EMG Classification and Gripping Force Calculation for Hand Functions

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ABSTRACT

This paper describes a four channel EMG acquisition and classifier system which controls the basic and necessary actions of the hand. The signals must be obtained from the proper muscles which is responsible to produce a particular action in normal persons. The residual capacity and muscle fatigue should also be considered while selecting the muscles. The force measuring system is used to test the impact of force spent by the hand over the EMG obtained while lifting various objects of different weights. By measuring the force and EMG parameters, the muscles, frequency range and amplification factor of the control system is determined. From experiments, the Flexor Carpi Ulnaris, Flexor Carpi Radialis, Extensor Carpi Radialis Longus, Extensor Carpi Ulnaris muscles were selected which forms the four channels to obtain the EMG. Surface electrodes were used to obtain the signal. The EMG obtained must be properly conditioned to remove ambient noise, transducer noise, cross talk and DC signal should be suppressed, which makes it suitable for classification. The signal obtained is classified using neural network which is the best tool for pattern classification. The EMG signal cannot be provided as such to ANN and the features which carry best information on the signal such as Mean value, Average value, Root Mean Square value, variance and standard deviation values are extracted. These values are provided as inputs to the Multilayer Perceptron network, which produces the action to be performed by the prosthetic hand.

Keywords
Myoelectric control, Muscle selection, Feature extraction, Artificial neural network, Pattern classification, Movement decision.

1. INTRODUCTION

The human body is an ingenious result of evolution. The Activities of Daily Life becomes difficult when a limb is lost. It is important to replace that with a functional limb which helps the amputee to take over their life in normal way. The amputees still have the neuronal and muscular activities (EMG) in the residual limb. Thus, myoelectric prosthetic uses sensors to detect the muscle activity. It then translates this muscle activity into information to control the artificial limbs movements. The Surface electromyography (sEMG) signals can be obtained from the residual limb using surface electrodes. Even though many myoelectric control systems are designed[1], an effective system for acquisition and processing of EMG is in developing stage. Our objective is to design an effective EMG acquisition system which acquires the myoelectric signals from various muscles of the arm and classifies it to simulate the flexion and gripping control actions of a prosthetic hand.

2. MUSCLE SELECTON

For every action performed certain muscle or combination of muscles are involved. So, to produce an action the signals must be obtained from appropriate muscles. The muscle fatigue should also be considered and muscles should be selected.

2.1 Determination of muscule fatigue

The amputees face many problems to do their day-to-day activities. A prosthetic should support them in all ways to perform any activity effectively. A major problem to be considered while designing a prosthetic is the muscular fatigue. Muscle fatigue, or physical fatigue, is the decline in ability of a muscle to generate force. Muscle fatigue is caused even in normal persons when the muscle becomes exhaust due to strenuous activities [2]. The physiological impairment causes a permanent fatigue in muscles. Fatigue can be caused by many different mechanisms, ranging from the accumulation of metabolites within muscle fibres to the generation of an inadequate motor command in the motor cortex. In case of amputees, the fatigue may be due to improper conduction of stimulus from motor cortex to muscles.Performing a motor task for long periods of time induces motor fatigue, which is generally defined as a decline in a person's ability to exert force [3].

The muscle fatigue in turn affects the muscle potential generated. The variation in the EMG waveform occurs as a result of changes in muscle potential. The prosthetic arm is controlled by the EMG obtained from the residual arm. For designing a smart myoelectrically controlled arm, the residual limb or arm size, neuronal capacity of the residual limb and the part to be substituted must be considered. The effective way is to measure the force and EMG generated by the muscles.

Our motive is, to design a system that can detect the EMG generated that is, to accurately capture the intention of the person and produce the movement in prosthetic hand accordingly. Hence, the system should be able to detect the changes in potential. To design such a system, a grip force measuring system has been designed to detect the force and simultaneously EMG has also been measured to detect the changes in potential during each stage.