Methodology for the multichannel recording of upper limb muscle activity

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Abstract. In the study of the functioning of the muscle, the study standard is to be able to analyze its behavior or functioning, this behavior is represented by a continuous signal where the muscle signal can be recorded and visualized, to perform this registration a designed circuit is required For the capture of electromyography signals, there are many options of these circuits in the market, depending on the application, the part of the body that is required to be analyzed, the best option can be chosen, in this work, we present a methodology for recording in Simultaneous 8 signals, for the characteristic use of the arm muscles, due to its special shape, which allows it to be placed in the form of a bracelet, the signals that are acquired simultaneously and individually, can be used in many applications depending on the problem and challenge, recommending for use on the arm and providing a clean signal allowing Being used in the design of detection mechanisms for some pathologies related to the arm muscles and in the design of control mechanisms for the design of prostheses.

1. Introduction

In the work related to the registration of biomedical signals, there are many options, among the most widely used is the design of its own circuit, in this sense it is necessary to work from the stage of acquisition, amplification, filtering and registration, this option allows the registration of a channel, understanding that a channel allows the registration of a muscle, if the registration is desired, it is necessary to have similar configurations depending on the number of muscles to be analyzed, a disadvantage of this option is the noise level in the signal, through which care must be taken throughout the design and development stage, the other option is to have an integrated device that records everything and provides us with the signal ready to work. Depending on the application and the use that we must give to the signal, we can choose the best option, making a review of the literature, we find works related to the recording of electromyography signals to analyze some

specific pathology, using embedded devices [1].

Depending on the application, you can choose to use surface electrodes and invasive electrodes that have to be placed inside the body, these electrodes that are in contact with the body are known as non-invasive electrodes and invasive electrodes [2]. Another mechanism for using signals is dedicated to the analysis of some muscle-related pathology, the most common of which is muscle fatigue [3]. Depending on the location of the muscle that needs to be analyzed, we can find designs with some characteristics to analyze the muscles of the upper or lower limbs [4].

The use of electromyography signals is used for the recording and subsequent analysis of muscle activity, in this sense it can be of help in the analysis of certain characteristic movements of the human body studied in human biomechanics [5] [6], having the I register the signal, the following procedure is the exploitation of the signal to try to find information contained in the signal, these procedures are known as digital signal processing, where they analyze the frequency, amplitude, phase among other characteristics of the signals. And it will depend on the use required [7] [8].

In this proposal, the use of the biomedical signal capture device known as MYO GESTURE is analyzed, where it is designed for interaction through the application of signals, our methodology is related to the simultaneous recording of the 8 channels that the device has , this registry is carried out continuously and independently, to be able to be used later in the diagnosis of any pathology [9] [10].

2. Materials and Methods

The methodology that we present is oriented in the description of the use and configuration of the MYO EMG device, so that it can be used from a mobile device, as well as making the respective registration for its later use, in figure 1, we present the block diagram of the methodology.
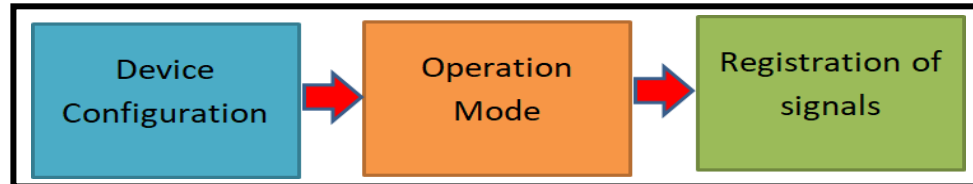

Figure 1: Block diagram of the proposal

2.1. Device Configuration

The configuration of the device begins with the download of the application from the repository depending on the operating system, after the installation the application is opened, to perform the configuration it is necessary that the device is turned on, to be able to access the connection via bluetooth, In figure 2, the application icon "MYO EMG VISUALIZER" is presented. This application allows us to register the 8 channels of EMG signals.
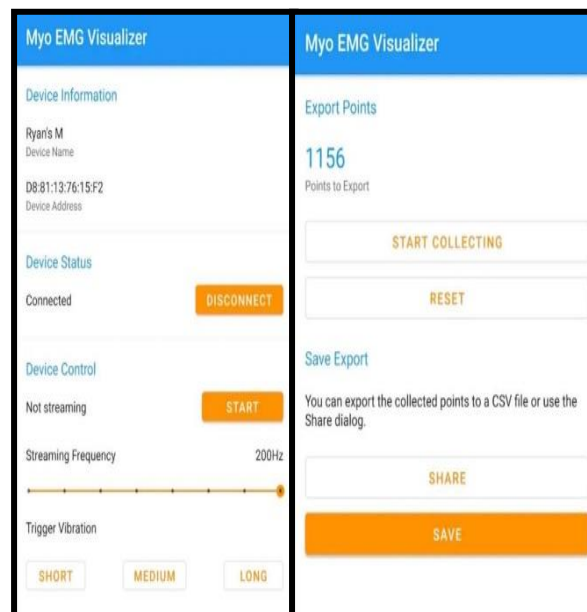

Figure 2: MYO EMG application icon

Figure 3: Configuration of the connection, recording and download of EMG signals.

After having downloaded the application, the next step is to connect the application with the device, this procedure is the same and similar to any connection via Bluetooth, after this connection, a screen is presented as shown in figure 3, where You have to configure the parameters of the signal acquisition, such as the frequency of registration, then the registration begins, when the registration is completed, a screen is displayed indicating the export of the registered signal, the application shows us It allows to export the signals corresponding to the 8 channels in CSV format, which is saved in the cellular equipment or to be able to export to email or another application. In figure 3, the screens corresponding to the configuration described are shown.

Having configured the application, it is placed on the arm of the person to be evaluated, according to figure 4, the location of the sensors must be taken into account for subsequent analysis.

Figure 4: Device configuration on the arm.

2.2. Operation Mode

The mode of operation is characterized by recording the EMG signal, by means of the device, in an action carried out by the person, in figure 5, the mode of operation is presented when it is desired to record the work of the muscles arm when manipulating the computer mouse, the idea is to present how the device should be located on the arm.

Figure 5: Device operating mode.

2.3. Registration of signals

When the registration process is finished, the file is exported in CSV format for subsequent analysis, at this stage, it depends on the experience and the use of computational tools that is mastered, in order to perform the signal analysis, in this In case it is necessary to be able to evaluate in advanced computer programs such as R, PYTHON, MATLAB, and also in the well-known and widely used EXCEL, the way the signal is presented is represented by a separation between columns, where each of them corresponds to a channel of acquisition, after the separation by individual channels, the analysis is carried out, in image 6, a sample of the signal of a channel is presented, an analysis of the shape of the signal can be carried out by means of a visual analysis, as well as being able to perform algorithms to analyze complex signal processing.
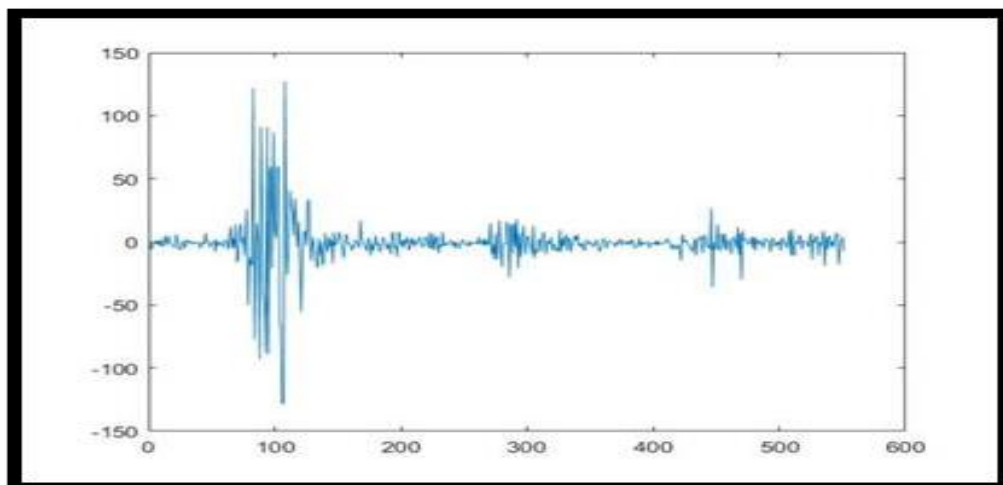

Figure 6: Recording an EMG signal.

3. Results

The results that are presented are represented in the form of the visualization of a continuous record of the 8 channels of the device, separating into an independent channel a vector of each signal is obtained, which can be shown by means of a graph, in figure 7, A sample of the record of the 8 channels is presented independently, each channel corresponds to a muscle, which can be analyzed according to the experience of the evaluator, as well as algorithms to evaluate the signals in a single channel or the 8 in simultaneous.

The simultaneous recording allows a complete analysis of the muscles that are present in the arm as well as its operation at the time of performing certain activities, depending on the application required, it is recommended to use devices that present a fine signal without the presence of noise , these devices are commonly used for more detailed control and analysis of muscle activity.
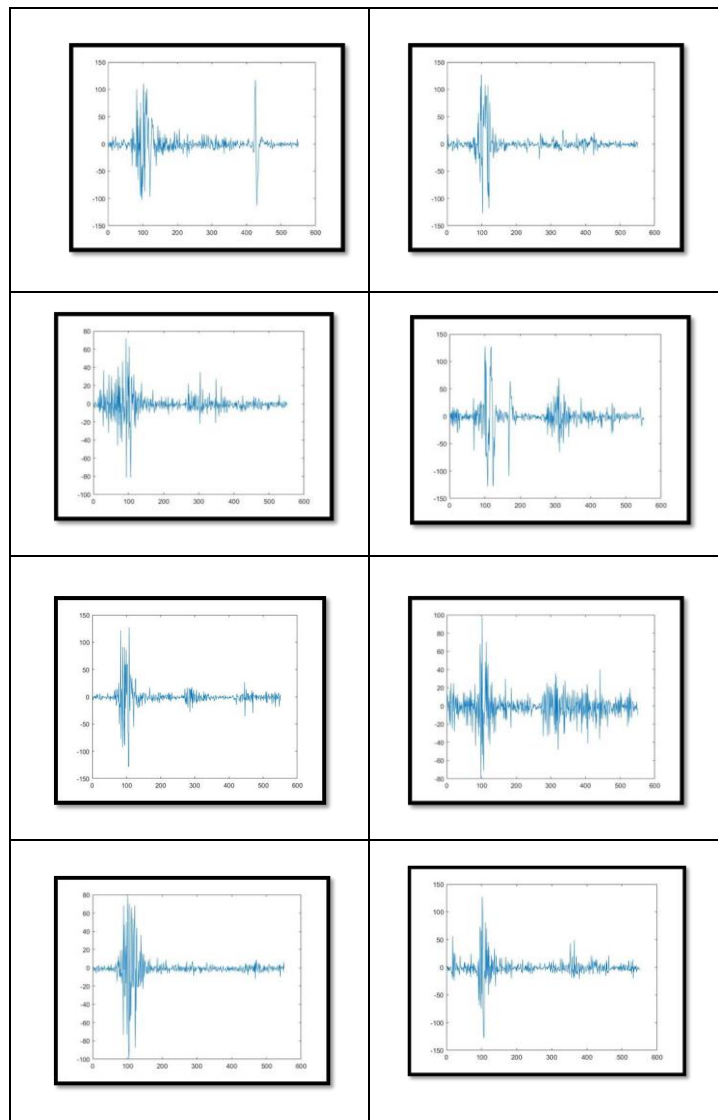

Figure 7: Visualization of the 8 signals simultaneously.

4. Conclusions

The conclusions that are reached at the end of this research are related to the recommendations that we can indicate, for the task of recording EMG signals, in order to know the analysis of the problem that leads us to use EMG signals, The first thing to know is the skills in the design of electronic circuits, if you have knowledge you can design your own signal acquisition circuit, in this case you must configure the use of medical grade amplifier circuits, in order to better signal / noise response, as well as considering the corresponding filters to be able to have a record of the signal without the presence of noise.

In the case that you do not have experience in the design of electronic circuits, it is recommended to use devices that present the signal clean and ready to work, in this case it is important to consider that for applications where it is necessary to have the signal that represents in the form Exact the behavior of the muscle, for which the investigation would concentrate on the analysis and exploitation of the signal, instead of using the available resources to clean the signal and obtain a better signal. The use of the circuits available to record any type of biomedical signal requires analyzing the type of use and application of the signal.

References

[1]   Wilver Auccahuasi, Gloria Rojas, Aly Auccahuasi, Edward Flores, Percy Castro, Fernando Sernaque, Ingrid Ginocchio, and Nabilt Moggiano. 2019. Analysis of a mechanism to evaluate upper limb muscle activity based on surface electromyography using the MYO-EMG device. In Proceedings of the 5th International Conference on Communication and Information Processing (ICCIP '19). *Association for Computing Machinery, New York, NY, USA*, 144–148. DOI:https://doi.org/10.1145/3369985.3370016

[2]   Angarita, J. I. G. (2009). La electromiografía: Un acercamiento al concepto fisiológico, la construcción de un equipo electromiográfico con registro no invasivo; y la resistencia galvánica de piel como método de relajación muscular (Doctoral dissertation, Universidad Tecnológica de Pereira. Facultad de Ciencias Básicas. Maestría en Instrumentación Física.).

[3]   Montoya, M. F., Muñoz, J., & Henao, O. A. (2015). Surface EMG based muscle fatigue detection using a low-cost wearable sensor and amplitude-frequency analysis-Detección de la fatiga muscular a través de un sensor wearable de bajo costo y análisis de amplitud y frecuencia de la señal EMG superficial. Actas de Ingeniería, 1, 29-33.

[4]   Carvajal, L. (2011). Diseño de un método para capturar señales mioeléctricas de miembros superiores. *Revista Universidad de Amazonas*, 1, 1-10.

[5]   Biomecánica de la actividad física y del deporte disponible en:http://www.futbolcarrasco.com/apartado/inef/3cursos/pdf, visitado el 15 de marzo 2011.

[6]   De luca, C.J, 1979, Physiology and mathemathic of myoelectric singnals. *Biomédical Engineering, IEEE Transactions on*, 1979(6): p. 313-325

[7]   Criswell, E., Cram's introducción to surface electromyography. 2010: Jones & Bartlett Publishers. Cobb, S. and A. Forbes, Electromyography Studies of muscular fatigue in man. *American Journal of Physiology*-- Legacy Content, 1923. 65(2): p. 234-251.

[8]   Gonzalo Méndez, Pozo; Facultad de Informática UCM, «PhD Thesis Gonzalo Méndez Pozo,» Septiembre 2008. [En línea]. Available: http://nil.fdi.ucm.es/sites/default/files/GonzaloMendezPhDThesis.pdf. [Último acceso: Mayo 2016].

[9]   Thalmic   Labs,   «Present | Myo   Gesture   Control   Armband,»   Available: https://www.myo.com/present. [Último acceso: 01 Junio 2016].

[10]   Thalmic Labs, «Myo Support: how to perform the sync gesture,» [En línea]. Available: https://support.getmyo.com/hc/en-us/articles/200755509-   How-to-perform-the-sync-gesture.[Último acceso: 10 Mayo 2016]