Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF ELECTROMYOGRAPHY SIGNAL ANALYSIS TECHNIQUE FOR MUSCULOSKELETAL DISORDERS

MUNIR NAFIS BIN NORDIN

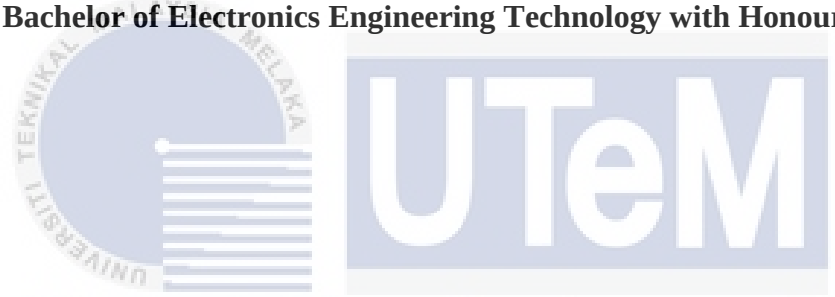
Bachelor of Electronics Engineering Technology with Honours

2021

DEVELOPMENT OF ELECTROMYOGRAPHY SIGNAL ANALYSIS TECHNIQUE FOR MUSCULOSKELETAL DISORDERS

MUNIR NAFIS BIN NORDIN

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours



Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek : Development of Electromyography Signal Analysis Technique for Musculoskeletal Disorder

Sesi Pengajian : 2020/2021

Saya Munir Nafis bin Nordin mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

☐ **SULIT*** (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

☐ **TERHAD*** (Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

☑ **TIDAK TERHAD**

Disahkan oleh:

Alamat Tetap:
KM22 Kampung Beringin,
76100 Durian Tunggal,
Melaka

TS. DR. NORHASHIMAH BINTI MOHD SAAD
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektronik dan Komputer
Fakulti Teknologi Kejuruteraan Elektrik & Elektronik
Universiti Teknikal Malaysia Melaka

Tarikh: 11/01/2022

Tarikh: 11/01/2022

*CATATAN: Jika laporan ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh laporan ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this project report entitled "Development of Electromyography Signal Analysis Technique Using Spectrogram For Musculoskeletal Disorders" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

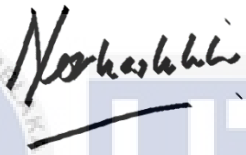
Signature : 

Student Name : MUNIR NAFIS BIN NORDIN

Date : 11/01/2022

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology with Honours.

Signature : 

Supervisor Name : TS. DR. NORHASHIMAH BINTI MOHD SAAD

Date : 11/01/2022

DEDICATION

Firstly, I dedicate this project to my beloved parents for providing all the support and assistance that have made this project complete worth the efforts. Their support truly helps me in the process of complete this project.

Next, I also dedicate this project to my supervisor, Ts. Dr. Norhashimah binti Mohd Saad for all the guidance, knowledge and encouragement word that gave me strength throughout this project.

Not forgotten also to my friends for their cooperation, advice and motivation during this final year project and last but not least, thank you for the Universiti Teknikal Malaysia Melaka for the lab usage to complete this a truly meaning during my degree's life.

ABSTRACT

Musculoskeletal disorders (MsD) are an injury that affects human body movement. One of the common MsD problems is back pain and slipped disc. Early detection of MsD can be detected using an electromyography (EMG) signal. The suggested method is being introduced because MsD detection using standard physical assessment is not reliable and accurate. For example, at Social Security Organization (SOCSO) rehabilitation centre, a health screening exam was performed on patients to evaluate MsD problem. The activity is completed manually by the patient and with the assistance of an instructor. This current method fails to identify which specific muscle is in the problem, so the patient cannot be declared as a MsD patient accurately and scientifically. This study proposes a signal processing approach to detect muscular disorder using signal analysis techniques. EMG can detect the electrical signal produced by the muscles and will be used to assess muscle health and establish whether the patient is at risk of acquiring a musculoskeletal condition or is already suffering from it. In addition, the test can evaluate muscle fatigue by performing some activities using the Functional Range of Motion (FROM) task. Shimmer devices and software collect the muscle data at a specific region: the biceps, erector spine and trapezius muscles, both left and right. The data collected based on the task given will be processed using the Matlab software. Two methods, Fast Fourier Transform (FFT) and spectrogram will apply in command of the Matlab. By doing so, the output result shown is the activity of the muscle health condition. Then, the respondent can be categorized into fit and fatigued muscle conditions.

ABSTRAK

Gangguan muskuloskeletal (MsD) adalah kecederaan yang menjejaskan pergerakan badan manusia. Salah satu masalah MsD yang biasa adalah sakit belakang dan cakera tergelincir. Pengesanan awal MsD boleh dikesan menggunakan isyarat elektromiografi (EMG). Kaedah yang dicandang diperkenalkan kerana pengesanan MsD menggunakan penilaian tahap fizikal tidak cukup tepat dan dipercayai. Sebagai contoh, di pusat pemulihan Pertubuhan Keselamatan Sosial (PERKESO), pemeriksaan saringan kesihatan dijalankan ke atas pesakit untuk menilai masalah MsD. Aktiviti ini dijalankan secara manual oleh pesakit dan dengan bantuan pengajar. Kaedah semasa ini gagal untuk mengenal pasti otot tertentu yang bermasalah, jadi pesakit tidak boleh diisytiharkan sebagai pesakit MsD dengan tepat dan cara saintifik. Kajian ini mencadangkan pendekatan pemprosesan isyarat untuk mengesan gangguan otot menggunakan teknik analisis isyarat. EMG boleh mengesan isyarat elektrik yang dihasilkan oleh otot dan akan digunakan untuk menilai kesihatan otot dan menentukan sama ada pesakit berisiko mendapat keadaan muskuloskeletal atau sudah mengalaminya. Selain itu, ujian tersebut boleh menilai kelesuan otot dengan melakukan beberapa aktiviti menggunakan tugasan Fungsi Julat Pergerakan (FROM). Data yang dikumpul berdasarkan tugasan yang diberikan akan diproses menggunakan perisian Matlab. Dua kaedah, Fast Fourier Transform (FFT) dan spektrogram akan digunakan dalam perintah Matlab. Dengan berbuat demikian, hasil keluaran yang ditunjukkan adalah aktiviti keadaan kesihatan otot. Kemudian, responden boleh dikategorikan kepada keadaan otot yang cergas dan letih. Penyelidikan ini membantu menganalisis dan mengkaji lebih lanjut tentang MsD untuk mengelakkan kecederaan atau keadaan ini.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Ts. Dr. Norhashimah Binti Mohd Saad for their precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) allow me to use the Advance Digital Signal Processing (ADSP) lab which enables me to accomplish the project. Not forgetting my fellow colleagues for the willingness of sharing his thoughts and ideas regarding the project.

Finally, my highest appreciation goes to my parents and family members for their love and prayer during the period of my study. Last but not least, I would like to thank all the individuals who being co-operative and helpful to me during this project.

TABLE OF CONTENTS

PAGE

DECLARATION

APPROVAL

DEDICATIONS

ABSTRACT **i**

ABSTRAK **ii**

ACKNOWLEDGEMENTS **iii**

TABLE OF CONTENTS **i**

LIST OF FIGURES **iii**

LIST OF SYMBOLS **iv**

CHAPTER 1 INTRODUCTION **5**
1.1 Background 5
1.2 Problem Statement 6
1.3 Project Objective 7
1.4 Scope of Project 7

CHAPTER 2 LITERATURE REVIEW **8**
2.1 Introduction 8
2.2 Structures of Neuron 8
2.2.1 Motor Neuron 9
2.3 Electromyography (EMG) 9
2.4 Electromyography Signal 10
2.5 Musculoskeletal Disorders (MsD) 11
2.5.1 What are Musculoskeletal Disorders 11
2.5.2 What causes of Musculoskeletal Disorders 11
2.5.3 How to diagnose and treat Musculoskeletal Disorders 12
2.6 Electromyography Machine 13
2.7 Spectrogram 14
2.8 Functional Range of Motion (FROM) 15
2.9 Summary 15

CHAPTER 3 METHODOLOGY **16**
3.1 Introduction 16
3.2 Methodology 17
3.2.1 Flowchart 17
3.3 Experimental Setup 18
3.3.1 Skin Preparation 18
3.3.2 Electrode Placement 19

3.3.3 Interfacing Between EMG Board and Consensys Software 20
3.3.4 Utilizing the FROM Pegboard 23
3.3.4.1 Standing Horizontal Reach 24
3.3.4.2 Crouching Reach 25
3.3.4.3 Kneeling Reach 26
3.3.4.4 Stooping Reach 27
3.3.4.5 Kneeling with Upper-Level Reach 28
3.3.4.6 Axial Rotation Reach 29
3.3.5 Estimation of muscle characteristic during FROM 30
3.3.6 Matlab 30
3.3.6.1 Signal Analysis Technique 30
3.3.6.2 Frequency Analysis Technique 30
3.3.6.3 Spectrogram Analysis Technique 31
3.3.7 Frequency Resolution 31
3.3.8 Peak Frequency 32
3.4 Equipment 32
3.4.1 Shimmer EMG 32
3.4.2 Consensys Software 33
3.4.3 Matlab Software 34
3.4.4 Pegboard 34
3.4.5 Summary 35

CHAPTER 4 RESULTS AND DISCUSSIONS 36
4.1 Introduction 36
4.2 Results 36
4.3 Fast Fourier Transform (FFT) Analysis 40
4.4 Spectrogram Analysis 41
4.5 Performance of spectrogram 42

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS 43
5.1 Conclusion 43
5.2 Future Works 44

REFERENCES 45

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1	Structures of neuron	8
Figure 2.2	Example of raw EMG signal	10
Figure 2.3	Example of Spectrogram Signal	14
Figure 3.1	Flowchart process	17
Figure 3.2	Removing hair process	18
Figure 3.3	Positioning of the electrode	19
Figure 3.4	EMG Board	20
Figure 3.5	Anatomical positions of selected electrode sites, frontal view	21
Figure 3.6	Anatomical positions of selected electrode sites, dorsal view	22
Figure 3.7	FROM Pegboard & Peg	23
Figure 3.8	Shimmer EMG board	32
Figure 3. 9	Consensys Software	33
Figure 3.10	Matlab Software	34
Figure 3.11	Pegboard	34

LIST OF SYMBOLS

$\int$	-	Integral
π	-	Pi
τ	-	Tau
v	-	Voltage
∞	-	Infinity
f	-	Frequency

CHAPTER 1

INTRODUCTION

1.1 Background

Musculoskeletal disorders (MsD) are injuries or conditions that can affect the human body movement. One of the common MsD problems is the slip disc. This is due to reasons such as weight lifting over the limit that can cause harm to the area mentioned. MsD also can affect lifestyle, occupation, and age. Another example is that an office worker is constantly sitting in the same position at a computer every day to complete the assigned tasks. By doing so, this also can lead to MsD condition such as back pain.

Electromyography (EMG) is the most popular technique to diagnose musculoskeletal disorders (MsD). EMG is an electrodiagnostic procedure that examines nerve and muscle health. An EMG nerve test will give your doctor clear information about the state of a nerve or muscle injury. By doing so, will allow the doctor to pinpoint the precise location of the injury.

In this research, a signal processing technique of electromyography (EMG) muscle analysis will be investigated to classify musculoskeletal disorders (MsD) for health screening system. The EMG signals from the human muscles in upper limb side will be analyzed during positional test using Functional Range of Motion (FROM). There are two signal analysis technique use in this experiment which is Fast Fourier Transform (FFT) and Spectrogram.. Then, the muscle performance between healthy and MsD can be classified. These criteria are very important to implement this research so that can be used to measure the overall performance of rehabilitation patients.

1.2 Problem Statement

Despite the availability of mechanical and automated technology, manual handling is an essential method of performing material handling tasks. These bodily movements frequently result in musculoskeletal diseases. As a growing country focusing on the industry sector, Malaysia is seeing an increase in the number of patients treated at SOCSO rehabilitation centres for MsD. In a rehabilitation centre, a health screening exam was performed to instruct and detect MsD patients using standard physical assessment techniques. However, the activity is completed manually by considering physical assessment only with the instructor's full assistance. Based on this evaluation, the patient will be evaluated for treatment or fitness to return to work. However, researchers are currently looking for the best way or technique to analyse the human muscle condition in muscle fatigue monitoring.

There is a various selection of tests for diagnosing musculoskeletal disorders (MsD). In addition to medical imaging such as X-rays, Computed Tomography (CT) scans and Magnetic Resonance Imaging (MRI) can be used because both provide much more detail than typical X-rays. The extent of these machines can detect fractures that are not visible on x-rays. However, both machines specialize in different things. For example, MRI is best for imaging muscles and tendons; meanwhile, CT scan is good in bone images. This raises the problem of which method is an excellent way to determine the MsD condition. This is where the use of electromyography (EMG) comes in. Hopefully, this EMG technique analysis can serve as a primary method to detect MsD conditions. During the EMG procedure, data will collect from design activities. Then, proceed with data analyzing which is an electrical signal from body parts such as the biceps, erector spine and trapezius muscle. After thorough data analysis, the researcher can conclude whether the subject have musculoskeletal disorders condition or not.

1.3 Project Objective

The primary goal of this project is to propose a systematic and effective methodology for assessing a person's musculoskeletal disorder condition efficiently and accurately. Specifically, the objectives are as follows:

a) To analyze electromyography (EMG) signals using signal processing technique for musculoskeletal disorders (MsD) during muscle health screening task.

b) To estimate the muscle characteristics from the signal analysis technique during Functional Range of Motion (FROM) task.

c) To evaluate the performance of the signal analysis technique by using spectrogram.

1.4 Scope of Project

To achieve the goals of this study, some requirements must be met to decide if electromyography signals can be evaluated and categorized using analysis techniques that can detect the presence of musculoskeletal disorders (MsD):

1. Ten randomly chosen respondents were eligible to participate.
2. Shimmer EMG board device is use to collect the data during Functional Range of Motion(FROM) Task.
3. Only 1 respondent selected used for analysis.
4. Analysis is done using Matlab software as the platform.
5. Use Fast Fourier Transform (FFT) to analyze the frequency spectrum of the EMG.
6. Use of spectrogram to analyze the time-freq distribution of the EMG muscle.
7. Muscle involve in this experiment are trapezius, biceps and erector spine.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Chapter 2 explains and proposes some literature review related to the proposed projects. Some terms need to be understood well, so then this project can be understood well. Previous studies and works in this field will be used for covered this chapter.

2.2 Structures of Neuron

According to (Tim Newman, 2017), neurons are responsible for carrying information throughout the human body. They use electrical and chemical impulses to assist in the coordination of all of life's necessary functions. For information, the brain and the spinal cord have approximately 100 billion and 13.5 million of neurons.

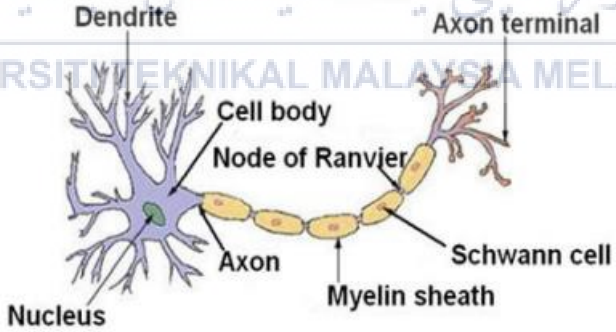


Figure 2.1 Structures of neuron

(Ericca Cirino, 2019) mentioned that neurons are made of three components which are dendrite, Axon and cell body. Dendrite is tree-like structures that function in receives messages 13 from other neurons. On the other hand, Axon is a long cable-like part that conducts electrical impulse away from the cell body.

2.2.1 Motor Neuron

(Nicolas Stifani, 2014), study state that motor neurons are central nervous system neuronal cells that influence a variety of downstream targets. Motor neurons are classified into two categories. Upper motor and lower motor neurons. An upper motor neurone resides in the brain. It provides higher-level motor information to the medulla located in the brain or to the appropriate spinal cord level outside the brain. Lower motor neurons transport motor information from the medulla or the spinal cord to muscle fibres, making them far more directly responsible for movement than upper motor neurons. Furthermore, The lower motor neuron controls the signal from the upper motor neuron to the effector's muscle to conduct a movement. Motor neurons in the brain and spinal cord transmit commands from the brain to the muscles, allowing them to perform actions such as moving and breathing.

2.3 Electromyography (EMG)

Based on (Danielle Moores, 2018), electromyography (EMG) is a test that evaluates the health of muscles and the nerve cells that control them. These nerve cells are known as motor neurons. They deliver electrical signals to the muscles, which cause them to contract and relax. Doctors can use the data generated by the EMG to help them make a diagnosis.When a patient exhibits muscle or nerve disease symptoms, a doctor will usually prescribe an electromyography test. These symptoms may include tingling, numbing, or limb fatigue. Electromyography data can assist doctors in diagnosing muscle problems, nerve illnesses, and injuries affecting the nerve-muscle link. EMG can also identify a difference between the wasting and exhaustion of myopathic and neurogenic muscles. By evaluating the 14 distribution of neurogenic abnormalities, EMG can further differentiate focal nerve,

plexus or radicular disorders. EMG also is an obligatory test of the motor neuron disease, which shows the broad denervation and fasciculation needed for a safe diagnosis.

2.4 Electromyography Signal

Refer from (Chowdury et al, 2013), there are two types of electromyography (EMG) signal which the first is surface electromyography and the other is intramuscular electrmyography. Both EMG signals can be recorded by non-invasive and invasive electrodes. Non-invasive electrode that used on surface EMG while invasive electrode needed to use of needle to track movement of the muscle. Due to its non-invasive features, surface electromyography was the favoured approach. That is mean surface electromyography easy to apply and free from pain. EMG signal commonly be used for the area that has muscle fatigue where it is a decline in performance the longer the activity does.

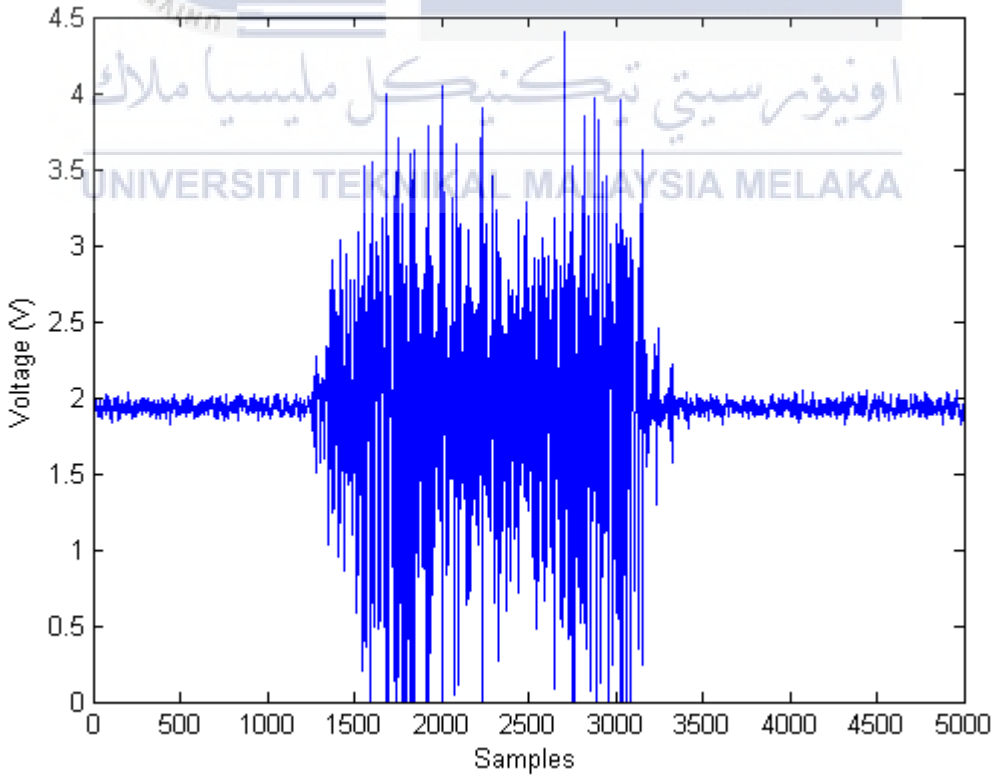


Figure 2.2 Example of raw EMG signal

Based on (Ezreen Farina Shair et al., 2016), mentioned that electromyography (EMG) signal could be categorized into two main components: baseline and muscle activation. Past research has been done to segment muscle contraction based on either time or frequency domain. These methods do not precisely segment signal by the nature of the signal itself, which changes the statistical properties over time in the time domain. Therefore, it is stated that EMG signals are complicated and non-stationary signal with highly complex time and frequency characteristics controlled by nervous signal because it is directly involved in muscle activity.

2.5 Musculoskeletal Disorders (MsD)

2.5.1 What are Musculoskeletal Disorders

According to (Matt Middlesworth,2019), musculoskeletal disorders (MsD) are injuries and disorders that impact the movement of the human body, such as muscles, tendons, etc. Some of the most common musculoskeletal disorders problems include carpal tunnel syndrome (CTS), ligament sprain and tension neck syndrome. The phrase "musculoskeletal disorder" is used because it accurately reflects the situation. To simplify this problem understanding to the general public, musculoskeletal disorders also named "repetitive motion injury".

2.5.2 What causes of Musculoskeletal Disorders

A study by (Isabel L. Nunes, 2020) found that a factor that leads to musculoskeletal disorders (MsD) is exposure to work-related. Some of the activities that contribute to the MsD are repetitive work and working in awkward or bad posture. Data recorded from this study shows that work-related MsD affects the lower back, neck, shoulders and upper limbs.

Supported by (Danuta Roman-Liu,2020), an employee's working posture is the position he or she adopts while doing work duties. It can be changed often, or a single posture can be maintained for a lengthy period of time. There is a possibility that the risk of acquiring neck and shoulder discomfort symptoms increases when neck twisting or bending postures are employed regularly at work, as opposed to when they are used infrequently.

The human body can be divided into two categories: the upper limb has musculoskeletal disorders (MsD) symptoms like neck and shoulder pain, while also has lower limb. The lower back of a person also can have musculoskeletal disorders condition due to the same reason. From (Nicolien de Langen, 2020), activity like prolonged standing affects the lower limb body. Standing for an extended period reduces blood circulation and nutrient supply to muscles, allowing muscular fatigue to develop. There is also prolonged sitting or static sitting. For example, office worker spends a lot of time at their desk or assigned workplace. The usual hour for an office worker is from 8 A.M. – 5 P.M. Without an excellent quality chair such as an ergonomic chair; people usually feel numb if they stay in the same position for several hours. It also a stated from (Viorica Petreanu and Aurelia-Mihaela Seracin, 2020), that the symptoms of the musculoskeletal disorder can develop over weeks, months, or even years, so it is critical to detect and treat them as soon as possible.

2.5.3 How to diagnose and treat Musculoskeletal Disorders

(Kristeen Cherney, 2018) mentioned that depending on the cause of your symptoms, your treatment plan will differ. As a result, it is critical to obtain an accurate diagnosis. Make an appointment with your doctor if you are experiencing symptoms of musculoskeletal disorders (MsD). They will most likely perform a physical exam to diagnose your condition. The doctor will check for the symptoms like stiff joints, swelling, and redness. Additionally, they may put your reflexes to the test. Irregular reflexes may be indication of nerve injury.

Furthermore, imaging tests such as X-rays or magnetic resonance imaging (MRI) scans may also be performed by your doctor. These tests can help in the examination of your bones and soft tissues.

Based on the doctor's imaging tests and physical exam, the doctor will recommend the best treatment to treat the musculoskeletal disorders (MsD). For minor discomfort, they may recommend moderate activity and over-the-counter medication such as Ibuprofen. This medication is supported by (Yvatte Brazier, 2021) stated that Ibuprofen is used to relieve pain such as strain and sprain. If the symptoms are severe, medications to relieve inflammation and pain may be prescribed. In some situations, doctors may recommend physical therapy, occupational therapy, or a combination of the two. These therapies can assist you in developing coping mechanisms for pain and discomfort. Additionally, therapy is beneficial for maintaining strength and movement for daily tasks. Supported from (T.N.S.T Zawawi et al, 2018) mentioned that the use of appropriate measures can eliminate or limit exposure to work-related risk factors can help reduce the chance of developing MsD on the workplace.

2.6 Electromyography Machine

Consensys is the software that interacts with shimmer sensors, providing your live data, managed data and devices with considerable capacities. It is created for adaptive field 18 data collecting, repeatable large-scale tests and general multi-sensor management. A high-pass filter is used to filter the acquired material. The spare time from the raw signal is removed, and precisely the data set is needed in the processing phase. The selected technique, the spectrogram, was then applied. In order to achieve high data accuracy, four characteristics are used from the signal created, including root mean square voltage (Vrms), medium frequency (MNF), variance (VAR) and default deviation (STD).

2.7 Spectrogram

According (Jade Vande Kamp, 2020) a spectrogram shows the strength of a signal at different frequencies of a waveform over time. Spectrograms can include 2-dimensional diagrams with a third colour variable or a 3-dimensional diagram with a fourth colour variable. A time-domain signal is split into shorter segments of equal length to generate a spectrogram. The rapid transformation of Fourier (FFT) is then applied to every segment. The spectrogram is an individual segment track of the spectrum. The Frame Count parameter determines how many FFTs the spectrogram can be created and, thus, the total time signal divided into separate FFTs.

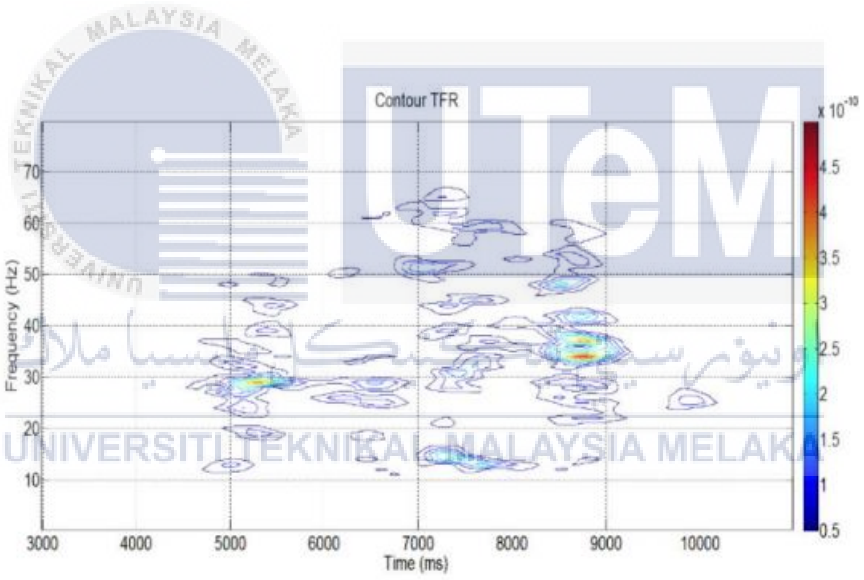


Figure 2.3 Example of Spectrogram Signal

2.8 Functional Range of Motion (FROM)

The Functional Range of Motion (FROM) pegboard can be used by evaluators to determine a patient's performance in terms of time required to place or move objects. The FROM system employs Tools Time Measurement (TTM), enabling evaluators to extrapolate regularly for periodic requests. TTM is a technique used in industrial engineering for determining the time-motion performance of workers performing work-related tasks. Evaluators can use the TTM standard score to distinguish between the quantity of a test subject's positional tolerance ability and the positional tolerance-specific productivity equivalency. Individuals must prove functionality within the specified posture and undertake positional tolerance procedures without failing a time-motion equivalence.

2.9 Summary

This chapter reviews existing research to emphasize the limitations, solutions, and benefits of the previous study of electromyography and the cause of the musculoskeletal disorder. Furthermore, this section of the study has a wealth of knowledge and insight into the method that will be implemented, which is the spectrogram analysis technique. This part also focuses on electromyography signal and the general idea of musculoskeletal disorders.