Arm Movement Activity Based User Authentication in P2P Systems

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Abstract

User authentication has become an essential security element that enables a wide range of applications in P2P systems for higher security and safety requirements.

This paper presents a novel user identification system based on the bio signal analysis of arm movement (3-axis accelerometer & 3-axis gyroscope) and electromyography (EMG) signal using Myo armband as a wearable user authentication system in P2P system that identifies users based on the bio-signal of movement of a person's arm.

In this study, the gesture and EMG signals are obtained from the sensor and denoised using wavelet denoising algorithm. The denoised signals are analyzed using the envelope and cepstrum analysis for extracting the potential feature vector. Finally, the feature vector is used to train and identify a user using multi-class support vector machine (MC-SVM) with different kernel function for user authentication.

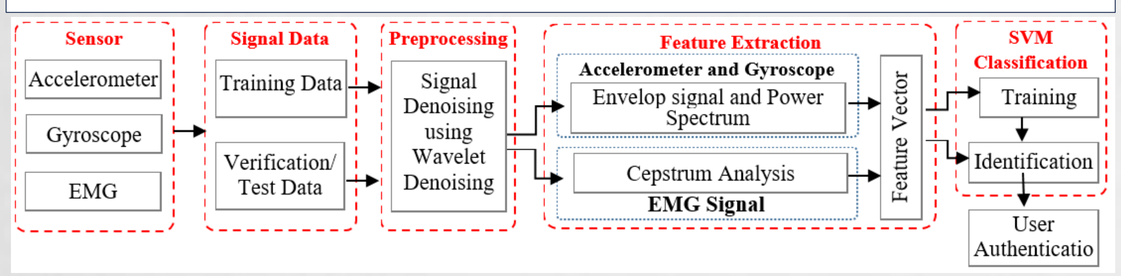
Introduction

In the recent decade, peer-to-peer (P2P) systems are increased dramatically, offering the possibility of sharing information, autonomy, and privacy. Within a P2P system, users connect with each other over the internet and share information directly between the systems on the network without the need for the client/server system. Each user of a P2P system works as a client as well as a server. However, the user requires to authenticate himself/herself when using P2P applications. It requires ID/password schemes which include P2P storages, personal identification number (PIN), backup, and social network. Security issues arise when user ID/password schemes used for authentication are stolen, e.g. by a hacker, and also the network protocols have some types of attacks such as insider, bit flipping, forgery, unfair key agreement attacks.

From this perspective, we propose an arm movement based user authentication on P2P system. A wearable device is introducing for a user authentication system in a P2P system, e.g., to determine whether a specific application should be user or whether such authorization should be rejected.

Proposed Method

This section presents the overall process of the proposed model including the signals of the Myo armband which is a wearable device with accelerometer, gyroscope and EMG sensors.



Data Collection, Preprocessing, Feature Extraction, and Results

The Myo armband is a device which has 8 dry and bipolar surface EMG pods and inbuilt accelerometer and gyroscope sensor and this sensor obtained the muscle activity near the waist, where the accelerometer and gyroscope sensor data sampled at 50Hz in 8 bits and EMG data at 200 Hz in 8 bits. Myo armband can be expandable between 7.5-13 inches (19 and 34 centimeters), which helps to fit with arm of almost everybody. It uses Bluetooth technology with 2.402-2.480 GHz frequency range for data transfer.

Figure 2. (a) 8-EMG pods, (b) position of the forearm, and (c) database system of Myo armband

We applied the wavelet de-noising technique to remove noise from the data. The signals are decomposed up-to 3rd level using wavelet decomposition.

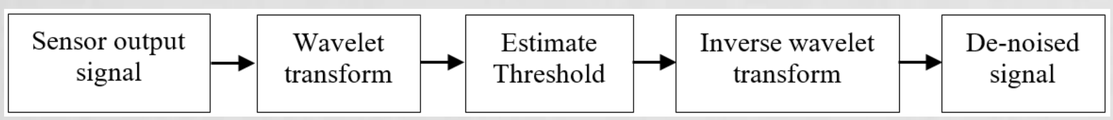


Figure 3. A basic structure for wavelet de-noising.

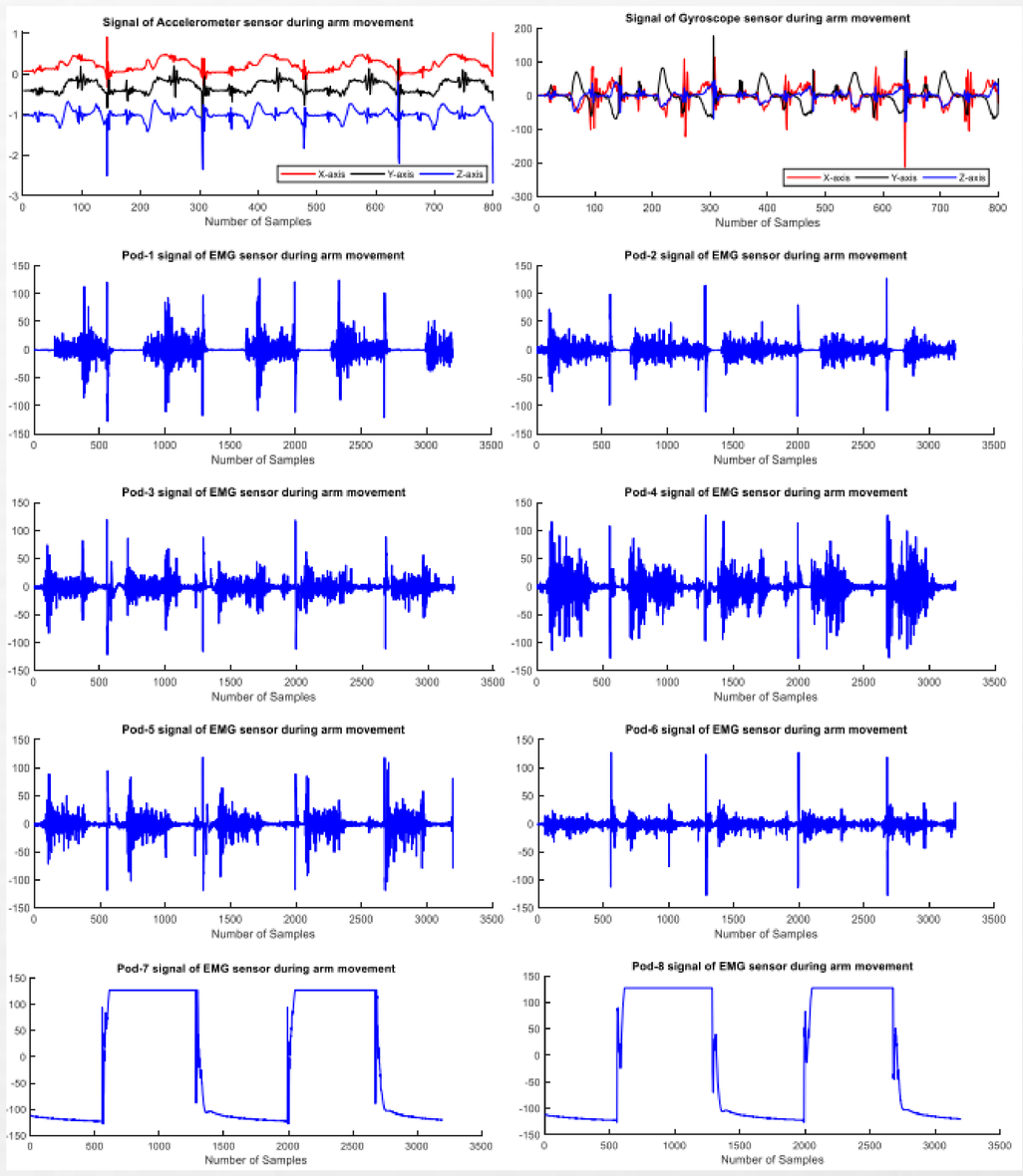


Figure 4. Example of 3-axis accelerometer, 3-axis gyroscope, and eight (8) EMG signals respectively

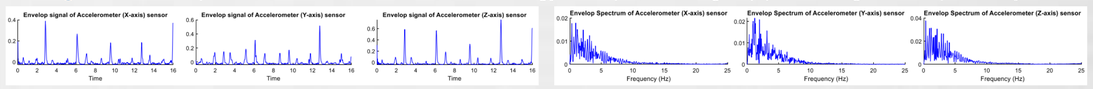


Figure 5. Envelope signal and spectrum of accelerometer (x, y, and z axis) signal.

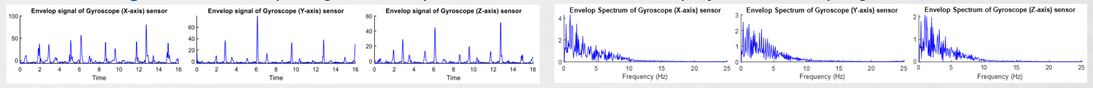


Figure 6. Envelope signal and spectrum of gyroscope (x, y, and z axis) signal

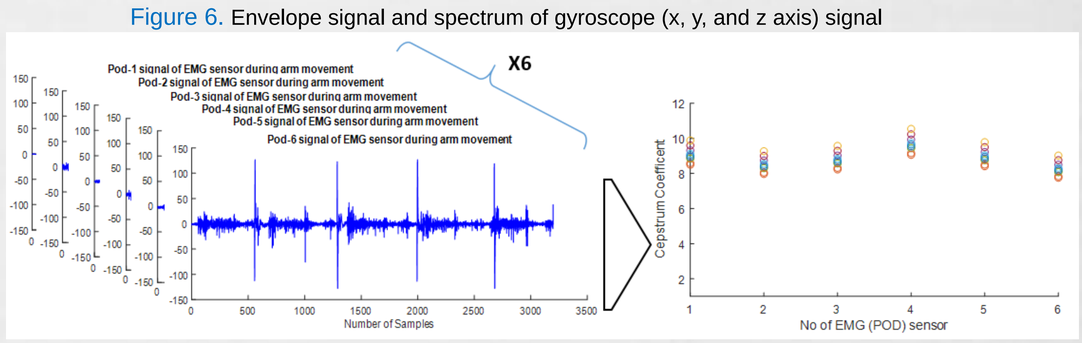


Figure 7. Cepstrum coefficient analysis using EMG Signals.

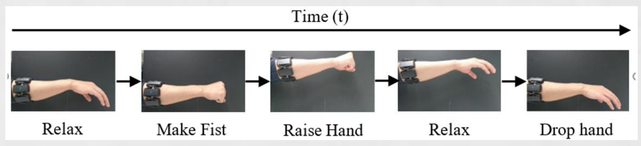


Figure 8. States of hand gesture.

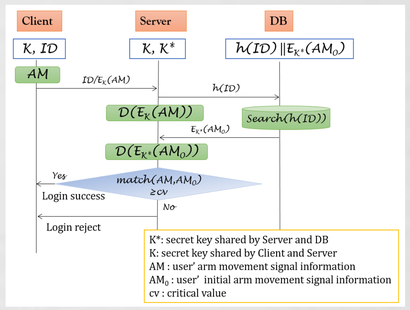


Figure 9. Arm movement signals based user authentication protocol.

Table 1. Classification accuracy using different kernels of SVM

SVM models	Average Classification Accuracy (%)
Linear kernel	97.23
Quadratic kernel	98.65
Cubic kernel	98.48
Fine Gaussian kernel	98.52
Medium Gaussian kernel	98.70
Coarse Gaussian kernel	95.16

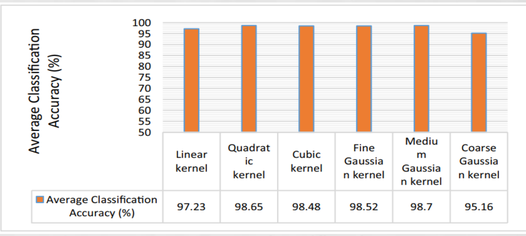


Figure 10. Average classification accuracy

Conclusions

In the modern era of information technology, the information security and cyber-attack is grate concern. Traditional user authentication system is outdated for verification. From this point of view, in this paper, a novel user authentication system is proposed based on arm movement bio signal analysis in a P2P system. In this proposed model accelerometer, gyroscope, and EMG signal are collected using Myo armband which has figured out arm movements and hand gestures using it in the user's arm.

Our proposed model shows 98.65% and 98.70% average classification accuracy using Quadratic SVM and Medium Gaussian SVM respectively.

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