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Feature Extraction using Principle Component Analysis on Wearable Multimodal Wireless Sensor Data used in Human Activity Recognition

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Abstract

The feature extraction and classification is an important stage in human activity recognition (HAR). In this paper, we discuss human activity classification using wearable multimodal wireless sensors in healthcare, especially in individuals with cardiovascular disease (CVD). We use majorly principle component analysis (PCA) on data collected using accelerometers and gyroscope data from subjects for 15 Local Muscular Endurance (LME) exercises. Well-known time domain and frequency-domain signal characteristic features are extracted and classification of best features is carried out with PCA. Supervised learning algorithms based with support vector machines (SVM) are used further for recognition of movement patterns.

1. Introduction

In delivering an effective rehabilitation programme for CVD patients the careful design and implementation of technical components is very much essential which can interact with the CVD patients, provide prompts and notifications, generate and evaluate the metrics. A module to automatically detect different exercises is one of the technical solution which requires automated feature detection and classification from the data captured.

2. Methodology

2.1. Data Capture

In this study Shimmer3, the robust, smallest wearable wireless sensor are used. They comprise of tri-axial accelerometers and gyroscope with a 3 MHz MSP430 CPU, Bluetooth connectivity for remote access and with a microSD card for local storage. Shimmers are verified and calibration using Shimmer 9DoF calibration v2.8. Low Noise Accelerometers and Wide Range Accelerometers with a range of ±16g and gyroscopes are calibrated with 2000dps. Shimmers were placed on left wrist, right wrist and on lower back of individual subject to continually capture the data at a sampling rate 512 Hz.

2.2. Segmentation and feature extraction

Segmentation was carried out checking for the initial start indication. With a suitable a 30 second data were segmented from each file as segmented data. Thus a 15360 samples on each dimension of each sensor is retained in the segmented part.

Figure 2 indicates the captured raw data using the low noise accelerometer from the left wrist and segmented data for Bicep curls.

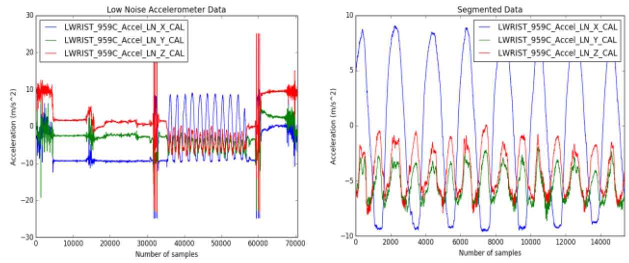
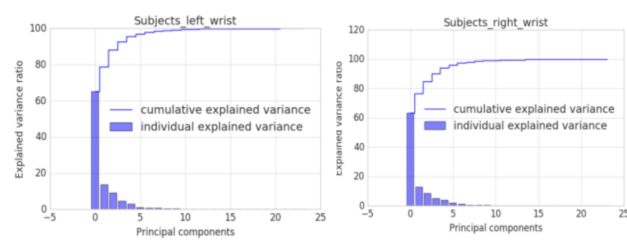


Figure 2. Low noise accelerometer data and A 30 second segmented data on x-axis.

A sliding window of size 512 with an overlap of 50% and with a step size of 256 is used over the segmented time series data. Time domain features like statistical mean, standard deviation, minimum, maximum, *rms* values on each axis of accelerometer data, Pearson correlation coefficients, Fourier coefficients, energy and entropy information on each axis is computed for each window. A Total of 24 features were computed. PCA is performed by calculating eigenvectors and eigenvalues from the covariance matrix obtained. Eigenvalues are sorted in decreasing order of significance. Singular Vector Decomposition is carried out and a decision is made to select 10 features. Eigenvectors with highest eigenvalues are the retained principle components of the segmented data set.



The features extracted from PCA are subjected to the linear supervised learning algorithm for activity classification mechanism using SVM.

3. References

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