Optimization and classification of EMG signals through Pattern recognition methods

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ABSTRACT

This paper presents a study based on the response optimization of an electromyograph through processing techniques for the analysis of surface electromyographic signals, in order to provide a useful tool as a strategy for the diagnosis and prognosis of clinical symptoms of muscle diseases (e.g. for patients with foot drop). The patients were previously diagnosed by physiatrists, seven of them were healthy and five showed foot drop neuropathy.

Keywords: EMG, FFT, MLP, PCA, foot drop, PNN

1. INTRODUCTION

Electromyography is a method of recording and analyzing bioelectrical activity in the skeletal muscle oriented to a diagnosis of neuromuscular diseases. In the mid-twentieth century it was introduced the first commercial computer electromyography for medical use, it was based on analog electronic circuits. Further development of digital technology has allowed using expert systems controlled by microprocessors increasingly reliable and powerful to capture, represent, store, analyze and classify the myoelectric signals (Khushaba et al., 2012). The advance of new technologies of information and communication could lead in the near future to the application of artificial intelligence developments that facilitate the automatic classification of signals and expert systems of support to the electromyographic diagnostic (Jung et al., 2012) y (Rogers et al., 2011).
The aim of this paper is to optimize the response of an EMG with surface electrodes, used in patients with foot drop through data processing techniques and pattern recognition methods ((i.e. Principal Component Analysis (PCA) and Neural networks) for classification of measures (Park et al., 2006) y (Da Silva, 2011).

2. EXPERIMENTAL

The signals were acquired from isometric contractions in the tibial anterior muscle during a time of four seconds, with a sampling frequency (Fs) of 10 kHz. The signal was recorded on a computer, which was monitored constantly and then later stored for further respective analysis. The software used for data acquisition and analysis was the Matlab R2009a.
In total 60 samples were obtained and for each patient 5 test were performed. The set of measurements were obtained from a sample of 12 people.

2.1 SIGNAL PROCESSING

The PCA method reduces, represent and extract relevant information of the data set and at the same time to see if they can identify clusters spontaneous between different measurements made previously [4-6]. For implementing the PCA algorithm, the columns of this matrix (variables) must be previously normalized. In this case we used the data-centric approach or "*Mean Centered*". The Multilayer Perceptron (MLP) and Probabilistic neural networks (PNN) were used to classify the set of EMG signals of patients with foot drop.

2. RESULTS

By comparing the characteristics of frequency (see Figure 1) between a healthy patient and another injured patient, it is observed that the spectrum of a healthy patient (wave with greater amplitude) has greater frequency value and greater amplitude value than the spectrum of the injured patient (wave with smaller amplitude), according to the graphs obtained from a healthy patient, the highest frequency value ranges from 0 to 1000 Hz, while the patient with injury ranges from 0 to 500 Hz.

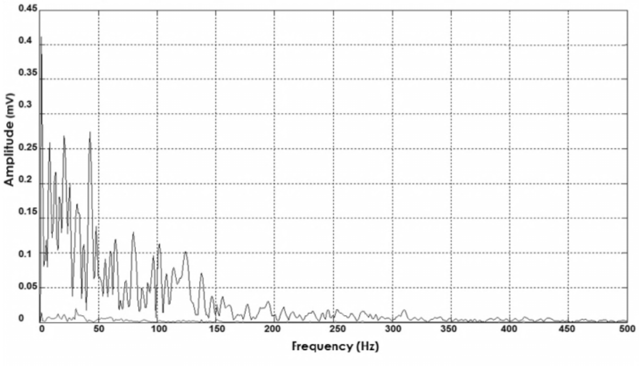

Figure 1. Fourier spectra of comparison from a healthy patient vs injured patient.

Figure 2 shows the result PCA, which we can highlight that patients could be distinguished from healthy to injured, and samples of each one.

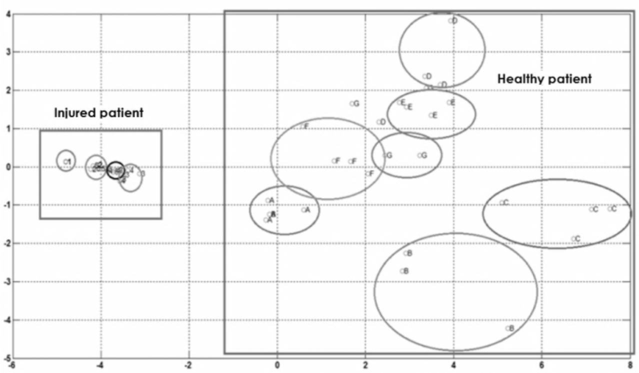

Figure 2: Principal Component Analysis Result.

Table 1 shows each classification answer of all 60 measures and 12 categories, using neural networks, where different groups were conducted in order to determine the success rate in the classification.

Table 1: Measures Classification

Number of Categories	**Classification Case**	**MLP Red**	**PNN Red**
12	All patients	40 %	80 %
7	healthy patients	60 %	94,3 %
5	injured patients	64 %	68 %
2	Patients in good condition and injured	100 %	100 %

In most cases a better response is achieved with the PNN network and a classification rate of 100% accuracy with both types of networks.

3. CONCLUTIONS

Through the Fourier Transform we succeeded in obtaining a relevant characteristic in the data set and the response signals from injured and not injured patients. PCA technique and Neural Networks (i.e., PNN and MLP) proves to be a useful tool with further study and precision for the EMG signal, and further serves of methodical and empirical support obtaining to discriminate the samples of healthy patient with those affected.

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