"I hereby declare that I have read through this report entitle "*Power Spectral Analysis of Surface EMG for Wight Lifting Atheletes*" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation and Automation)"

Signature : …….

Supervisor name : Wan Mohd Bukhari bin Wan Daud
…….

Date : …….

© Universiti Teknikal Malaysia Melaka

POWER SPECTRAL ANALYSIS OF SURFACE EMG OF SURFACE EMG FOR WEIGHT LIFTING ATHELETES

MUHAMMAD AZRI BIN OMANAP

A report submitted in partial fulfillment of the requirements for the degree of Bachelor in Electrical Engineering (Control, Instrumentations and Instrumentations) with Honours

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2015

© Universiti Teknikal Malaysia Melaka

I declare that this report entitle "*Power Spectral Analysis of Surface EMG for Wight Lifting Atheletes*" 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 : …….

Name : Muhammad Azri Bin Omanap
…….

Date : ……

© Universiti Teknikal Malaysia Melaka

ACKNOWLEDGEMENT

I would like to express my grateful to Encik Wan Mohd Bukhari bin Wan Daud for supervising me in this research. I would also give my gratitude, especially to my family for their guidance, advices, and motivation. Also my colleagues and others who involve in assisting me in collecting and analyzing data and figures in the experiment process. Without their continued support and interest, this project would not have been presented here. Nevertheless, I would also like to express my thanks to all of the test subject that involved in this experiment without asking any payment.

Lastly, I would like to praise my special thanks to Universiti Teknikal Malaysia Melaka (UTeM) especially to Fakulti Kejuruteraan Elektrik (FKE) for giving me a chance to apply the engineering knowledge and improve skills of electrical field in this project. Besides that, thanks a lot to final year project committee in providing program and preparations in order to complete the final year project. My sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions.

© Universiti Teknikal Malaysia Melaka

ABSTRACT

The study of feature Power Spectral Analysis of Surface Electromyography, (sEMG) for weight lifting athletes was done to help further research and medical purpose for human body. This study will focus on weight lifting athletes body part called muscle biceps brachii and arms. This study will relate the relationship between Power Spectral Analysis, (PSA) and EMG signal formed by human arms. The study first objective is to record the Motor Unit Action Potential, (MUAP) from the sEMG by using developed acquisition system. Then the study continue to analyze and validate the recorded sEMG signal using PSA technique. The scopes of this study are 3 different weight of dumbbell, with healthy test subject with no sickness. No sickness mean healthy person with no biceps brachii problem that can alter the test result. Then, the test subject will do biceps curl exercise. This exercise will be recorded using sEMG for 10 second. The sEMG uses are in the Figure 1.1, with compilation hardware of Arduino Mega, EKG/EMG Shield as sensor, and Passive Electrodes. The overall of this study is to implement the understanding of recorded EMG signal into usable signal using PSA, for further study. By the end of this study, a comprehensive report about PSA analysis and discussion made based on the results obtained from the test subject and experiment conduct.

© Universiti Teknikal Malaysia Melaka

ABSTRAK

Kajian Analisa Kuasa Spektral menggunakan Elektromyografi, (sEMG) untuk atlet angkat berat telah dilakukan untuk tujuan untuk membantu penyelidikan lanjut dan tujuan perubatan untuk badan manusia. Kajian ini akan memberi tumpuan kepada atlet angkat berat bahagian badan dipanggil otot bisep brachii dan tangan. Kajian ini akan berkaitan hubungan antara Kuasa spektral Analisis, (PSA) dan isyarat EMG yang dibentuk oleh tangan manusia. Objektif pertama kajian adalah untuk merekodkan Potensi Unit Motor Aksi, (MUAP) dari sEMG dengan menggunakan sistem perolehan maju. Kemudian kajian terus menganalisis dan mengesahkan isyarat sEMG yang dirakam menggunakan teknik PSA. Skop kajian ini adalah 3 jenis pemberat yang berbeza, dengan keadaan sihat pada subjek ujian tanpa penyakit. Tiada penyakit bermakna orang yang sihat tanpa sebarang masalah brachii bisep yang boleh mengubah keputusan ujian. Maka, subjek ujian akan melakukan senaman bisep curl. Latihan ini akan dirakam menggunakan sEMG selama 10 saat. Penggunaan sEMG berada dalam Rajah 1.1, dengan perkakasan penyusunan Arduino Mega, EMG/EKG Shield sebagai sensor, dan Pasif Elektrod. Keseluruhan kajian ini adalah untuk melaksanakan pemahaman mencatatkan isyarat EMG kepada isyarat yang boleh digunakan menggunakan PSA, untuk kajian lanjut. Pada akhir kajian ini, satu laporan komprehensif tentang analisis PSA dan perbincangan dibuat berdasarkan keputusan yang diperolehi daripada subjek ujian dan proses eksperimen.

© Universiti Teknikal Malaysia Melaka

TABLE OF CONTENTS

© Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

LIST OF TABLES

© Universiti Teknikal Malaysia Melaka

LIST OF FIGURES

© Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

LIST OF ABBREVIATIONS

Abbreviation	Meaning
sEMG	Surface Electromyography
EMG	Electromyography
PSA	Power System Analysis
MU	Motor Unit
MUAP	Motor Unit Action Potential
EKG/EMG Shield	Electrocardiography Electromyography Shield
RMS	Root Mean Square
dB	Decibel
mV	millivolt
Na+	Sodium Ion
K+	Potassium Ion
Hz	Hertz
FFT	Fast Fourier Transform
PSD	Power Spectral Density

© Universiti Teknikal Malaysia Melaka

LIST OF APPENDICES

© Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

Chapter 1, will give a brief explanation of the 'Power Spectral Analysis of Surface EMG for Weight Lifting Athletes'. Also the research background and motivation of the research will be discuss. Then all problem statement and scope will be determine by the end of this Chapter 1.

1.1 Research background

The Electromyography or EMG is a technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG can be record by various method from low tech and low cost, to a high end tech but high cost method. Basically EMG is perform using an instrument or device call electromyography to produce a record called an electromyogram. An electromyography will detect the electrical potential generated by muscle cells when these cells are electrically or neurologically activated. The signals can be analyzed to detect medical abnormalities, activation level, or recruitment order to analyze the biomechanics of human movement.

For Power Spectral analysis of Surface EMG for weight lifting athletes cases, the focus will be on using the Surface EMG (sEMG) method. There are different methods like intramuscular that uses electrode needle that dangerous and pain. This why sEMG is completely safe in this cases. The hardware of sEMG device used shown in Figure 1.1.

© Universiti Teknikal Malaysia Melaka

Figure 1.1: The sEMG device

1.2 Problem Statement

The EMG signals are used in many clinical and biomedical applications. EMG is used as a diagnostics tool for identifying neuromuscular diseases, assessing low-back pain, kinesiology, and disorders of motor control. EMG signals are also used as a control signal for prosthetic devices such as prosthetic hands, arms, and lower limbs. Thus analyzing the EMG signal is the next step in solving this problem.

1.3 Objectives

The main objectives of this research are:

1. To record the MUAP from sEMG by using developed acquisition system.
2. To analyze and validate the EMG signals using Power Spectral Analysis.

© Universiti Teknikal Malaysia Melaka

1.4 Scope of work

This study scope will be a guideline towards achieving the objectives. The scopes of this study are the muscles that will be used in this study is biceps brachii. The exercise that will be done in this research is by using biceps curl method. The sEMG that will be uses is Olimex Ekg/Emg Shield with Arduino Mega 2560 and also Passive Electrode will be used in this study. The Arduino Mega 2560 will be used as the microcontroller that acts as a data acquisition. The feature extraction that will be used is in the time domain which is mean, root mean square (RMS), standard deviation and variance. The analyze part of feature extraction electromyography (EMG) is using power spectral analysis using Matlab. There are 3 different weight with 5 tries. Table 1.1. There will be 5 person acted as test subject to help generated EMG signal from their hand into the sEMG device. The data collected from these test subject are by doing 10 second arm at rest and 10 second biceps curl. Also the test subject are healthy and no health issues especially nerves issues. Table 1.2.

Table 1.1: Example Data Table for EMG Recording for Test Subject

	Duration (20 second)		
Trial\Weight	2.5 KG	5 KG	10 KG
1			
2			
3			
4			
5			

© Universiti Teknikal Malaysia Melaka

Table 1.2: Specification of the Test Subject

Specification	Age	Height	Weight	Trial Weight	Health Condition
5 Male	20-25	160 cm to 190 cm	50 Kg to 80 Kg	2.5 Kg, 5 Kg, 10 Kg	Normal

© Universiti Teknikal Malaysia Melaka

CHAPTER 2

LITERATURE REVIEW

Chapter 2 will give a brief explanation of the theory and the history of EMG. Further basic principles, review of previous related works, summary and discussion of the review will be discuss. The knowledge of using sEMG and Power Spectral Analysis concept also will be describes.

2.1 Theory and basic principles

EMG is an experimental technique concerned with the improvement, recording and examination of myoelectrical sign or EMG sign create by the physical varieties in the condition of muscle fiber layers. This sign can be utilized as an assessment apparatus for applied research, physiotherapy, rehabilitation, and sports training. It is similar to what are the muscle doing in certain point with specific situations [1, 2].

Common advantages of EMG will be EMG permits to specifically "look" into the muscle, permits estimation of muscle execution, helps in choice making both before/after surgery, reports treatment and preparing administrations, helps patients to "find" and train their muscles, permits examination to enhance sports exercises and identifies muscle reaction in ergonomic studies.

© Universiti Teknikal Malaysia Melaka

2.1.1 Weightlifting, Power Spectral Analysis, Motor Unit Action Potential (MUAP).

Weightlifting is a focused quality based game, where competitors switch from the barbell position from the floor to the overhead position when endeavoring a greatest weight single lift. This movement includes entire body muscle power.

The Power Spectral analysis, for example, frequency range and median frequency and made correlations between information got from the influenced and contra-lateral sides of the subjects [3]. Power spectral analysis of surface EMG signals has been utilized to identify possible alterations in the firing frequency as well as action potential shapes. Most EMG enhancers utilize a high pass channel (frequently set at 20-450 Hz) such that the firing frequency range is typically lower than the bandwidth of the filter and thereby limits the ability to identify firing frequencies. Studies have demonstrated that the median frequency of the power spectrum is corresponded to activity potential shape, specifically name the action potential duration. [4]

The Motor Unit Action Potential (MUAP), is an essential idea in electromyography is the alleged motor unit (MU), which represent the anatomical and utilitarian component of the neuromuscular framework. The MU is shaped by the alpha spinal motor neuron and its innervated set of muscular cells [5]. The electrical changes created by action of the MU can be obtained and increased by cathodes spotted in muscle mass and these progressions can be recorded and altered utilizing EMG devices. A MUAP waveform can be described by various parameters identified with specific parts of the structure and physiology of the MU [6]. Figure 2.1.

© Universiti Teknikal Malaysia Melaka

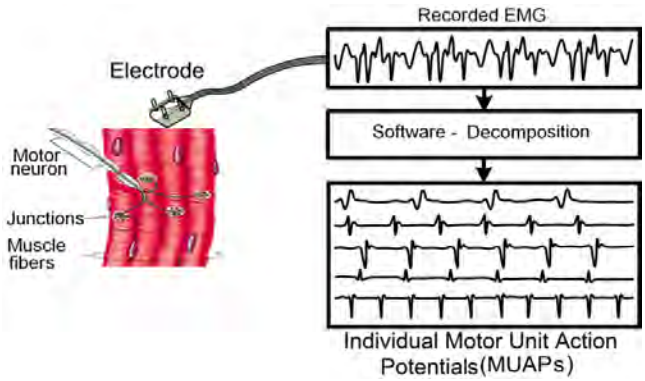

Figure 2.1: MUAPs extract from sEMG

2.1.2 The Motor Unit, (MU).

The Motor Unit consist of Alpha Motoneuron, Axon, Muscle Fibers, Motor Endplates, and Muscle fibers. Figure 2.2.

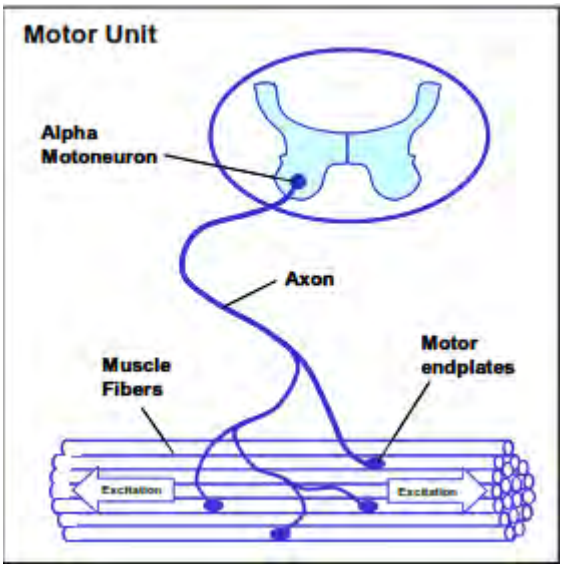

Figure 2.2: Motor Unit

© Universiti Teknikal Malaysia Melaka

2.1.2 Excitability of Muscle Membranes.

The nerve system will excite a control over muscle membranes. The ion pump in muscle cell create a balance between the internal and external of the muscle membrane. The muscle membrane have 3 stage called the Resting Potential, Depolarization process, and Repolarization. Figure 2.3. [7,8] Resting Potential is where the muscle is not moving, Depolarization is where the muscle moving forward, and Repolarization is where the muscle moving backward [9]. The Na+ ion charges play an important part in this process.

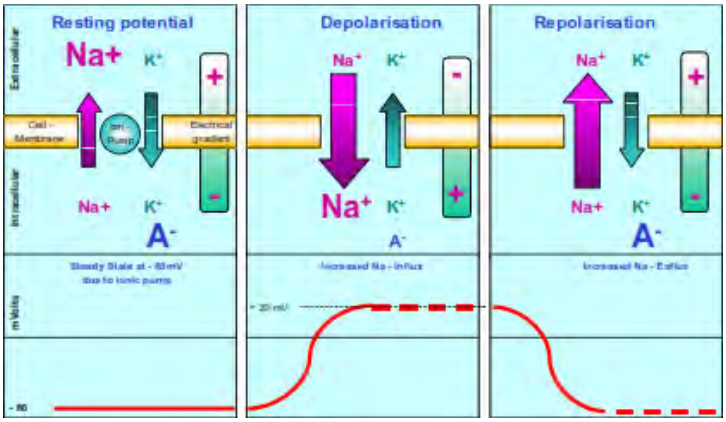

Figure 2.3: The Depolarization and Repolarization of Motor Unit (MU).

© Universiti Teknikal Malaysia Melaka

2.1.3 The Action Potential.

The Action Potential also known as Motor Unit Action Potential (MUAP), explain the Depolarization of muscle membrane which is counter by Repolarization immediately after that. Figure 2.4. This process produce about -80mV to +30mV of MUAP [10, 11].

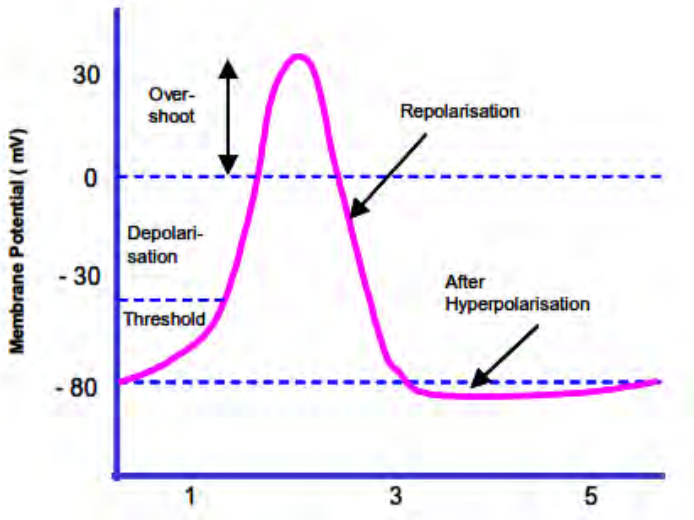

Figure 2.4: The Action Potential

The EMG signal from the Depolarization and Repolarization process will be collect by the sEMG device. Figure 2.5.

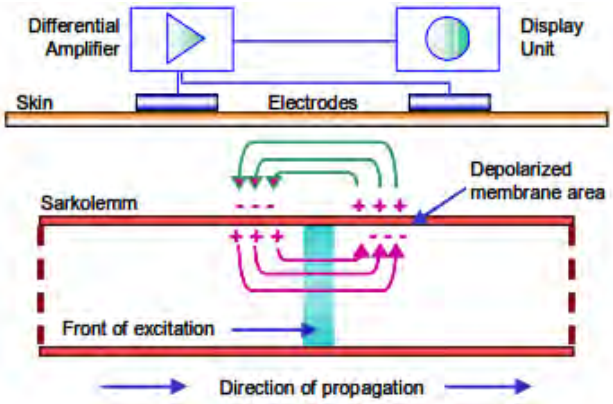

Figure 2.5: The depolarization zone on muscle fiber membranes.

© Universiti Teknikal Malaysia Melaka

2.1.4 Signal Propagation and Detection

The Depolarization and Repolarization process of the muscle membrane produce MUAP, that will be detect by the electrode and amplify by the sEMG device. This will give EMG signal depend on the specific requirement that will affect the EMG signal. Figure 2.9.

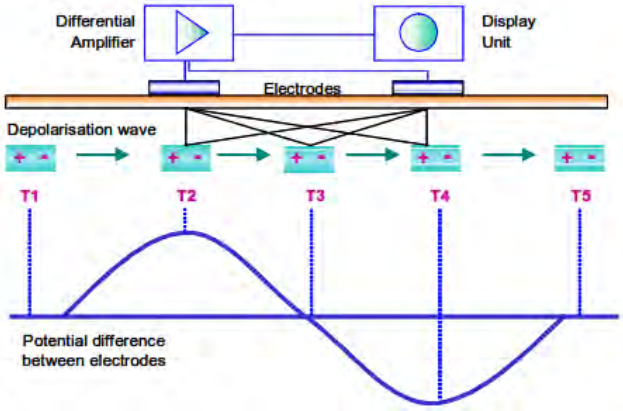

Figure 2.6: The model of a wandering electrical dipole on muscle fiber membranes

Figure 2.6 show at time point T1 the MUAP is created and ventures towards the electrode. An expanding potential contrast is measured between the electrodes which is at position T2. In the event that the dipole achieves an equivalent distance between the terminals electrodes and passes the zero line and gets to be most elevated at position T4, which implies the nearest to electrode 2. This model clarifies why the monopolar MUAP give out bipolar MUAP inside the differential amplification process [12, 13]. Commonly, all muscle membrane created triphasic MUAP, which depend on the location of electrode. The MUAP of all dynamic Motor Unit (MU), discernible under the electrode site are electrically superposed, and the bipolar signal with symmetric dispersion of positive and negative amplitudes. Figure 2.7. The most important factor affecting the MUAP is the recruitment of MUAP by all muscle within electrode area and their firing frequency [14]. For easy understanding, the EMG signal reflects the recruitment and firing characteristic of the identified motor units inside the muscle. Figure 2.8.

© Universiti Teknikal Malaysia Melaka

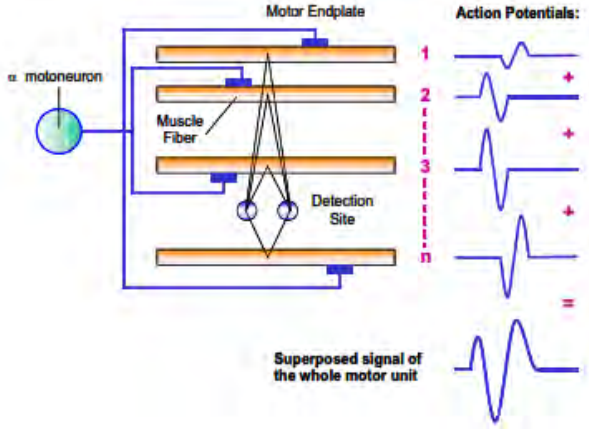

Figure 2.7: Generation of the triphasic MUAP

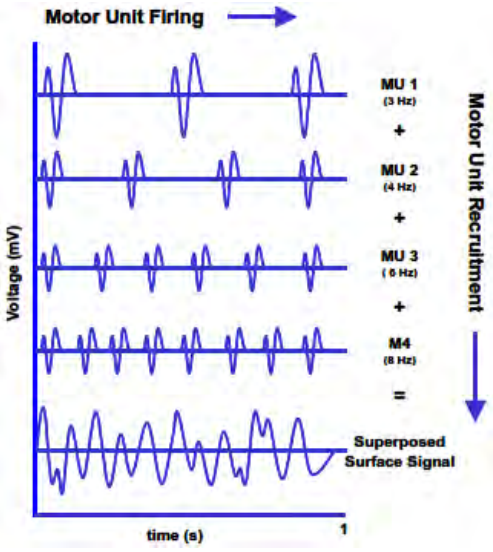

Figure 2.8: Motor Unit Recruitmentand Firing Frequency

2.1.5 Factor Effecting the EMG signal.

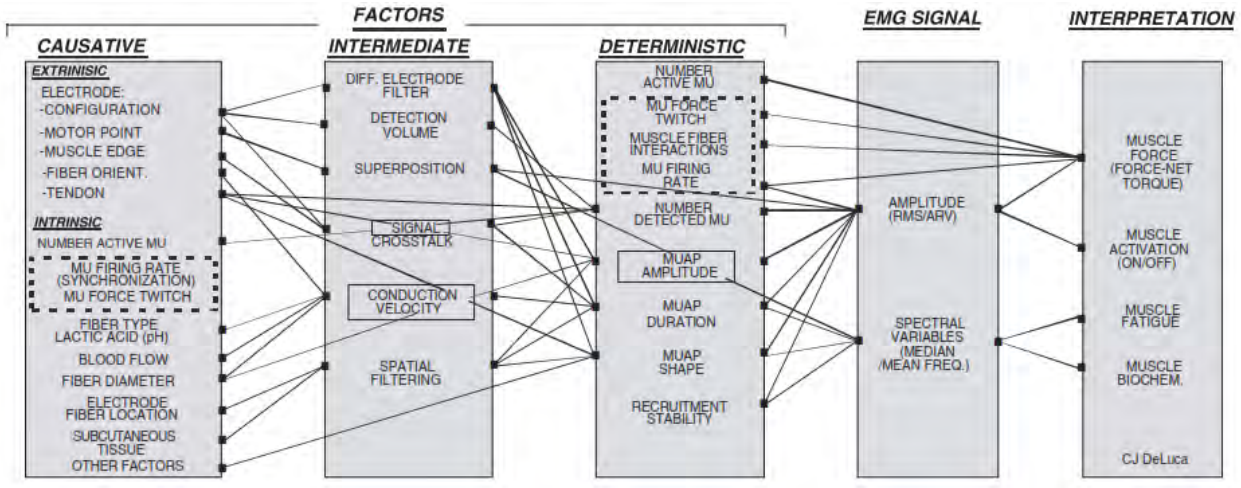

Figure 2.9: Factor effecting the EMG signal by C.J De Luca

© Universiti Teknikal Malaysia Melaka