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Classification Of Emg Signals For Muscle Disorder Diagnosis

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Abstract
Electromyogram is one of electrophysiological recording methods. Many people are likely to be familiar with other electrophysiological recording methods: Electroencephalogram for the record of electrical movement across the scalp, and Electrocardiogram for the record of the electrical activity of the heart, Electromyography is a method for measuring and recording the electrical activity provided by skeletal muscles. The electromyographic signal is essentially the voltage stimulation arising due to ionic flow through the films of the muscle cells, when this human cell gets electrically or neurologically stimulated. Next, based on the electromyography signal, one can analyze the simple natural rhythms of muscles. From that, one can further deduce the neural motion of the spinal line and possibly the focal sense system. The signal of electromyography can be separated to study neuromuscular disease, such as: stroke and Parkinson's disease.
Keywords: *Nervous System, Muscles, Fourier Analysis, Electromyography.*

INTRODUCTION

Neuromuscular disorder affects a majority of world's population and deteriorates the quality of life. It is the name given for disorders of any area of the nerve and muscle [1]. They are differentiated on the basis of features such as pattern of inheritance, origin of the gene mutation, incidence, symptoms, age of onset, progressive rate, and prognosis. The Neuromuscular System is a complex physiological system consisting of the muscular system and the nervous system. The neuromuscular system is a highly intricate electromechanical system with interrelated variables and different subsystems [9]. The neuromuscular system consists of motor units consisting of motor neurons, Schwann cells, neuromuscular junctions and various muscle fibers stimulated by the motor neurons. The neuromuscular junction is classified into three categories such as presynaptic, synaptic space and post synaptic regions. The electrical currents generated by the neuromuscular is measured either by placing Surface Electrodes (SE) on the surface of the skin or Needle Electrodes (NE) that are put inside the muscles. Acquisition of EMG signals using needle electrodes is painful and uncomfortable for the patients, whereas acquisition of EMG signals using surface electrodes is comfortable to the patients but, in some rare cases, skin irritation occurs [3]. Methods of information analysis have, recently, been used in the selection of electrodes for electrophysiological measurement. The electromyograms are chaotic, non-linear, and non-stationary in nature, so the diagnosis of the disorders using electromyograms is done using quantitative analysis techniques [2]. Thus, proper analysis of EMG signals requires the development of computer-aided diagnostic systems that utilize techniques such as feature extrication, feature reduction, and development of classification systems. Furthermore, Genetic Algorithms (GA) have been used to construct evolvable hardware devices that correlate certain hand movements with EMG data.

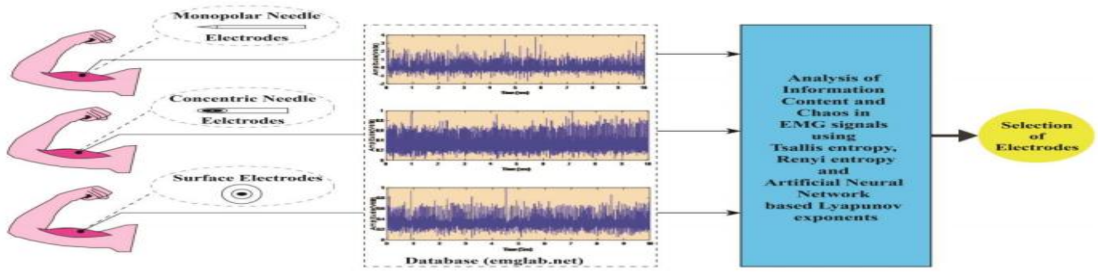

Figure 1: Analysis of Information Content

It is usual to describe EMG amplitude in terms of rectifying and averaging the signal in some way since the user tends to be specially concerned with the amplitude of the signal. The nervous system, composed of a vast array of excitable, interconnected cells termed neurons, acts as the body's network for communication and control. These neurons convey electrical signals that allow for rapid and accurate communication across different parts of the body.

REVIEW OF LITERATURE

Almost after 35 years from the initial description of sEMG by Hermes et al. [10], studies on computerized analysis of EMG continues to date in order to fully elucidate the true applicability of sEMG in the clinical environment[5]. To extract quantitative data and categorize the EMG signals for identifying various neuromuscular diseases, the appropriate and suitable features need to be chosen to develop the feature vector. In order to overcome the challenge of automated extraction of meaningful properties from EMG signals and to describe them, a feature descriptor that can effectively capture the overall structural properties of the signal is strongly desired [5]. The choice of effective tools for feature extraction and classification is a major challenge in this research field. A first observation of the literature is that a lot of the earlier work has been focused on constructing Time Domain (TD), Frequency Domain (FD), and Time-Frequency Domain (TFD) features to construct the feature vector. Timedomain features are very noise-sensitive because they are predominantly signal amplitude-dependent. Frequency domain features can provide improved classification accuracy only when combined with TD features [4] . TFD features can also enhance subject-dependent classification accuracy. In order to obtain a reliable classifier output, feature descriptors must be close within a class and widely separated across various classes. It is evident from the literature review that various significant types of studies have been conducted to discriminate between normal and pathological EMG signals [6] . It is important to consider that much little effort has been put forth in the domain of progressive monitoring of the skeletal muscles' status [11]. It was such loopholes that compelled us to propose a structured methodology to derive refined features from EMG signals and investigate the behavior of the refined features under normal and disease-causing conditions with a view to form new EMG signal classification strategies.

MATERIALS AND METHODS

Electromyography, or EMG for short, is the investigation of the electrical impulses from muscles. Surface electromyography is one method that captures the data of these muscle action potentials. The second issue is signal distortion, which means that the relative contribution of every frequency component to the EMG signal should not be altered. Muscle signals are detected by two types of electrodes: invasive and non-invasive electrodes. If EMG is detected from electrodes placed directly on the skin, the resulting signal is a blend of all muscle fiber action potentials occurring in the muscles beneath the electrodes. These action potentials occur at random time intervals so the EMG signal alternates between positive and negative voltages at any instant. Single muscle fiber action potentials can be detected with wire or needle electrodes that are inserted directly into the muscle [7-12]. The motor unit action potential (MUAP), the total of the action potentials of all the muscle fibers within a single motor unit, can be recorded with either an invasive needle electrode placed within the muscle or a non-invasive skin surface electrode placed nearby.

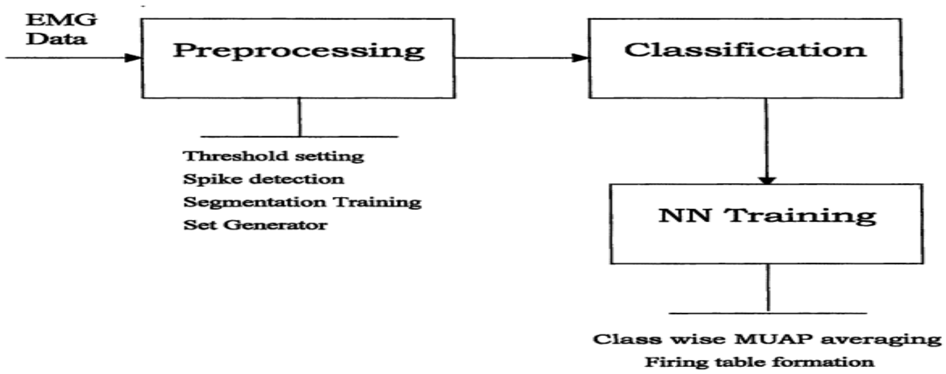

Figure 2: Proposed design

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Neuronal signals cause skeletal muscle contraction, which is often voluntary. For contraction, skeletal muscle fibers get a plentiful supply of neurons, particularly motor neurons, which are in close proximity to the muscle tissue but do not form a direct connection with it. Multiple muscle fibers can be stimulated by a single motor neuron [8].

RESULT AND DISCUSSION

However, because of differences in ionic concentrations throughout the plasma membrane, the membrane of nerve cells displays polarization when at rest.

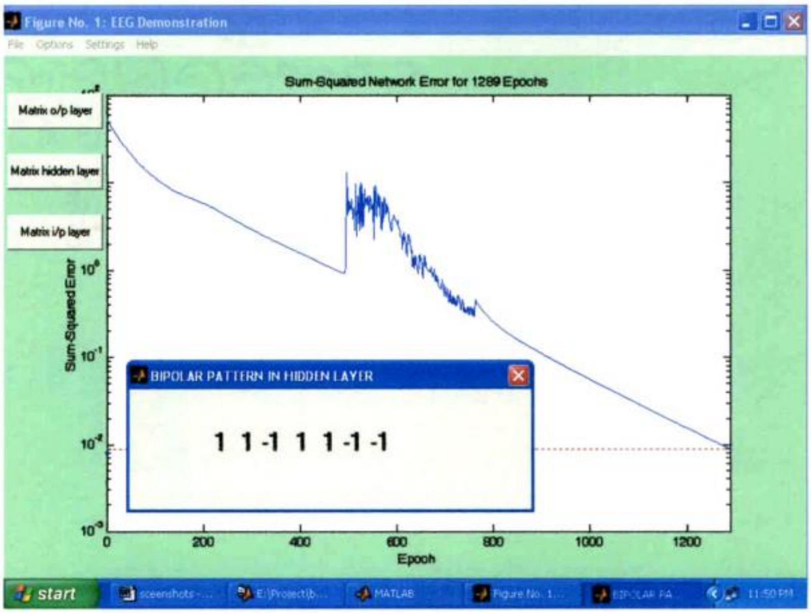

Figure 3: Error curve

A possible distinction between the cell's external and intracellular fluids is established. A muscle fiber depolarizes when a neuron stimulates it, causing a twitch as the signal moves over its surface[13]. This depolarization, or movement of ions, produces an electric field around every muscle fiber. A series of Motor Unit Action Potentials (MUAPs) that illustrate how the muscle responds to brain stimulation is represented by an electromyography (EMG) signal.

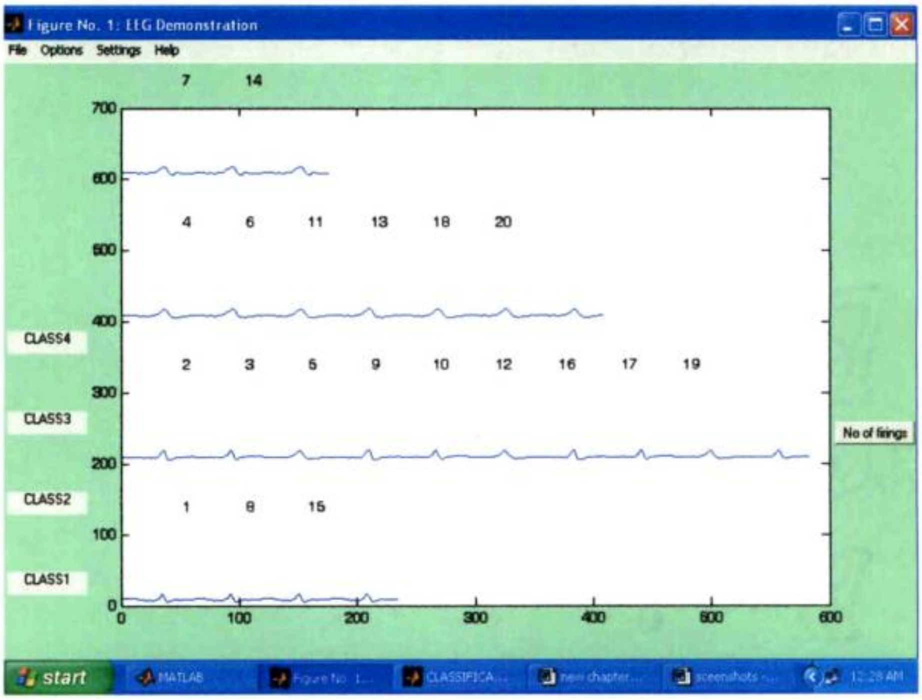

Figure 4: Classification results

The MUAP serves as the filter in the filtered impulse process model, which is commonly characterized as a Poisson process and correlates to neuron pulses. The EMG signal often seems random.

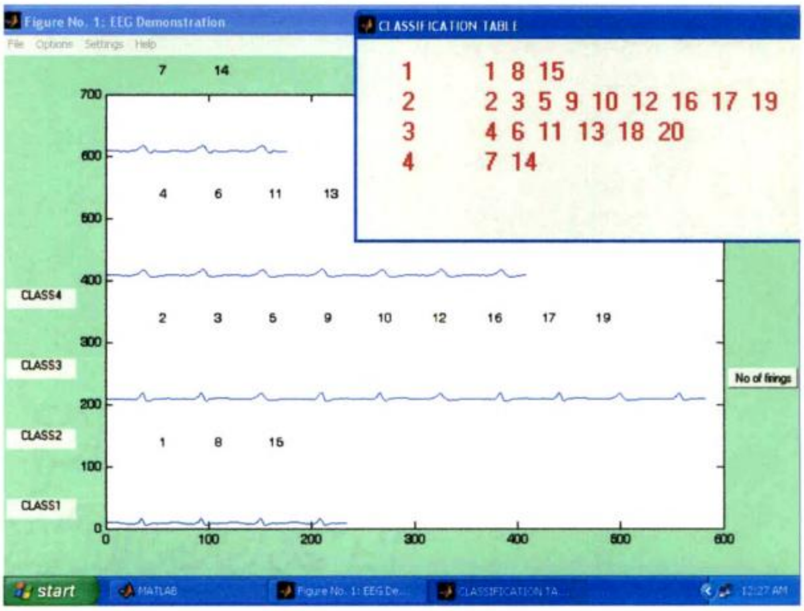

Figure 5: Classification table

One of its several uses; EMG is clinically utilized to diagnose neuromuscular and neurological disorders. It is utilized as a diagnostic tool in gait labs by biofeedback or ergonomic examiners who are clinicians [14]. In addition, EMG is utilized in numerous different research contexts, such as those that involve biomechanics, movement disorders, motor control, postural control, neuromuscular physiology, and physical therapy [15].

CONCLUSION

Important information about the nervous system can be obtained from the electromyography (EMG) signal. This essay seeks to provide a succinct introduction to EMG and investigate the different approaches to signal analysis. It covers methods for detecting, breaking down, processing, and classifying EMG signals as well as the benefits and drawbacks of each. Better alternatives are frequently developed when problems or limitations in one approach are identified. This work accounts for the various forms of EMG signal processing techniques to guarantee the correct techniques are applied in biological studies, clinical diagnostics, hardware realizations, and end-user implementations. Even with the growing popularity and awareness of the advantages of reconfigurable hardware devices, like Field Programmable Gate Arrays (FPGAs) and Programmable Logic Devices (PLDs), it is clear from examining hardware implementations that FPGA reconfiguration is not done automatically but requires human action. Therefore, Evolvable Hardware (EHW) is a promising new direction in reconfigurable hardware beyond FPGA.

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