American Sign Language Recognition using Electromyographic Signals via Myo Armband

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Abstract

Human and computer interaction has become an important tool in the 21st century. One of the most promising technologies for human/computer interaction is speech recognition (SR) which is a system composed of microphones, soundcards and speech engine software in which isolate words, spoken by an emitter is recognized through calculation of a minimum prediction residual (Johnson et al., 2014). Nowadays there has been many studies around this form of technology but the hearing-impaired population cannot benefit from these advancements. This study proposes to address this problem by applying the Myo Armband, a wearable commercial band that captures Electromyographic signals (EMG) and tests its potential to correctly classify American Sign Language (ASL) gestures by applying a brain-computer interface methodology in which consist of three parts: data acquisition, signal processing and classification. This methodology was applied to three types of hand-gestures with the objective of extracting a mean power value for each sensor and compare it to experimental signals to determine if a correct classification was obtained. In the end, the brain-computer interface methodology was accomplished successfully, as it was possible to measure the power of every sensor. After finalizing the research, it is possible to say that the approach taken to satisfy the primary goal, which was recognizing the three gestures, was not accurate, as it did not reach a satisfying accuracy percentage. There can be many factors of why this happened. One can be the fact that the algorithm created and the approach of measuring the power of every sensor of the Myo Armband was not the indicated or the best to recognize EMG signals or that the sample experimental size was very small. One potential candidate to enhance the obtained results is to increase the number of experimental samples or to develop a new approach to process the obtained signals and enhance the classification.

Introduction

Communicating has always been important to mankind and as time passes by and technology improves, new and more creative ways of interaction and communication arises. For example, one of the most promising technologies for human/computer interaction, especially in healthcare, is speech recognition (SR) which is a system composed of microphones, soundcards and speech engine software in which isolate words, spoken by an emitter are recognized through calculation of a minimum prediction residual (Johnson et al., 2014). Nevertheless, this incredible technology does not benefit the hearing-impaired community because they communicate via sign language. This language is based on hand gestures, signs and body movements. Sign Language Recognition (SLR) is an alternative to SR but addressed to the hearing-impaired community, where it can predict via a computer software this incredible language. To do so the Myo armband was put to the test, a Thalmic Labs product that can read electromyographic (EMG) signals at 200Hz, which are defined as the electric potential of the muscles due to the muscle activation. These signals can help us detect what muscles are being used for different hand gestures and therefore characterize them for recognition.

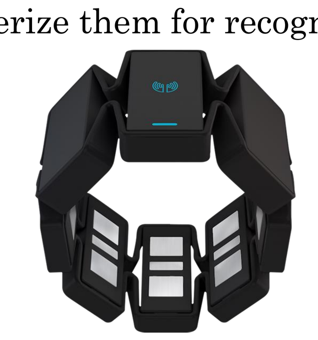


Figure #1: Myo Armband Image retrieved from: https://www.myo.com

Objectives

- Acquire the raw EMG signal utilizing the Matlab package Myo SDK Matlab Mex Wrapper by Mark Tomaszewski.
- Apply a feature extraction to the raw EMG signal.
- Recognize the following three different gestures.

Figure #2: This image demonstrates the three hand gesture performed in the research methodology.

Image retrieved from: http://cdn4.livelongandtravel.com/Hand-Gestures.jpg
Image retrieved from: http://cdn4.livelongandtravel.com/Hand-Gestures.jpg
Image retrieved from: https://www.istockphoto.com/photos/letter-o-in-american-sign-language?excludenudity=true&mediatype=photography&phrase=letter%20o%20in%20american%20sign%20language&sort=mostpopular

Methods

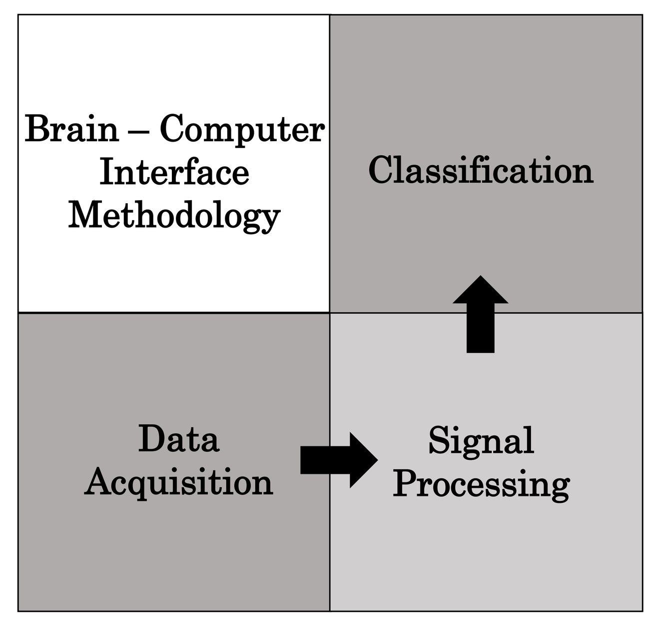
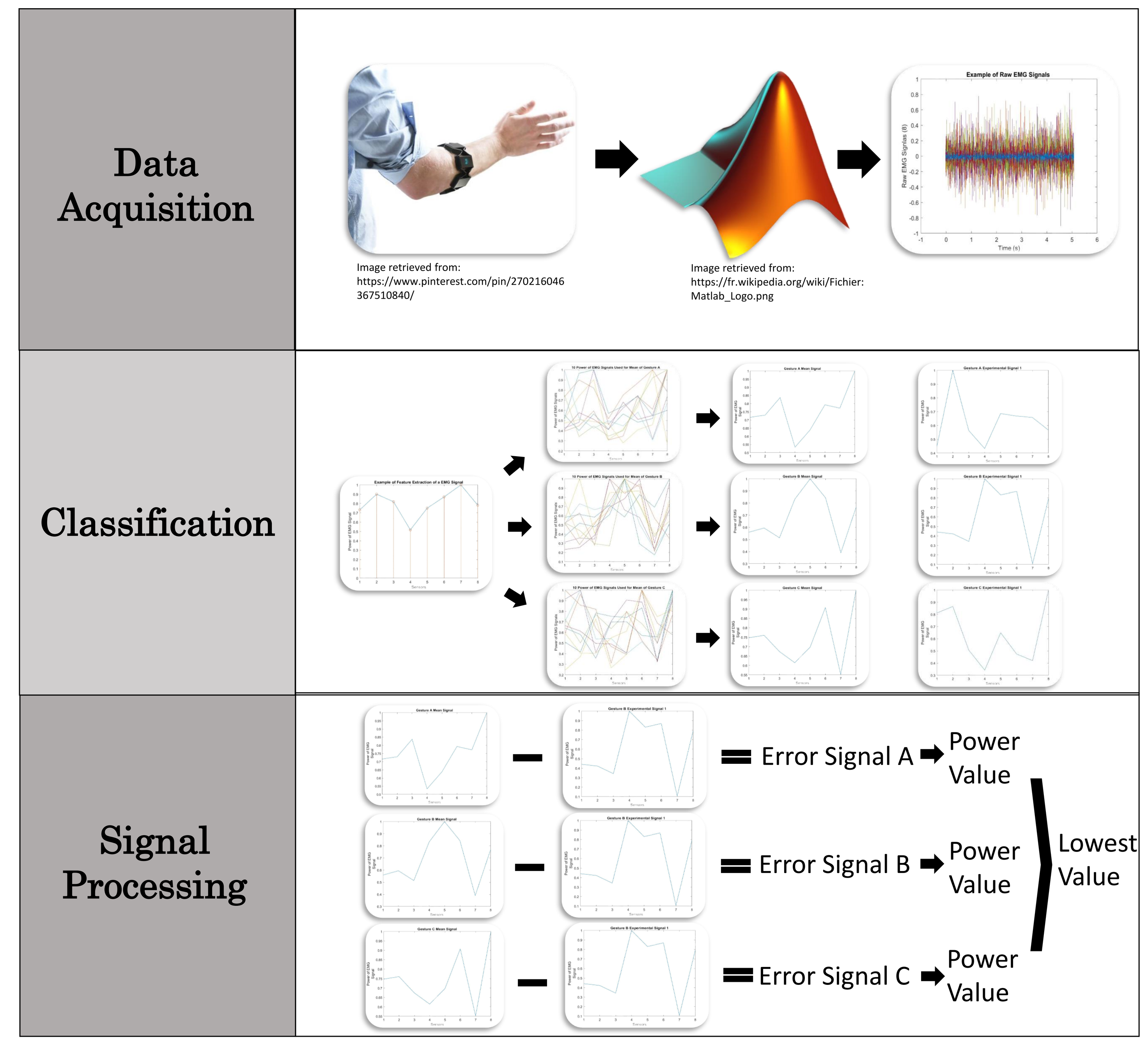


Figure #3: Visual representation of the brain–computer interface methodology employed in the research.



Data

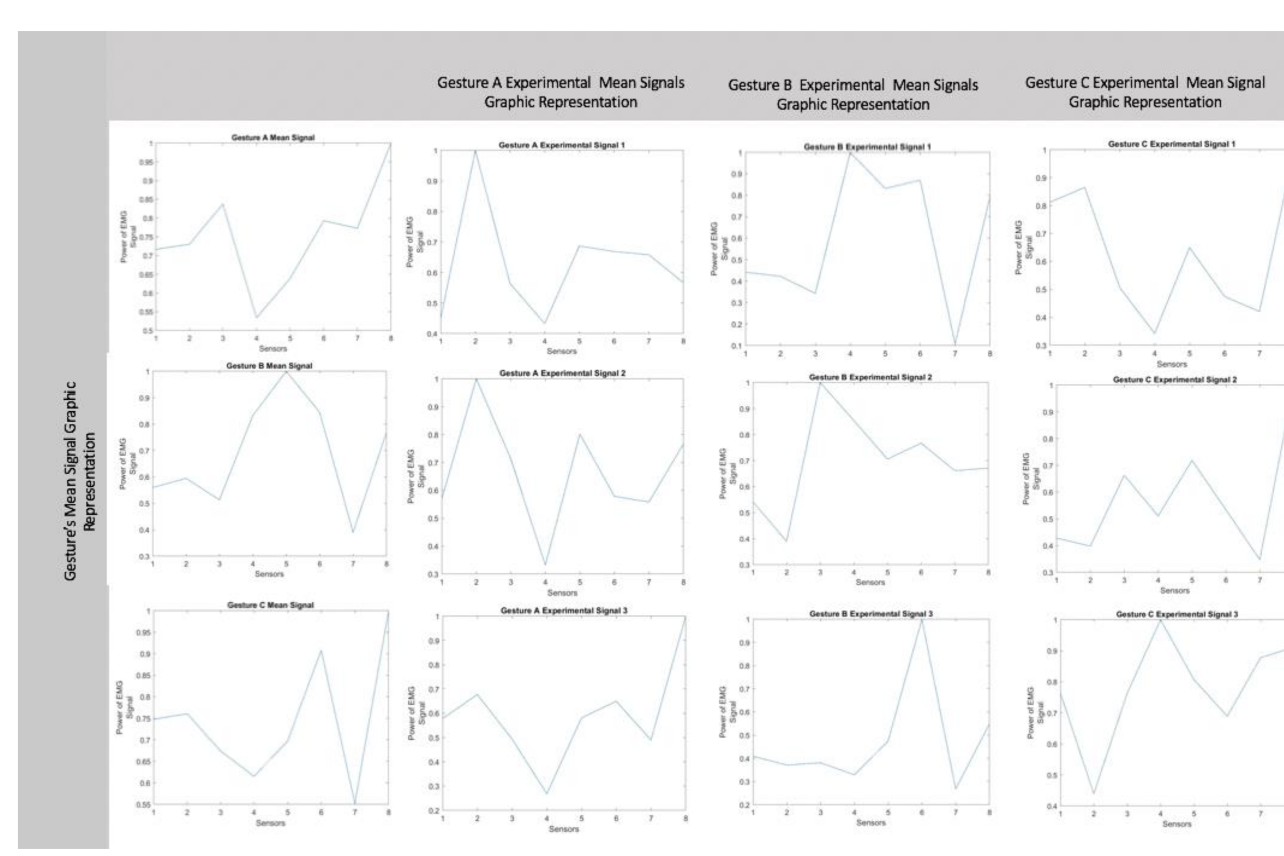


Figure #4: Demonstration of the model mean signals and the experimental signal of the three gesture employed to test out the Myo Armband after the signal processing phase. In the first column you can appreciate the mean signal graphic of gesture A, B and C, while later in the next columns respectively there are the experimental graphic representation of the three experimental gesture's made.

Table 1: Comparison for recognition of experimental signal gesture A with each signal model gesture

Signal Model	Experimental Power Value 1	Experimental Power Value 2	Experimental Power Value 3
Gesture A	0.0462	0.0374	0.0154
	Experimental Power Value 1	Experimental Power Value 2	Experimental Power Value 3
Gesture B	0.0788	0.0840	0.0757
	Experimental Power Value 1	Experimental Power Value 2	Experimental Power Value 3
Gesture C	0.0486	0.0420	0.0125

Table 2: Comparison for recognition of experimental signal gesture B with each signal model gesture

Signal Model	Experimental Power Value 1	Experimental Power Value 2	Experimental Power Value 3
Gesture A	0.1395	0.0539	0.0535
	Experimental Power Value 1	Experimental Power Value 2	Experimental Power Value 3
Gesture B	0.0215	0.0648	0.0481
	Experimental Power Value 1	Experimental Power Value 2	Experimental Power Value 3
Gesture C	0.0804	0.0666	0.0266

Table 3: Comparison for recognition of experimental signal gesture C with each signal model gesture

Signal Model	Experimental Power Value 1	Experimental Power Value 2	Experimental Power Value 3
Gesture A	0.0408	0.0323	0.0516
	Experimental Power Value 1	Experimental Power Value 2	Experimental Power Value 3
Gesture B	0.0953	0.0444	0.0579
	Experimental Power Value 1	Experimental Power Value 2	Experimental Power Value 3
Gesture C	0.0325	0.0282	0.0604

Analysis and Results

- Table 1 demonstrates the 3 values of power of the experimental error signals of the gesture A in which the first two values were correctly identified because the lowest value corresponded to the mean signal of gesture A. The power value of the third error signal of gesture A (represented in the fourth column) was mistakenly identified with gesture C which represents a negative result.
- Table 2 demonstrates the 3 values of power of the experimental error signals of the gesture B in which the power value of the first experimental error signal (represented in column 2) was correctly identified because the lowest value corresponded to the mean signal of gesture B. On the contrary, the power values of the second and third experimental signals of gesture B (represented in the third and fourth column) were mistakenly identifies with gesture A and C respectively.
- Table 3 demonstrates the 3 values of power of the error experimental signal of gesture C in which the first and second power values of the error signals (represented in the second and third column respectively) were correctly identified because the lowest values corresponded to the mean signal of gesture C. Nevertheless, the power value of the third error signal (represented in the fourth column) was not correctly identified with gesture C in fact, it was identified with gesture A.

Conclusion

- The brain-computer interface method applied was accomplished successfully, as it was possible to measure the power of the EMG signals of every sensor in the Myo Armband.
- The approach implemented for the classification of the signal was not accurate as it did not reach a high accuracy percentage in the recognition of a signal corresponding a specific hand gesture.
- There can be many factors that had a huge impact in the obtained results such as sample experimental signs and the amount of sample signals use to create the model mean signal.

Future Work

- Make more samples of each hand gestures applying the same methodology to see if this can influenced for better results.
- Study the best position to have the Myo Armband on the arm for signal acquisition.
- Apply a different methodology for signal processing.

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