the major sensor used in the wearable device.
- i) Threshold-based methods (TBM) in which a fall is reported when the acceleration peaks, valleys or other shape features reach predefined thresholds.
- ii) Machine learning methods. Nearly both the studies concur that the broader categories of typical fall events are forward, backward and sideways, although some of them extend these categories to cover a large number of fall situations.

Advantages

Wearable devices are easily portable. The declared performance is very high when compared to other methods. In smart-phones we can create Apps which would analyze the fall and fall patterns .

Disadvantages

The fact is that there is little use of these devices in daily geriatric practice and no significant industrial deployment of fall detectors, mainly due to the significant number of false alarms, resulting in inappropriate alerts.

Fall Detection Prototype

- The three-axial accelerometer sensor measures the gait movements and angular deflection.
- When the fall is detected, a buzzer rings so that the people around the patient can get notified about the fall.
- A GPS-GSM module is installed to get the exact location of the person and an alert message is sent to a family member, doctor and/or ambulance.
- The gait signals can be viewed later for the diagnosis as it gets stored in the memory card of the smart-phone device. The prototype is mounted on the knee pad so that it can measure a proper angular deflection (Figure 1).

Signal Analysis and Feature Extraction

In this study, a gait signal database from PhysioNet website is used as inputs. The database includes data recorded from 15 patients suffering from PD, 20 from HD, 13 from ALS and 16 Healthy control subjects. Each record included two signals; left foot and right foot of the subject. The signals were first plotted and time domain features like Power Spectral Density (PSD), Peak and Mean values are computed and extracted.

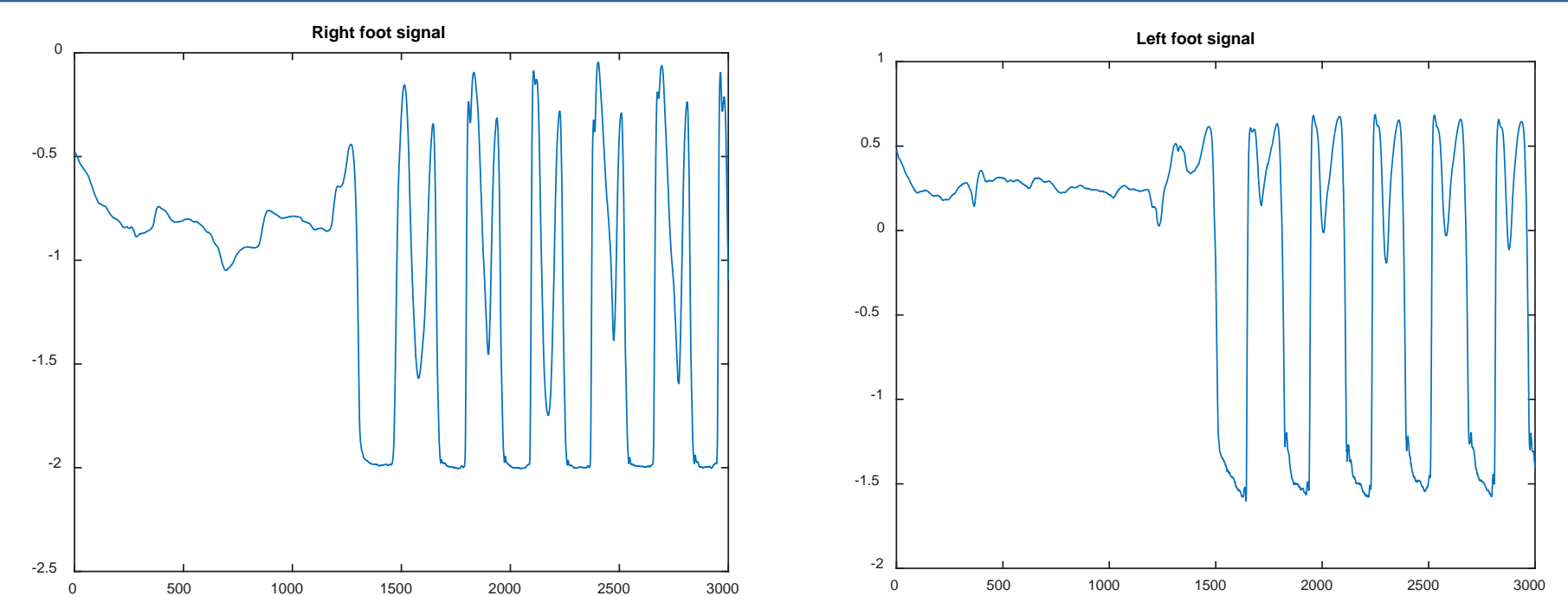


Figure 2-3: Left foot & right foot plot of PD

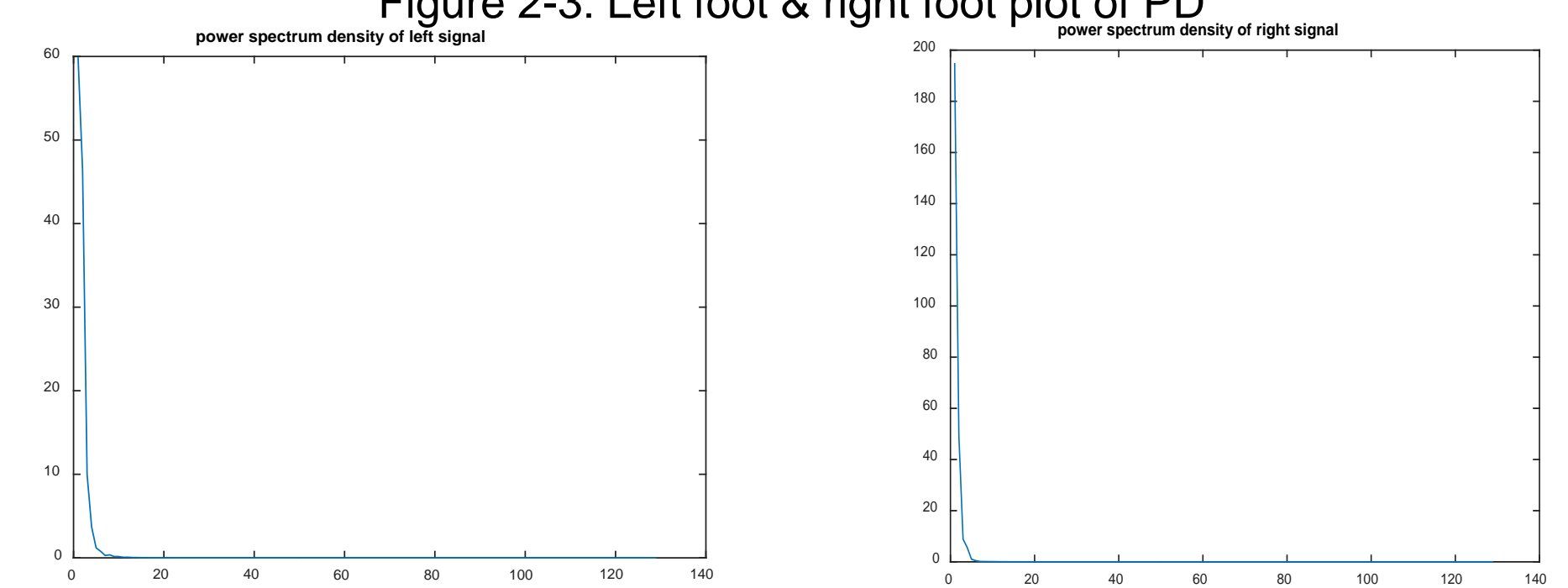


Figure 4-5 : PSD Plot of right and left foot

Conclusion and Outcome

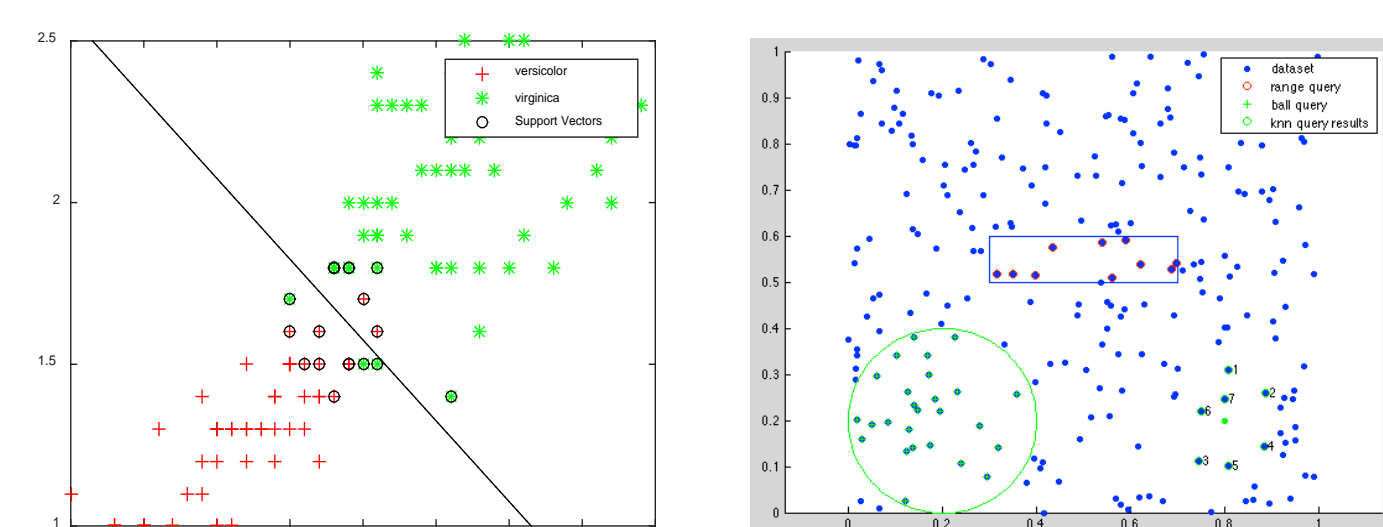


Figure 6: SVM and KNN classification

Fall detectors are essential in order to provide a rapid assistance and to prevent fear of falling and their adverse health consequences. The number of studies in vision-based systems is still increasing. Besides, there is a new trend towards the integration of fall detectors into smart-phones. Both biomedical engineers and clinicians should become aware of the limitations and potential of fall detection systems. This poster introduces a gait balance classification prototype, in an effort to detect the fall. The classification of gait signals is done with the help classifiers such as Support Vector Machine (SVM), K-Nearest Neighbor, (KNN), neural networks, and linear thresholding techniques. Although researchers have made great efforts to improve methods for fall detection, it still remains a complex process for which currently there is not a standardized solution.