DOI: 10.20396/revpibic2720192283

XXVII Congresso de Iniciação Científica Unicamp
16 a 18 de outubro de 2019 - Campinas | Brasil

Identification of hand gestures using pattern recognition of electromyography signals acquired with MyoArmband

Bruno G. Sgambato*, Gabriela Castellano

Abstract

The most used way to record hand gestures' information is through the Electromyography (EMG) technique. However, the research in the area is still fragmented. This study aimed at reproducing the high classification performance of hand gestures using EMG data reported in the literature, using a MyoArmband EMG equipment for data acquisition and an LDA classifier, and testing different features and feature selection techniques. The results showed that a performance of 75% is achievable with selected features.

Key words:

Electromyography, classification, hand gestures.

Introduction

Identification of hand gestures is important in many fields, since this information can be easily integrated to already existing technologies as well as provide ground for novel applications' development. Together with pattern recognition systems the elctromyography (EMG) biosignal has been shown to be capable of providing enough information for high gesture recognition rates.This study aimed at reproducing these rates, using a MyoArmband EMG equipment for data acquisition and an LDA classifier. The EMG biosignal is generated in the muscles during a contraction and measured via skin contact with three metal electrodes. The MyoArmband equipment (www.support.getmyo.com) uses 8 EMG detectors evenly spaced. It records the signal with a limited 100 Hz bandwidth and sends it via Bluetooth Low Energy (BLE) to a nearby capable device. Our aim was to use a supervised classification approach (LDA) in order to identify 5 different hand gestures (classes) from the MyoArmband signals.

Results and Discussion

Data from 8 participants were collected with the MyoArmband positioned right below the elbow. Each subject performed 5 hand gestures (Image 1) 10 times each in random order.

Image 1. Hand gestures performed; from left to right: double tap, fist, spread, wave in and wave out.

Subjects were instructed not to hold the gestures and to perform these naturally. To choose the appropriate features and classifier we resorted to a literature research. The LDA classifier appeared as one of the most robust, consistent, simplest and more computationally efficient methods[1]. The features chosen for test were: root mean square (RMS), mean absolute value (MAV), slope sign change (SSC), waveform length (WL), zero crossings (ZC), Willison amplitude (WAMP), cardinality (CARD), sample entropy (SampEn) and approximate entropy (ApEn)[2]. The classifier was trained with n features, where n ranged from 1 to 8. For each n all the possible feature combinations were tested; this was done in order to find the combinations that maximized separability and classification accuracy while evading overfitting in the model. The validation of the models was performed with an 8-fold cross validation with each fold containing one participant. This validation methodology is strict as the model needs to fit the intra-participant variability with no bias whatsoever. The best results for each n are shown in Table 1.

N	Acc ± std	Features
1	0.69 ± 0.11	CARD
2	0.72 ± 0.16	CARD,SampEn
3	0.74 ± 0.14	SSC,CARD,SampEn
4	0.73 ± 0.10	SSC,CARD,SampEn,ApEn
5	0.75 ± 0.10	SSC,ZC,WAMP,SampEn,ApEn
6	0.72 ± 0.10	SSC,WL,WAMP,CARD,SampEn,ApEn
7	0.71 ± 0.10	SSC,WL,ZC ,WAMP,CARD,SampEn,ApEn
8	0.68 ± 0.09	RMS,MAV,SSC,ZC,WAMP,CARD,SampEn,ApEn
9	0.64 ± 0.11	RMS,MAV,SSC,WL,ZC,WAMP,CARD,SampEn, ApEn

Table 1. Metrics for performance evaluation.

The best result is a 75% accuracy using 5 features.

Conclusions

We were able to replicate the results found in the literature and improve our understanding of the challenges and possible advances needed in this area. The follow-ups of this study are to improve its results by implementing new features, filters and classifiers; and to use the classification output as a control parameter for an electrical muscular stimulation (EMS) system for generating haptic feedback.

Acknowledgement

We thank FAPESP (São Paulo Research Foundation) and FINEP (Studies and Projects Financing Agency) for financial support.

[1]Chen, X., & Wang, Z. J. (2013). Pattern recognition of number gestures based on a wireless surface EMG system. Biomedical Signal Processing and Control, 8(2), 184–192.

[2]Phinyomark, A., Quaine, F., Charbonnier, S., Serviere, C., Tarpin-Bernard, F., & Laurillau, Y. (2013). EMG feature evaluation for improving myoelectric pattern recognition robustness. Expert Systems with Applications, 40(12), 4832–4840.