"I hereby declare that I have read through this report entitle "Pattern Recognition Of EMG Signal During Load Lifting Using Artificial Neural Network (ANN)" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)"

Signature : …….

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Date : 1/6/2015

PATTERN RECOGNITION OF EMG SIGNAL DURING LOAD LIFTING USING ARTIFICIAL NEURAL NETWORK (ANN)

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A report submitted in partial fulfilment of the requirements for the degree of Bachelor in Electrical Engineering (Control, Instrumentation & Automation)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

To my beloved parents

Moh Minah Binti Abdullah and Kamaruzaman Bin Mat Ali

And

Fellow Friends

"I declare that this report entitle "Pattern Recognition of EMG Signal during Load Lifting Using Artificial Neural Network (ANN) is the result of my own research except as cited in references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : …….

Student name : NOOR FAIZA BINTI KAMARUZAMAN

Date : 1/6/2015

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ABSTRACT

This research describes pattern recognition of electromyography (EMG) signal during load lifting using Artificial Neural Network (ANN). EMG is a technique to quantify and record the muscle action when people perform certain operation and activities. This research will classify the EMG signal based on force apply to the arm due to the gravity act on it during load lifting. Recognizing pattern based on EMG signal is not an easy task because of the nonlinearities behavior of the signal. It required a good classifier to distinguish each pattern. The motivation of this project is to help the person suffer with hemiparesis to perform daily activities as well as to improve the lifestyle. It is important for patients to realize the hopes of hemiparesis after experiencing their inability to do activity as a normal human. Recognizing EMG pattern is crucially important for design the prosthesis arm that enables the patients to lift the heavy load despite of their muscle weaknesses. Therefore, a proper analysis of muscle behavior is necessary. The objectives of this research are to extract the important features of EMG signal using time domain analysis and to classify EMG signal based on load lifting using ANN. The analysis was performed to five subjects that were chosen for the most part in view of criteria determined. The EMG signal are gained at long head biceps brachii. At that point, the subjects were solicited to lift the heaps from 2kg, 5kg, and 7kg.It is expected an accurate classifier which can recognize the pattern precisely and could be further used for design the prosthesis arm.

ABSTRAK

Kajian ini menerangkan cara mengenalpasti corak isyarat Electromyography (EMG) semasa mengangkat beban dengan menggunakan Artificial Neural Network (ANN). EMG adalah teknik untuk mengukur dan merekodkan tindakan otot apabila manusia melakukan operasi dan aktiviti-aktiviti tertentu. Kajian ini akan mengelaskan isyarat EMG berdasarkan daya dikenakan kepada lengan akibat tindakan graviti di atasnya semasa mengangkat beban. Mengenalpasti corak berdasarkan isyarat EMG bukan satu tugas yang mudah kerana situasi parameter bagi isyarat adalah tidak sekata. Ia memerlukan pengelas yang baik untuk membezakan setiap corak. Motivasi projek ini adalah untuk membantu orang yang menderita dengan hemiparesis untuk melakukan aktiviti harian dan juga untuk meningkatkan gaya hidup mereka. Adalah penting untuk merealisasikan harapan pesakit hemiparesis selepas mereka mengalami ketidakmampuan untuk melakukan aktiviti sebagai manusia biasa. Menyedari corak EMG amat penting untuk mencipta lengan prostesis yang membolehkan pesakit untuk mengangkat berat walaupun mereka mengalami masalah lemah otot. Oleh itu, analisis yang betul untuk mengenalpasti tindakan otot diperlukan. Objektif kajian ini adalah untuk mendapatkan ciri-ciri penting isyarat EMG dengan menggunakan analisis domain masa dan untuk mengelaskan isyarat EMG berdasarkan mengangkat beban dengan menggunakan ANN. Analisis ini dilakukan ke atas lima orang yang telah dipilih berdasarkan kriteria yang telah ditetapkan. Isyarat EMG yang dibaca adalah di bisep brachii. Pada ketika itu, subjek telah diminta untuk mengangkat beban daripada 2kg, 5kg, dan 7kg. ANN dijangka satu pengelas yang tepat di mana ANN dapat mengenalpasti corak dengan tepat dan boleh digunakan untuk mencipta lengan prostesis.

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CHAPTER 1

INTRODUCTION

1.0 Project Background

Electromyography research started when Francesco Redi [1] found that muscle could create power in 1666 by reported that electrical ray fish produced electricity by utilizing a specific muscle [2]. Then, Alessandro Volta [2] had made a gadget which could create electricity and could be utilized to stimulate muscle. The next invention that was done by Luigi Galvani[1] has done a research to a frog in 1971 and has demonstrated that electrical incitement of muscular tissue produces contraction and force. The absence of constrained instrumentation has restricted Luigi Galvani[2] work and has held his labor for 40 years until a galvanometer is created in early 1800. In year 1838, Carlo Matteucci [1] has demonstrated that bioelectricity can be produced by muscular contraction and in 1842 he has shown that from the frog's muscle, action potential can be created from it. Guillaume Duchenne [3] has empowered electrically by reaching it to skeletal muscle and he is the one that initiated that medical electricity could be used for medical purposes. Guillaume Duchenne [2] also systematically mapped out function of about every facial muscle and established out that the muscles around the eye are just only active during genuine smile, meanwhile for a not genuine smile; it will just influence the muscle in the

mouth[4]. Willem Einthoven[1] has built up a thin conductor wire that could be utilized for electromyography as a part of 1903 which has permitted Forbes to be the first individual to utilize floating electrode in a moving body which has permitted them to record electromyography signal of an elephant and Forbes [1] additionally utilized Cathode Ray Tube (CRT) to amplify the action potential. At that point, the improvement of concentric needle electrode was develop by Adrian and Bronk [3] in 1929 and has utilized it for researching motor control and muscle schemes. This has enabled the detection of electromyography signal in individual and small group of muscle fibers [1] and the development of concentric needle electrode has been changed to the hypodermic needle with protected wire in its barrel [2]. Then, Herbert Jasper [5] has built a first electromyography and made a unipolar needle electrode amid his exploration from year 1942-1944. In 1962, John Basmajian [5] has gathered all the information of electromyography furthermore made a fine-wire electrode which is more agreeable contrasted with needle electrode. Finally, the most vital individual in the surface electromyography history is Carlo J. De Luca [4] and has written a cited-paper on 'The Use of Surface Electromyography in Biomechanics.

The electromyography is the inquiry of the electrical signal when the muscles emanate.. Myoelectric sign is framed by a variety in the condition of muscle fiber membranes. There are numerous boundless utilization of electromyography that is in the rehabilitation part, medical research, ergonomic and sports science. This boundless utilization can help in the estimation of muscular performance through investigating muscle signal. There are two sorts of electrodes which can be utilized to distinguish electromyography signal that is surface and needle electrodes. . Feature extraction of electromyography signal can be done by using three basic methods that are in time domain analysis method, frequency domain analysis method and time-

frequency analysis method. Other than that, there are two sorts of contraction which is finished by our muscle, which comprises of isometric and non-isometric (element) contraction.

The role of Electromyography inside biomechanics contemplated and setup can be measured by 4 major areas that is, a body part, forces, movement and muscle activation. The body parts will be controlled by bone and segment which will have the analysis in term of structure and 2 proportions. Next, the development will analyzed based on distance, angle, velocity or acceleration and force will be analyzed in term of linear force, moment and torque. Finally, the muscle initiation will be examined on the muscle action capability of the muscle. These four strategies can be classified as kinesiological investigation, which is utilized as a base to begin a research on new things. This research will be in view of EMG in term of force which can be utilized to help numerous applications, for example, prosthesis design, rehabilitation of muscle and designing a workout regime.

The purpose of this project is to develop a classification of electromyography (EMG) for load lifting using Artificial Neural Network (ANN). From movement of our body, electrode will detect and change impulse signal to electrical signal. After EMG signal acquisition, analysis the signals are proceed by selecting the feature extraction. Then the last part of EMG signal is selecting the classification for EMG signal. In this research, feature extraction is in time domain while for classification is Artificial Neural Network

1.1 Motivation Of Project

Hemiparesis or one-sided weakness affects about 8 out of 10 stroke survivors, causing weakness or the inability to move one side of the body. One-sided weakness can affect arms, hands, legs and facial muscles.. Hence, prosthesis arm will be expected to help the hemiparesis individual to procure a living without the assistance from others. Thusly, the improvement of upgrade of prosthesis equipment was expected to guarantee that the operation of prosthetic hand is the same as the operation of a typical human hand. This upgrade of prosthesis equipment needs an analysis which can be utilized as a guideline or data to build up the enhancement of prosthesis arm.

Therefore, a utilization of bio signal l is important in analyzing the reaction of the body that will be valuable to help in the process of outlining the prosthetic hand based on the reaction of an electrical signal or bio signal send toward the muscle. The electromyography is an electrical signal that will be acquired when the reaction of muscle happens and this data could help in the designing another prosthetic arm.

The prosthesis arm design ought to consider numerous factors that could influence the movement and the load that could be lifted by the arm. The design of the arm additionally relies on upon the experimental setup. Consequently, the following inspiration of this venture is to focus the pattern recognition of electromyography (EMG) signal during load lifting. Ultimately, the fundamental inspiration of this project is to describe pattern recognition of electromyography (EMG) signal during load lifting using Artificial Neural Network (ANN) that can be utilized as a part of the design of prosthetic arm.

1.2 Problem Statement

To identity the actual EMG signal that originates in the muscle is not easy due to the various noise signals or artifacts. The attributes of the EMG signal depend on the internal structure of the subject like individual skin formation, blood flow velocity and the measuring site. These attributes produce different types of noise signals that can be found in EMG signals. . This research is an important step for prosthetic arm design. Prosthetic arm could not emulate hundred percent human normal hands and limited their life capabilities but it can help them to live as a normal person.

Therefore, a proper analysis of muscle behavior is necessary. The force that is applied to the biceps brachii muscle will be focused in this research. The force will be varied by the weights of the loads. The surface electromyography (sEMG) signal will be extracted to obtain the characteristic of the muscle and will be evaluated to feed into the classifier. The classification of EMG signals is very important to categorize the intended action. There are many type of EMG classification, which can be differentiating based on the accuracy.

1.3 Project Objective

Below describes the objective on this project:

1. To extracted the EMG signal using time domain analysis.
2. To classify EMG signal for load lifting using Artificial Neural Network (ANN).
3. To analyze the ANN classification performance.

1.4 Project Scope

Project scope will be a guideline to achieve the objectives and of this project. The scope was shown as below:

1. Long head biceps brachii will be the muscle that used in this research.
2. This research will use surface electrode.
3. NI myRIO, Muscle V3 and LabVIEW will be used for data acquisition
4. The feature extraction that will be used in this research is the time domain.
5. The feature parameters will be used are root mean square (RMS) , mean absolute value (MAV), standard deviation(STD) and variance.
6. Artificial Neural Network (ANN) will be the classifier in this research.
7. There are 5 subjects based on the criteria in Table 1.1:

Table 1.0: The criteria of target subject

Specification	**Age**	**Height (cm)**	**Weight (kg)**	**Load Applied To The Muscle (kg)**	**Health Condition**
5 Male	20-30	160-180	60-90	2,5 and 7	Normal

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Electromyography (EMG) is a record of external activity from the muscle (Z., Mohammed, and Abbas H, 2012) [6]. Nowadays, many research about detect, analysis, process and classify of EMG were done because application of EMG signal in biomedical and clinical is very important. This EMG signal can be study as muscle contraction activity based on behavior of body movement. Electric signal will be produce when contraction or tighten of muscle occurs in the body movement.

The understanding of EMG signal origin and character is necessary background to proceed to the study of pattern recognition [2]. The EMG origin related with the work of nervous system. The transmission of electromechanical is between starting nerves from the brain that produces action potential that propagates through nerve fibers. Action potential will move with nerve fiber and finally stimulate the prosthetic muscle.

2.1 Literature Review

2.1.1 EMG signal

EMG sensor is uses to measure the electrical activity of muscle. The electrical activity produces an electrical signal from the muscle by placing EMG sensor on the surface of the skin. This raw EMG signal consist of a series of spikes whose amplitudes depends on the amount of force delivered from load by muscle.

2.1.2 Type of Electrode

Surface electrode is an example of non-intrusive electrode that have been utilized for measuring muscle electrical activities amid muscle contraction. The surface electrodes are separated into two main groups which are inactive and active electrodes. Passive electrodes have no inbuilt circuitry including amplifiers and filter [7] other than these electrodes obliges gel to beat a high impedance amid muscle contraction. Meanwhile, for active electrode, it has constructed in amplifier and filter which are they decrease motion artifact and increase the signal to noise ratio [8].

Figure 2.0: Surface Electrode

The advantages of utilizing surface electrodes are these electrodes are easy to understand, simple to apply and without a doubt its exceptionally helpful while amid the exercises or moving application amid the muscle contraction [7]. Other than that, the individual who conducts the process of paste the surface electrodes do not oblige any certificated or medical supervision [9]. Other than that, by utilizing this non-invasive electrodes, there is minimal pain will cause minimal pain with the application [7] [8]. The weaknesses of non-invasive electrodes are the process of paste the surface electrodes are restricted just in a skin surface and this electrode only can measure the large muscle. Other than that, this electrode additionally has a large pick-up area and will have more potential for crosstalk form adjacent of muscles [10].

Gregory S Rash [10] expressed that the most of the researchers these days utilized surface electrode as a part of their approach and research to measure an electrical signal delivered by a muscle because of its advantages and features.

2.1.3 Feature Parameter, Feature Extraction and EMG Classification

EMG classification is one of the most difficult in EMG analysis due to large variations in EMG features. To extract useful features from the residual muscle is difficult. Nowadays, many researches proposed many kinds of EMG feature to classify posture. However, how to select a feature subset with the best discrimination ability from those features is still an issue for classifying EMG signals (Huang et al., 2003) [11]. Since it is very difficult to extract a feature parameter, the multiple feature parameters for EMG pattern classification is desirable to uses. But overall pattern recognition performance may degrade due to the inclusion of an additional feature parameter with a small reparability. Table 2 shows several example feature parameters [12]

Table 2.0 Feature Parameters

Feature Parameters (Phinyomark & Baraani ,2009)	
1. Integrated EMG	$IEMG = \sum_{n=1}^{N} \lvert h_n \rvert$
2. Mean Absolute Value	$MAV = \frac{1}{N} \sum_{n=1}^{N} \lvert h_n \rvert$
3. Modified Mean Absolute Value	$MMAV = \frac{1}{N} \sum_{n=1}^{N} \lvert h_n \rvert W_n \qquad W_x = \begin{cases} 1 & 0.25N \le n \le 0.75N \\ 0.5 & otherwise \end{cases}$
4. Variance of EMG	$VAR = \frac{1}{N-1} \sum_{n=1}^{N} h_n^2$
5. Waveform Length	$WL = \sum_{n=1}^{N-1} \lvert h_{n+1} - h_n \rvert$
6. Wilson Amplitude(WAMP)	$WAMP = \sum_{n=1}^{N-1} f(\lvert h_{n+1} - h_n \rvert), \; f(x) = \begin{cases} 1 & x \ge threshold \\ 0 & otherwise \end{cases}$

The total of features analysis in the electromyography (EMG) signal is three which are time domain, frequency domain and time, frequency domain [13]. The time domain features are simple and fast method to do features extractions of EMG signals because it already in time domain. So, it is unnecessary to transform the signal to another and the calculation of the time domain features can be calculated from raw EMG signal after preprocessing.

The classification of electromyography (EMG) signal patterns has been research by many researchers in this era. There are different types of classifiers, which are effectively used for different EMG applications, such as Artificial Neural Network (ANN), fuzzy classifier, Linear Discriminant Analysis (LDA), Self-Organizing Map (SOM) and Support Vector

Machines (SVM).[14] The raw EMG signal is represented as a feature vector in the feature extraction process, which is used as an input to the classifier. Because raw EMG signals directly feed to the classifier, they are not practical due to the randomness of the EMG signal.

2.1.4 Biceps Muscle

The biceps muscle that will select in this research is biceps brachii and the position of the muscle is shown in Figure 2.0. Biceps brachii is Latin phrase that meaning two headed muscle which are the long head biceps brachii and the short head biceps brachii. Long head biceps brachii is the more visible.

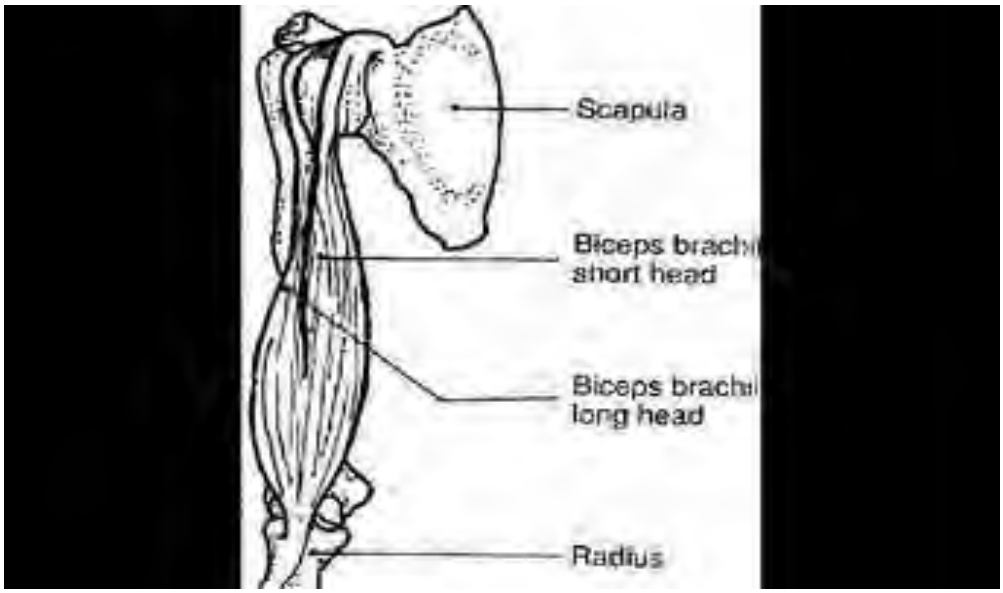

Figure 2.1: Bicep Branchii