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A Review on EMG Signal Classification for neurological disorder using neural network

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ABSTRACT : *Specialists diagnose the neuromuscular diseases using visual inspection of the recorded Electromyogram (EMG) of the patients and compare their shape and key points to the standard ones. This paper represent the review on implementation of EMG classification of recorded signals from bicep muscles. The signals are collected from various patient group like normal, mayopathic and nueropathic during 25%, 50% and 75% muscles contraction. This recorded signals is then processed to extract some predefined features as input to the nueral network. The time and frequency based extracted features are use to train the nueral network. The trained nueral network will classify these signals using decompositioning the EMG signals.*

Keywords *: Electromyogram(EMG), motor unit action potentials, neural networks, chaos, BPNN(Back Propogation neural network), RNN(Radial Basis function neural network).*

I. INTRODUCTION

Skeletal or voluntary muscles constitute the principal organ of locomotion. There are more than 600 separate muscles in the human body, which constitute 40% of weight in the adults [6]. EMG can be defined as a signal that records the electric activities generated by the depolarization of muscle cells during muscle contraction, and the nerve impulses that initiate the depolarization of the muscle. The EMG signals is a type of neural signal which find its application in various applications, such as: diagnoses of neuromuscular diseases, rehabilitation through controlling assistive devices like prosthetic orthotic devices and for human computer interfacing. The quantitative analysis of EMG signals also provides an important source of information for the diagnosis of neuromuscular disorders. However, there are a numbers of physiological processes which may complicate the interpretation of the recorded EMG signal. A large variation in EMG signals can be observed, having different signatures depending on age, muscles activity, motor unit paths, skin-fat layer and gesture style. Compared to other biosignals, EMG signal contains complicated types of noise that are caused by inherent equipment and environment noise, electromagnetic radiations, motion artifacts and the interaction of different tissues. Sometimes it is difficult to extract useful features from the residual muscles of an amputee or disabled. This difficulty becomes more critical when it is resolving multiclass classification problems. To maximize the classification accuracy, many researchers have studied various types of different statistical and learning algorithm-based classifiers. Beside this, number of researchers have attempted to extract more information from the EMG signals to help the classifiers for better classification of user's intended motion. A variety of signal features representing both amplitude and spectral property have been used to supplement the information given to the classifier and have been shown to increase classification accuracies.

Although a number of EMG signal decomposition and analysis have been developed so far, some of them are commercially available, none of them got wide acceptance for extensive clinical use. A hybrid visual-computer decomposition scheme based on template matching and firing statistics for MUAP identification have been studied by DeLuca and LeFever [1], [2]. Two different pattern recognition techniques are presented by Christodoulos I. Christodoulou and Constantinos S. Pattichis : i) an artificial neural network (ANN) technique based on unsupervised learning, using a modified version of the self-organizing feature maps (SOFM) algorithm and learning vector quantization (LVQ) and ii) a statistical pattern recognition technique based on the Euclidean distance.13 subjects suffering from myopathy, and 15 subjects suffering from motor neuron disease were analyzed [3].

II. METHODOLOGY

In the current study the multichannel EMG signals are recorded from biceps muscles of normal (NOR), Mayo (MYO) and neuropathy (MND) subjects. This signals segmented using an algorithm that automatically detects the areas of low activity and candidate MUAPs [3]. From this segmented data the clusters of different patient groups are constructed and plotted. Furthermore, the time domain, autoregressive (AR) and Correlation dimension, for calculating the chaos, features of MUAP clusters are extracted and are given to a neural network (NN) classifier for their classification into NOR, MYO and MND classes. Finally, the performance of NN classifier with time domain, AR parameters and chaos will be compared. The detailed steps for implementation are discussed below

III. DATA ACQUISITION AND PRE-PROCESSING.

Data has been generated for Normal, Myopathic and Neuropathic subjects using the simulator published as: Hamilton-Wright A, Stashuk DW. Physiologically based simulation of clinical EMG signals. IEEE Trans Biomed Eng, 52: 171-183, 2005. Myopathic/Neuropathic data has been simulated for 25, 50 and 75% fibre/motor unit involvement. Each study contains 5 contractions; each is in the range 7.5-12.5 MVC. All this data are collected form biceps muscle. The biceps muscle recording arrangement is shown in figure below

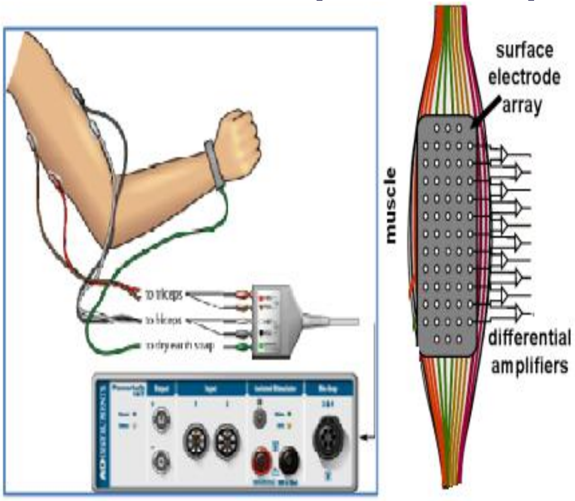

Fig.1 Arrangement multichannel Biceps muscle recording.

Segmentation:

The EMG signal cut into segments of possible MUAP waveforms to eliminate areas of low activity [3]. The segmentation algorithm basically calculates a threshold depending on the maximum value and the mean absolute value of the whole EMG signal, The Threshold T is calculated as:

If $\max_i \{x_i\} > (30 \div L)\sum_{i=1}^{l} |xi|$ then $(5 \div L)\sum_{i=1}^{l} |xi|$

else $\max_i\{x_i\}/5$

Clustering:

In this technique the Euclidian distance is used to identify and group similar MUAP waveforms [4]. The group average is continuously calculated and is used for the classification of MUAPs using a constant threshold.

Feature Extraction:

The time domain, AR parameters and correlation dimension features are calculated. The following time domain parameters are computed from the MUAP waveforms: Spike duration: measured from the first to the last positive peak. Amplitude: Amplitude difference between minimum positive and maximum negative peak. Area: Rectified MUAPs integrated over the calculated. The autoregressive (AR) model a current signal x(n) is described as linear combination of previous samples x(n- k) weighted by a coefficient . A common strategy to calculate the AR coefficients is to use the Burg's algorithm. It provides an iterative and fast method to figure out the parameters of the AR-model adaptively. We have used this method in our work to find the AR coefficients a0 to a2 of a 3rd order AR model. For the correlation dimension GP (Grassberger and procaccia's) algorithm will be used to characterize the dimensions produce by chaotic sytem.

Classification:

In order to classify the clustered MUAPs into NOR, MYO and MND classes, a NN classifier is employed. BPNN or RNN can be used for the classification of EMG signals. The overall classification rate for BPNN is 88% For PNN, the overall classification rate is slightly higher,89.33% [7]. Statistically, RNN is a better classifier compared to BPNN according to the classification rate achieved in the experiment [7]. Nonetheless, BPNN still has its own advantages which beat against RNN. For real time application, BPNN is a better choice since it has faster performance when dealing with new cases.

IV. FUTURE WORK

One of the best neural network tools will be developed for online classification of EMG signal for muscular diseases. With the help of neuromuscular human expertise the classified result will be verified for different pathologies. The optimized neural network tool will be developed for estimating the better result of classification of different muscular disease [5].

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