ANALYSIS OF ELECTROMYOGRAPH (EMG) FOR CONTROLLING WHEELCHAIR MOTION

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ABSTRACT

Nowadays, due to the aging of the current population, the need of wheelchair has significantly increased not only to the disabled community but also to the old citizen. However, the use of manual wheelchair is restricted to the user with leg impairment only. Yet, for the user with severe impairment (arm and leg) the smart wheelchair that controlled by the alternative user interface is necessary. Since the target of this project is for the user who has high level Spinal Cord Injury (SCI), the EMG signal from neck has been chose to trigger the wheelchair.

The EMG signals are obtained using disposable electrode from neck muscles which are Sternocleidomastoid and Trapezius muscles, with different direction. For the acquisition of SEMG signal MyDAQ is used. The features are extracted from the conditioned EMG signal such as: root mean square value and mean absolute value. To classify such kind of signal, a classifier able to withstand uncertainties in data is required. So, in this work a fuzzy classifier is designed and implemented using LabVIEW software. The classifier system is tested using 10 subjects. The simulation results have authenticated the capability of implemented system.

ABSTRAK

Pada masa kini, disebabkan peningkatan penuaan di kalangan masyarakat, keperluan terhadap penggunaan kerusi roda telah meningkat dengan ketara bukan sahaja kepada masyarakat orang kurang upaya tetapi juga untuk warga tua. Walau bagaimanapun, penggunaan kerusi roda manual adalah terhad kepada pengguna yang mempunyai masalah kaki sahaja. Namun, untuk pengguna yang mengalami masalah yang teruk (lengan dan kaki) kerusi roda pintar yang dikawal oleh antara muka pengguna alternatif adalah perlu. Oleh kerana sasaran projek ini adalah untuk pengguna yang mempunyai tahap yang tinggi Cord Kecederaan tulang belakang (SCI), isyarat EMG di leher telah memilih untuk mencetuskan kerusi roda.

Isyarat EMG diperolehi menggunakan elektrod guna dari otot bahagian leher iaitu sternokleidomastoid dan trapezius,dari arah yang berbeza. Untuk pengambilan SEMG isyarat otot tersebut, MyDAQ digunakan. Ciri-ciri yang diambil dari isyarat EMG yang diambilkira adalahi: *root mean square* dan *mean absolute* value. Untuk mengklasifikasikan isyarat-isyarat tersebut, Fuzzy Network digunakan dari perisian Labview. Sistem pengklasifikasian ini menggunakan 10 sampel dari pelbagai subjek. Keputusan simulasi telah mengesahkan bahawa system ini Berjaya mengklasifikasikan signal-signal tersebut.

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LIST OF SYMBOLS AND ABBREVIATIONS

Hz	Hertz
s	seconds
V	Voltage
EMG	Electromyogram
SCI	Spinal Cord Injury
HMI	Human Machine Interface
BCI	Brain Machine Interface
MUAP	Motor Unit Action Potential
STFT	Short Time Fourier Transform
WPT	Wavelet Packet Transform
WT	Wavelet Transform
RMS	Root Mean Square
ARV	Average Rectified
SCM	Sternocleidomastoid

CHAPTER 1

INTRODUCTION

1.1 Introduction

Nowadays, due to the aging of the current population, the need of wheelchair has significantly increased not only to the disabled community but also to the old citizen. However, the use of manual wheelchair is restricted to the user with leg impairment only. Yet, for the user with severe impairment (arm and leg) the smart wheelchair that controlled by the alternative user interface is necessary

Since the target of this project is for the user who has high level Spinal Cord Injury (SCI), the EMG signal at neck muscle will be chosen to move the wheelchair. The user need to move his/her head to make sure that the wheelchair is in the right direction.

The EMG signals are obtained using disposable electrode from neck muscles which are Sternocleidomastoid and Trapezius muscles, with different direction. Then, the raw signal will be amplified and filtered by using KL720 before it will be acquired using MyDAQ. Next, by using LabView program, the features from the signal was extracted from the conditioned EMG signal such as: root mean square value and mean absolute value. This feature will be classified using Fuzzy Network and the classify data will be determine the direction of the wheelchair which are Left, Right and Straight.

1.2 Problem Statement

The extensive literature and research reports about the important of the development of Smart wheelchair have been studied since 1980 [1]. Before that, the use of manual wheelchair is widely used. Unfortunately, the manual wheelchair only useful to the individuals with physical impairment but are poorly suited to the patient who involves with a severe impairment [2]. Based on Fehr [3], shows that out of 200 practicing clinicians:

- 9 to 10 percent of patients are having difficulties to use the power wheelchair in their daily living.
- The percentage of patient is drop to 40 when asked about steering and manoeuvring task.
- 85 percent of the clinicians reported that there are patients that cannot use a powered wheelchair because of lack of motor skill strength or visual acuity.
- According to the clinicians, automated navigation system will be the solution for the patients that unable to control the conventional wheelchair.

To cater the problems, the Smart Wheelchair is introduced. Smart wheelchair is a powered wheelchair that has been integrated with sensors and has an on-board computer. It consists of computer and collection of sensors or mobile robot base that will be attached to the seat of the wheelchair. Traditionally, the wheelchair can be control using joystick, however nowadays the joystick can be replace with user interface input. This approach will be discussed further in Chapter 2.This type of wheelchair is not just for the person who cannot use the standard wheelchair but also for the person who have sufficient sensory abilities to detect when stopping is necessary [4].

1.3 Aim and Objectives

The aim of the project is to classify the EMG signal based on neck muscles using Electromyography Signal for users with high – level spinal cord injury. The tasks of developing the wheelchair are split into the following area:

i. Acquire signal from neck muscle
ii. Develop a signal processing algorithm to control the movement of the wheelchair
iii. Classify the signal based on the direction using Fuzzy Network.

1.4 Scopes

The study of the project involves the selection of the sensor and the most appropriate place to attach the sensors. Since the focus of the project is for patients suffering from severe impairment, then the part of the body should be taken into account is the neck. To capture the signal, surface electrode will be use.

The operator of the wheelchair plays an important role for the movement in the wheelchair. To increase the performance of the wheelchair, the operator will have some training and practice to learn the response of the device to his/her muscle contractions.

There are three modes of operation for controlling the wheelchair; the modes are forward, left and right. These modes depend on the movement of the muscle of the neck. A specific route will in the indoor environment only and the time consumption for the user to reach the destination will be counted and compared with the other wheelchair.

1.5 Outline of thesis

This project is classified into five chapters. The scope of each chapter is explained as below:

First chapter gives the background of the thesis, problem statement, aim and objective, scopes of works and outline of the thesis.

Chapter II is about the literature review, in which previous studies and theories related to this project are discussed and reviewed. It also describes about the smart wheelchair, the concept of muscular system, principle of Electromyogram, techniques of EMG, signal processing for EMG and fuzzy. Literature review provides a background of this project and also gives and direction in this research.

Chapter III deals with a research methodology. It describes the detailed method that has been used to conduct this project. This chapter proposes the list of material that will be used for the hardware development such as selection of surface electrode, signal and data acquisition devices. It also discusses the theory of classification of signal of this project.

Chapter IV is for the results and discussion. This chapter will highlight the simulation result done in LabVIEW and its implementation on the hardware. It also discusses the classification of signal using fuzzy network.

Chapter V concludes this project. It also describes the next step that need to be done in the future works.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is separated into several sections to show clearly the different approaches and components used to control a “smart” wheelchair by using EMG signal the past few decades. The first section describes the history and development of the wheelchair and also the recent development of “smart” wheelchairs. The following sections will discuss the control method using EMG signal.

2.2 Wheelchair

The increasing numbers of people that suffer from disabilities due to accidents, neurological disorders, and brain damages contribute to the demanding of care-givers for day to day activities including mobility, communication with environment, controlling the house hold equipment and the difficulty of getting a care-giver resulting the need of assistive technology. This kind of assistive technology will be alternative way to improve communication, accessibility, mobility and cognitive domains of the patient. One the example of assistive technology is the smart wheelchair that allows the person to move freely and independently [5] .

Previously, the use of a manual wheelchair is widely used. It requires human power to move them. Usually, this type of wheelchair is suitable to individuals with physical impairments but is poorly suited for individual with a combination of physical and cognitive or perceptual impairment [2]. The next generation of wheelchair is Powered Wheelchair.

Powered Wheelchair is the ultimate choice to the elderly and disabled patients. The user needs to control the wheelchair by using the joystick, switches, pedals and buttons. The development of the powered wheelchair systems gives the new perspective of life especially to the handicapped people and to the elderly. For handicapped people and elderly, with the invention of powered wheelchair, the quality of their lives has been improve; not just in mobility but also in reduction of effort and discomfort. However the joystick can be a limiting factor since it can be used only by people who still have some sort of control, enough for manipulating it. Some physically disabled people will have the difficulty in using the powered wheelchair due to lack of necessary motor skills, strength or visual ability.

The latest technology of wheelchair is Smart Wheelchair. It consists of computer and collection of sensor or mobile robot base that will be attached to the seat of the wheelchair. Compared to powered wheelchair, smart wheelchair is design to reduce the effort of the user in controlling the wheelchair. This will ensure the safety of the user during movement and enabling them to move around freely without depending on the care givers. Usually this type of wheelchair will be used for a patient that suffers from severe motor dysfunction which only can move body parts located above their shoulders. Between the three types of wheelchairs, the smart wheelchair will be discussed further on in this chapter.

2.3 Smart Wheelchair

Smart Wheelchair consists of computer and collection of sensors or mobile robot base that will be attached to the seat of the wheelchair. It also designed to provide navigation assistance to the user in a number of different ways, such as assuring collision-free travel, aiding the performance of specific tasks (e.g., passing through doorways), and autonomously transporting the user between locations[1]. Most patients who will use smart wheelchair is patients with high-level Spinal Cord Injury (SCI), nervous system diseases, cognitive impairment, and blindness, presumably in conjunction with mobility impairment [3]. A smart wheelchair can restore autonomy to patient with sensory-motor disabilities by enabling them to move around freely without depending on the care givers.

The different between smart and manual/powered wheelchairs is the ability of the machine to interact with the user. This interaction is steered by sensors that have been installed to the wheelchair. This sensor must be accurate, inexpensive, small, lightweight, consume little power and robust to stand up to environmental conditions [6].

The input of the smart wheelchair can be divided into two types which are Human Machine Interface (HMI) and Brain Machine Interface (BCI).As described in [7] HMI is a discipline which design to make human control or communicate with devices by using bio signals. While BCI is a method that will use the bio signals that generates from the activity of brain for controlling the device. Both HMI and BCI is generates from bio signals that produces by human and interprets them to do a specific task. The main difference between HMI and BCI is that the HMI is a system that use bio signal generated in the body rather than brain.

2.3.1 Brain Computer Interface (BCI)

BCI is a technique that helps users controlling wheelchair using the bio signal that generate from the activity of brain. In [8] proved that the EEG signal can be used to control the wheelchair. This is done by capturing the signal of the brain when the eye movements such as opening eyes, blinking eyes, glancing left and right. The signal is captured and filtered using Hamming low pass filter before it trained using autoregressive neural network method .Finally, in [9] is about the research of controlling the wheelchair by using gaze expression. The information from the environment is obtained using combination of laser and Kinect sensors before it will be analyzed in order to decide the final control operation according to the user intention. By incorporating the safety map, apparently collision can be avoided in mode, i.e, manual and semi-auto, and hence may reduce user burden of continuously monitoring the surrounding while maneuvering.

2.3.2 Human Machine Interface

Typically, powered wheelchair can be controlled using a joystick, it only limit to the people who still have some sort of control [5]. To solve the problem, instead of using a joystick, wheelchair can be controlled by using Human Machine Interface. This type of input will use human signal to control the wheelchair.

One of the popular user interfaces is a voice recognition wheelchair. It allows physically disabled person to maneuver the wheelchair easily without the need to use their hands. However, the voice recognition wheelchair is not suitable to use in the in busy and noisy environments Furthermore, it is not good and sometimes considered to be impolite to talk aloud in a silent area. To move the wheelchair the user must say specific words For example the NavChair speech vocabulary includes: `stop', 'go forward', `go backward', `soft left', `hard left', `soft right'. These words tell the system to move forward, backward, left, right, etc. [10].Another project using voice recognition is done by Kathirvelan [11] where the voice commands produced by the user are captured and processed using Standalone Controlling System Embedded LabVIEW and Compact Reconfigurable Input/output FPGA Card-cRIO-9074 and integrated with Ultrasonic sensor and IR sensor for obstacle detection and path finding. Recently research by Puviarasi [12] shows that a voice recognition wheelchair could be part of the assistive technology for the disabled persons without the help from third person. This microcontroller based project is done by evaluating the accuracy and velocity in various environments. The velocity of the wheelchair system will reduce as the load carried by the system is increasing while the accuracy of the voice recognition circuit in silent condition is less compared to that in the noisy condition.

Another approach was used electro-oculographic activity (recording and interpreting eye movements).This is done by Nguyen where the bio signal was from human's eye using electrodes and process it by using microcontroller[13].Rafael Barea [14] has done a project using EOG signal as a guidance to the wheelchair. With the help of neural network, the inverse eye model can be identifies and therefore the saccadic eye movements can be detected and the location of the gaze can be determine.

Morten [15] shows that powered wheelchair can also be control using a tongue. The system is based on an intra-oral device with sensors that register the movement of a ferromagnetic tongue piercing and with fuzzy system; it allows the multidirectional control of the wheelchair can be control.

As stated above, there are a lot of researches relating to the HMI that have been done. The point of interest of this project is using an EMG as an input to maneuver the wheelchair. To cater the user that has severe impairment, the possible location to apply the EMG is at neck. The details about how EMG can be applied to the wheelchair will be explained on the next section.

2.4 Muscular System

The word EMG is come from the abbreviation of Electromyography which myo is actually is another word for muscle. So in other word, EMG is a technique for evaluating and recording the electrical activity produce by muscles. There are about 700 named muscles that responsible for the movement of the human body which each of them are discrete organ constructed of skeletal muscle tissue, blood vessels, tendons, and nerves. Humans have three types of muscles which are smooth, cardiac and skeletal. Cardiac muscle is found in the human heart while the smooth muscle is located within the organs in the body systems. The highest number of muscles is called skeletal muscles and most of them are close to the surface of human body, between the integumentary system and the bones[16].This paper will focus on skeletal muscle.

Skeletal muscles are voluntary because its contraction is controlled and stimulated by the nervous system. Skeletal function has several functions which are supporting the body, controlling the movements of the bones and body parts, maintaining the human body temperature, assisting movement in cardiovascular and lymphatic vessels and finally protecting the internal organs and stabilize the joints [16].

There are two types of bone that function during the contraction of muscles which called the stationary and insertion bone. The stationary is the origin of a muscle while the insertion muscle is on the bone that moves. To move the body part, a group of muscle will be working together and this muscle called prime mover. The naming of the muscle is combination of size, shape, direction of fibers, location, attachment, number of attachment and action [16].

In this paper, the discussion are focus on the muscles of the neck that will move the since the point of interest is to the person that having the spinal cord injury (SCI) disease. There are two muscle that moves head which are sternocleidomastoid and trapezius muscle.

Sternocleidomastoid muscle will focus on the flexion and rotating the head. Flexion is the movement that closest the angle and rotation is the movement of a part around its own axis. When this muscle contracts (left and right), flexion of the head occurs which will makes the head towards the chest. When only one of them is contracts, the head will move to the opposite direction. For example, the left sternocleidomastoid will be shorten when the head turns to the right.

The trapezius muscle is responsible for moving, rotating, stabilizing the scapula (shoulder blade) and extending the head at the neck. The origin of this muscle is at the base of the skull and the insertion is on a clavicle and scapula. Like most muscles, there are two trapezius muscles which located at the right and the left.

Based on the these types of muscle, for this project the suitable muscle to place the electrode is sternocleidomastoid because the capabilities of the muscle to contract when the head is move to left or right.

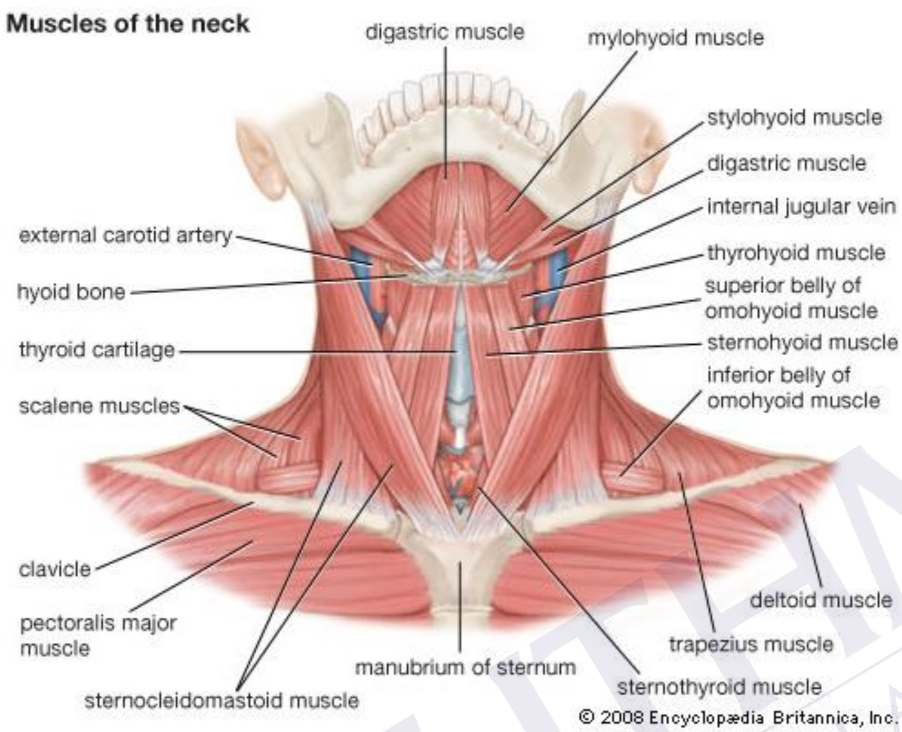

Figure 2.1: The anatomy of muscle at the neck[17]

2.5 Principle of Electromyography (EMG)

When contractions and relaxation occurred, the human brain will generate commands through neurons that responsible for different movements of human skeletal system. These kinds of commands are carried through the nervous system which will generate an electrical activity in the muscles. The electrical potential that has been generating by the muscle will record and this called electromyography.

The electromyography (EMG) signal is a measurement of electrical currents generated in muscles during its contraction. It is a result of the summation of all Motor Unit Action Potentials (MUAP) in the region near the electrodes. The motor unit is the smallest functional unit of the muscle that consists of a somatic motor neuron and muscle fiber it innervates. For fine force, the number of motor unit will be small, as forces increasing the muscle fibers will produce a large amount of motor units.

When a muscle fiber contracts, the nerve will be stimulate causes the muscular membrane depolarizes and propagates an action potential down the length of the muscle fiber. The condition when the voltage controlled sodium channels called depolarization. Charged sodium ions enter the membrane and initiate the action potential. The positively charged sodium will enter the membrane and trigger the action potential. Other charged ions such as calcium, potassium, and chloride also play a vital role in producing and propagating the action potential.

2.6 Techniques of EMG

There are two methods to measure the electrical activity of the muscular system, which is by using fine wire electrodes and surfaces electrode. Fine wire electrode is a needle electrode that will be inserted inside the territory of a discharging motor unit records from all the muscles fibers active within its uptake area. This procedure can measure voluntary motor activity and also be able to assess the insertional activity. Since it will be inserted inside the body, this kind of procedure only can be done by a person with the proper knowledge of the musculature [18].

The common method of measurement of muscular activity is called Surface Electrode (sEMG).This electrode is located at the surface of the skin and will examine the summation of all electrical activity from the surface above the muscle on the skin Signal acquisition of sEMG is simple than the needle electrode, this reason makes the sEMG become the popular method of capturing the signal of the muscle. However, the amplitude of the signal is small which lies in the range of 0 – 10mV peak to peak causes the possibilities to be effected by noise is higher [19].

By comparing these two methods, the needle electrode has the advantages in terms of accuracy and consistency of measurement since it is not just assess the voluntary motor activity but also able to assess what is labeled insertional activity. However this procedure only can be done by a person with the proper knowledge of the musculature. Otherwise, though the sEMG is simple and easier to apply to the patient and can be done by all, the application of sEMG quite limited clinical usefulness and usually only applicable on diagnose purpose. All of the work completed in this paper assumes the measurement of sEMG as the technique used.

A number of works have been reported surface EMG signals and some of them are used for controlling the wheelchair [20], [21], robotic purposes [22]–[24] as well as rehabilitation aids[25].

2.7 EMG Signal

The effect of using surface electrodes should also be noted by the user. For example, an unfiltered and unprocessed signal detecting of MUAP is called a raw EMG signal. The example of raw EMG signal is shown in Figure 2.1

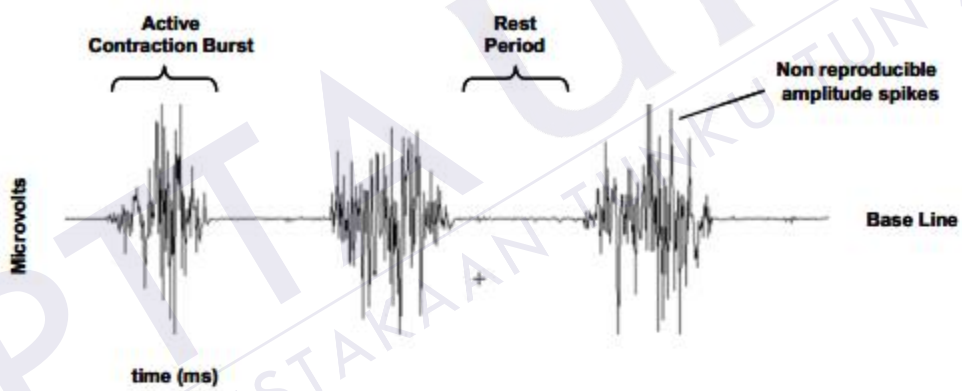

Figure 2.2: The raw EMG recording of three contractions burst of the biceps brachii muscle[26]

When the muscle relaxed, the noise-free EMG baseline can be seen. To reduce noise, the user must ensure the quality of the amplifier, the environment noise and the quality of the given detection condition. The averaged baseline noise must below than 3 – 5 microvolts. EMG spikes shape is very random, which means that each recording burst will not produce the exact shape. Strong superposition spike will produce when two or more motor unit fire at the same time and the location between the motor unit and the electrodes is near. Raw EMG range is 0.1µV to 20mV and from 2Hz to 2kHz which may change between different kinds of people [27]

Since the amplitude of the raw signal is very small, it must be amplify and sometimes it requires more than one amplification stages. Besides that, the signal must also go through the filter in order to eliminate low or high frequency noise.

After amplifying and filtering stages, the point of interest of the signal is in the range of 0 to 10mVpp while the frequency is between 0 to 500 Hz with the dominating frequency between 50 to 150 Hz [28]

2.8 Interfacing EMG to the wheelchair

EMG signal is generate by the contraction of the human body muscle, with signal levels is between 100 µ V to 90 mV with frequency ranging from DC to 10 kHz. They are currently being used to control the robotic devices such as manipulators (robot arm) and mobile robots (Smart Wheelchair). The aim of the design is actually to help users with different motor disabilities.

The example design for robot manipulators has been covered by Rani [29].The project was inspired by Morse code-based telegraphic communication, the EMG sensors was placed on Flexor Carpi Radialis and Brachioradialis muscles in order to generate a series of activations in order handle the gripper so that they can execute the activity in the daily life easily. Artemiadis [30] has proved that EMG signal can be used for robot manipulator and position tracker. The system design a new master-slave manipulator system that uses no mechanical master controller but EMG signals from the muscles of a human arm. The robot elbow is controlled by joint angle from EMG signal during smooth forearm motion while the robot’s shoulder is controlled by a position tracker

Some system used EMG signal to control the movement of the wheelchair. There are a lot of research that have been done relating to this, the first research on a human interface based on EMG signal was done by Norbert Wiener in 1948[31]. Since then, the study about this concept is growing intensively. The latest research was done by Vashisth [20] where the surface EMG electrode was used to capture the signal on neck. For clean display and better result, the raw signal is processed and filters using

MATLAB. Su Han [32] has developed an a smart wheelchair by using an EMG signal as input. The raw EMG signal must go through a pattern recognition which includes data acquisition, preprocessing, feature extraction, learning pattern and finally classification of signal. Fuzzy min-max Neural Network was used as a learning tool to recognize the pattern of the signal. The result from this project shows that the mode operation of the wheelchair plays important role in determining the comfort to the wheelchair's users.

As the conclusion, there are several works that use EMG signal as the input to control the devices. Based on this, many types of muscles can be used as a command. It is depend on the level of difficulty of the user. The muscles for wrist and elbow are the most widely used, but for the user who cannot use that muscle especially for the user that has the SCI injuries, it is common to use the shoulders and/or neck muscles. For the critical user who cannot move any part of their body, the EMG signals from eye command can be used.

2.9 Signal Processing for EMG Signal

Signal processing is the important part in this project. This to make sure that the quality of EMG signal is extracted and at the same time the unwanted parts of EMG signal are removed. The method of signal processing includes pre-processing of the raw data, feature extraction, dimensionality reduction, pattern recognition, and finally online and offline learning. Nowadays, the signal analysis involves digital signal processing either by computer software or processor. Until now, more techniques have been done that proved to be more efficient than the traditional approach.

To analyse the signal there are three possible domains can be apply which are frequency domain, time domain and time-frequency domain. Based on the research by Mahdavi[33], due to the computational simplicity, the time domain has been used but it is not consistent with the essence of the EMG signal while in the frequency domain the disadvantages is the problem of not having access to the time domain. Englehart[34], has proved that by using Short Time Forier Transform (STFT),Wavelet Transform (WT) and Wavelet Packet Transform (WPT) there is an improvement of the systems when using the time-frequency domain compared to the others.

In time domain, there are few features that can be apply, the features are Mean Absolute Value, Root Mean Square, Slope Sign Change, Zero Crossing, Waveform Length, Willson Amplitude and Variance. Mahdavi[33] for example had applied the Wavelet Transform features for extracting the Surface EMG signal. From the evaluation of RES index (the ratio of a Euclidean distance to a standard deviation) and scatter plot, there is an improvement in class separability of hand movement in feature space.

However, between the features for frequency domain are Power Spectral Density, Mean Frequency, Median Frequency and Time-frequency analysis. Compare to the time domain, frequency domain is required more computation and time to be calculated.

2.10 Classification

The extracted features need to be classify into distinctive classes for the recognition of the movement. In EMG, there are few reasons that will affected the large variationin the value of the particular movement. The reasons are i) Nature of muscle signal ii) electrode position and iii) skin preparation. A good classifier must be fast and real time, stability of classification performance and efficient in classifying the pattern [35].

The commonly techniques to classify the signal are Neural Network [36][37]. Fuzzy approach [38], Neuro-Fuzzy approach and Probabilistic Approach

2.11 Conclusion

It can be conclude that there are many research and work that have been done relating to the EMG signal. The use of powered wheelchair can be replaced using Smart Wheelchair which the use of joystick are replaced by bio signal from muscle.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter is focused on the steps of designing the Smart Wheelchair. It start with the chosen of sensor and also the circuit of signal conditioning is deciding to make sure the signal is suitable for processing. Matlab is used as signal processing and also as a tool to train the signal that will be control the movement of the wheelchair. The microcontroller is carefully chosen to make sure that it is suitable for controlling the wheelchair.

3.2 Block Diagram

The block diagram of this project consists of two parts, which are (1) Signal Acquisition (2) Signal Classification.

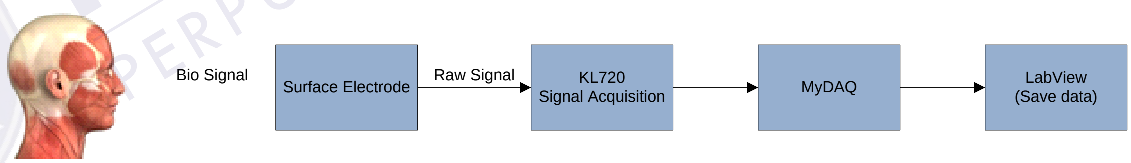

Figure 3.1: Signal Acquisition

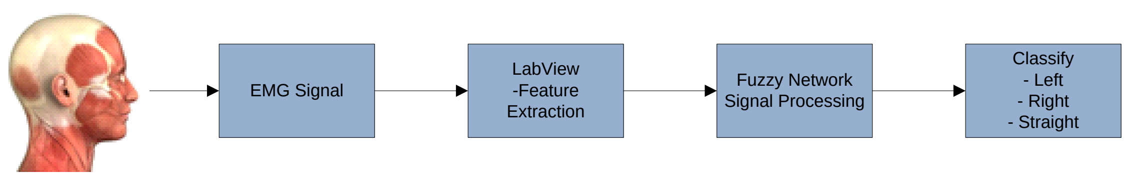

Figure 3.2: Signal Classification

Figure 3.1 shows the block diagram of the signal acquisition. As for this project, three Ag/AgCl surface electrodes were used. Two electrodes were patched on left and right sternocleidomastoid muscle and one electrode was patched on right hand as reference electrode. The raw signal from the electrode will be amplify, filter and rectify by using the EMG module of KANDH. The output signal of the EMG module will be captured using myDAQ for National Instrument (NI myDAQ) and by using a programming of LabVIEW the signal was saved in *lvm form. EMG signal is recorded about 1000 samples per second and the particular EMG signal saved in PC using LabVIEW software. A file *.jpg and *.lvm (file format) is generated by the system, which can be used by PC for analysis purpose.

The next steps are shown in Figure 3.2. By using LabVIEW, the saved data will be analysed and processed based on root mean square value and mean absolute value. This feature will be classified using Fuzzy Network and the classify data will be determine the direction of the wheelchair which are Left, Right and Straight.

3.3 Selection of surface electrode

The selection of surface electrode is one of the important parts of the project. It plays an important role to interface between biomedical instrumentation tool and electronic system at human body. During contraction, the nerves will send a signal to initiate muscle and a potential will be developed across the muscle due to the flow of ions in and out of muscle cells. Then, this ionic current will be converted into electronic current with surface electrodes placed on the surface of the skin measure[28].

For this project, the surface electrode type Ag-AgCl will be used. Ag-AgCl is the common most common composite for the metallic part of surface electrode. To make sure the conductivity of the surface electrode, an electrolytic gel is used as an interface between the skin and the metallic part of the electrode. The AgCl layer allows current from the muscle to pass freely across the junction between the electrolyte and the electrode. Due to this, less electrical noise will produce as compared with equivalent metallic electrodes and because of this, this type of surface electrode are used in over 80% of surface EMG applications. In the market, there are disposable and reusable electrodes. The disposable electrodes are the most common size there are very light and it comes in a wide assortment of shapes and sizes. With proper application, the disposable electrodes can minimize the risk of electrode displacement even during rapid movement.

However, since the electrodes area applied on the skin, some limitations must take into action. The surface electrode are must use on the muscle that close to the surface of the skin only and the position of the electrodes must be kept stable with skin in order to avoid the distortion effect.

3.4 Signal Acquisition

Figure 3.3: Block diagram of Signal Acquisition

For Signal Acquisition, KL720 was used. The KL720 Biomedical Measurement System of KL-720 as in Figure 2.10 is equipment, which helps in designing and understanding the basic in biomedical instrument. It contains many modules such as Electrocardiogram , Electromyogram (EMG), Respiratory Ventilation Detection and others. The output can be displayed to either on oscilloscope or computer with its software being installed in.

For this project, EMG module was used. This module will monitor the change of the electrical potential on different muscles activities, including conscious controls and triggering events of muscle. The block diagram of the EMG measurement of the KL720 module as shown in Figure 3.4.

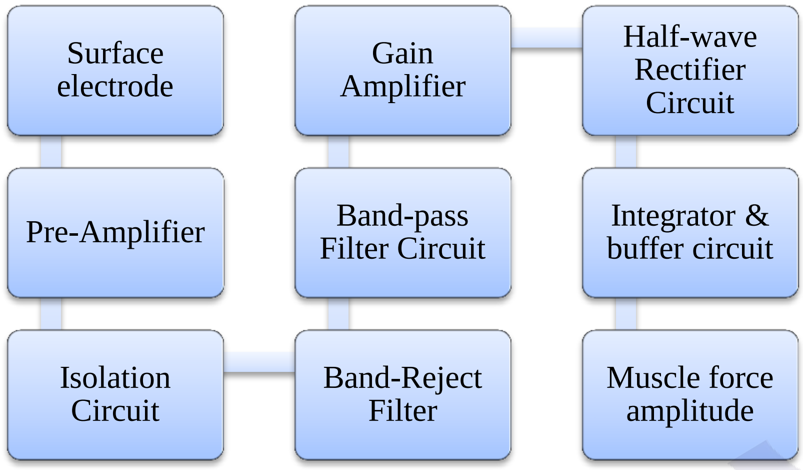

Figure 3.4: Block Diagram of EMG Measurement.

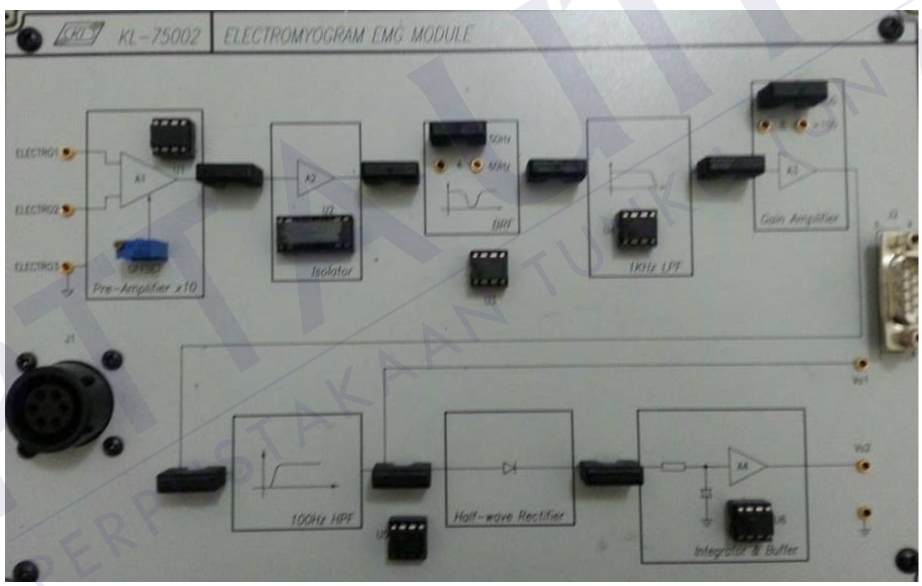

Figure 3.5: KL720 EMG Module

The next step is to display and save the signal that have been captured by KL720 EMG module. The output from KL720 EMG module will be connected to analogue input of MyDAQ. NI myDAQ is a low-cost data acquisition (DAQ) device that gives the user the ability to measure and analyse live signals anywhere, anytime. NI myDAQ includes two analog inputs and two analog outputs at 200 kS/s and 16 bits, allowing for applications such as sampling an audio signal; eight digital inputs and output lines, providing power for simple circuits with +5, +15, and -15 volt power supplies; and a 60 V DMM to measure voltage, current, and resistance.

After acquiring of the EMG signal from MyDAQ, in order to analysis the data, a program is developed in LabVIEW for acquiring to LabVIEW environment. Block diagram and front panel of program is shown in Figure 3.7 and Figure 3.8. The block diagram was programmed so that the user can display and save the signal capture for analysis purpose.

Figure 3.6: NI MyDAQ

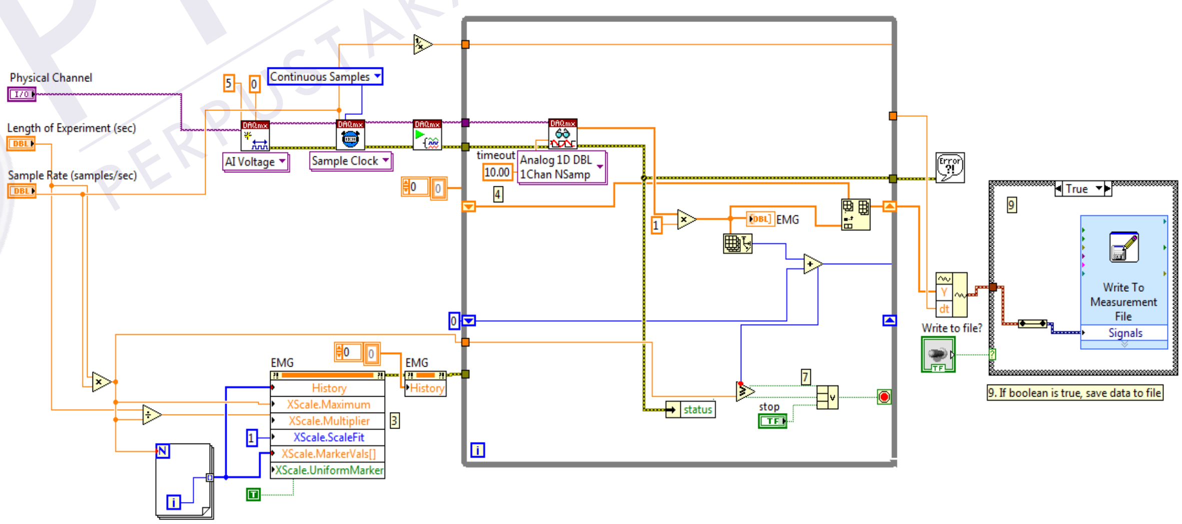

Figure 3.7: Block diagram of program to acquiring the signal in LabVIEW

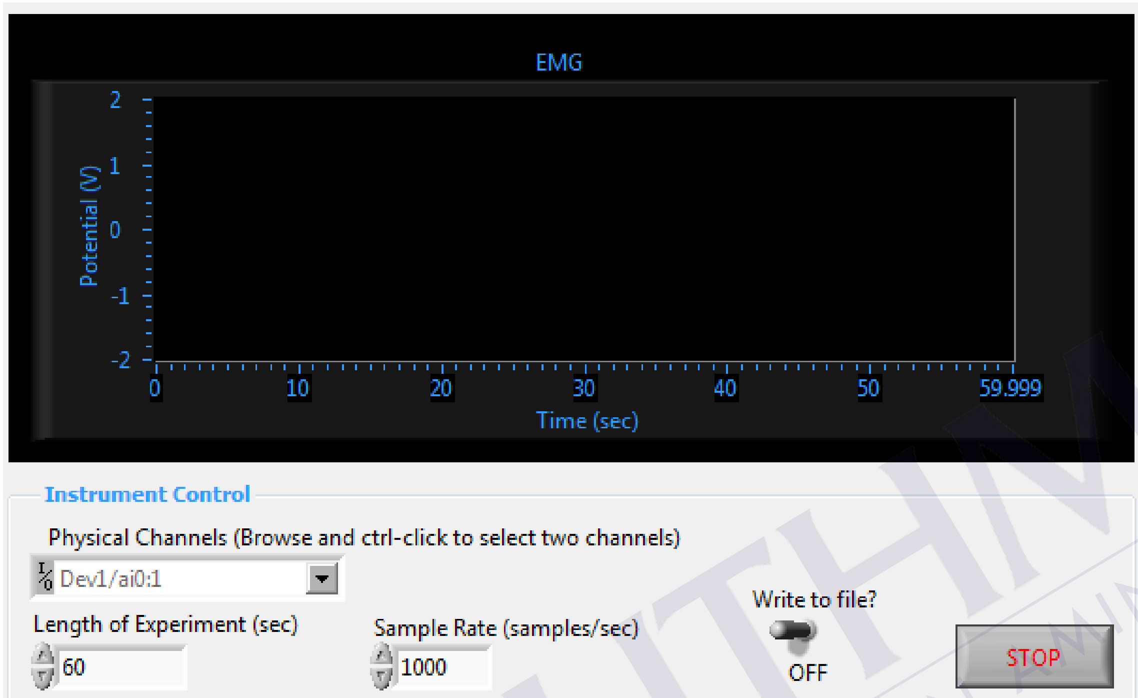

Figure 3.8: Front panel of program to acquiring the signal in LabVIEW

3.5 Signal Classification

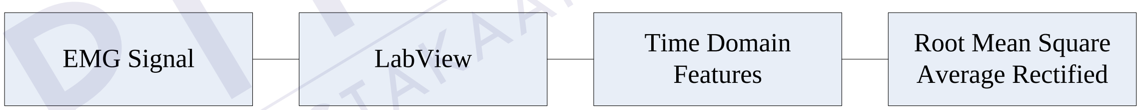

Figure 3.9: Block diagram of signal classiification

For Signal Classification of the SEMG signals is done by using LabVIEW. A program was made for reading the EMG signal which recorded by the system. Time domain features of EMG signal like Root Mean Square and Average Rectified EMG will be discussed in this project.

Each set of raw data consists of 10 samples and each sample contains 3 different motions which are turn left, right and forward. Each sample is recorded for 6 sec of time window. There are several approaches to feature extraction specifically relevant to EMG data. (1) Temporal and (2) spectral. In the presented work, only temporal feature are selected. The signal classification are summarized as fallows

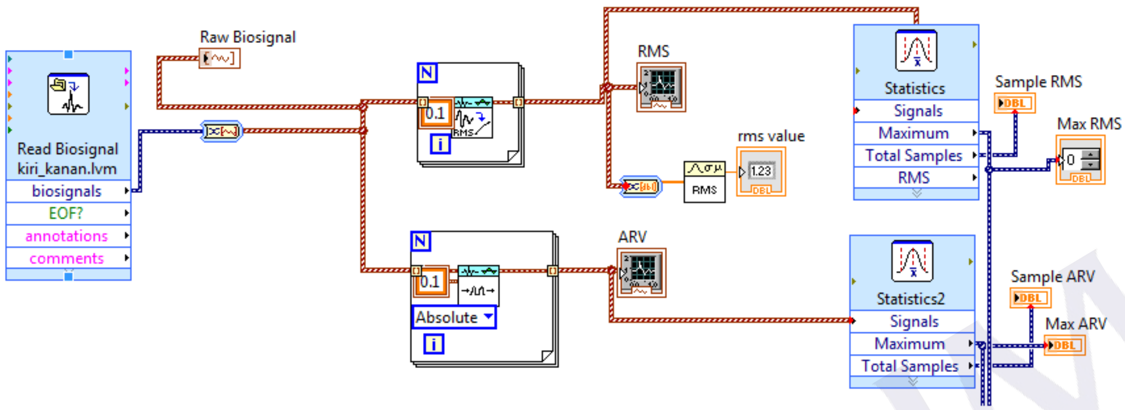

Figure 3.10: Block diagram of program to classify the signal in LabVIEW

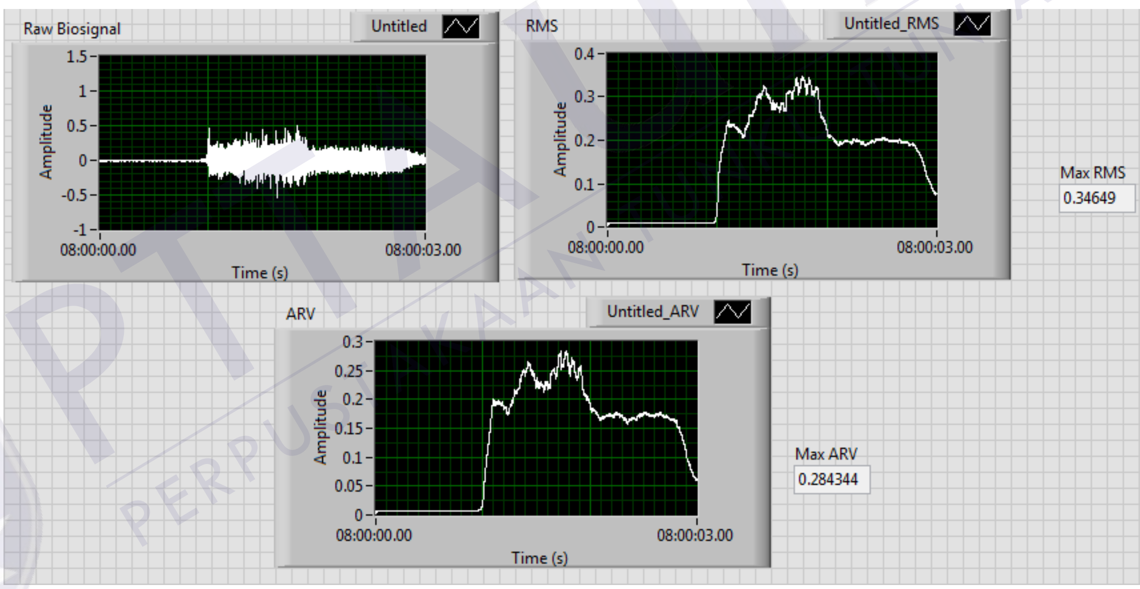

Figure 3.11: Front panel of program to classify the signal in LabVIEW

3.5.1 Read Bio signal

This function is to read bio signal from files that have been saving in 4.3. This VI read bio signal block by block and supports reading multiple channels and reading annotations. The signal was taken for 5 seconds only. Figure X shows the amplitude of the raw signal from KL 710.

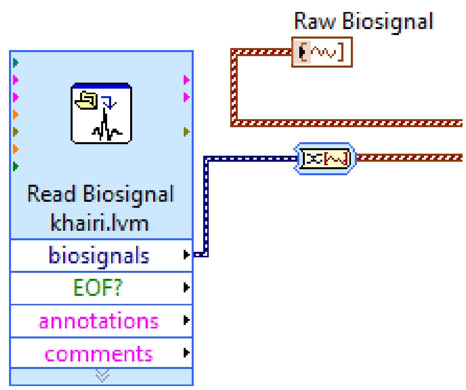

Figure 3.12: Read Bio signal VI

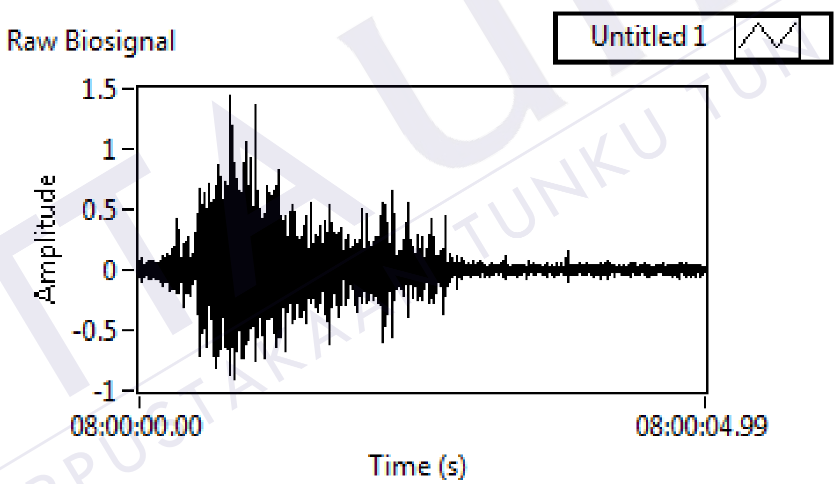

Figure 3.13: Raw bio signal of EMG

3.5.2 Root Mean Square (Vrms)

The root mean square (abbreviated RMS or rms), also known as the quadratic mean, is a statistical measure of the magnitude of a varying quantity. It is especially useful when variants are positive and negative. The RMS value of a set of values (or a continuous-time waveform) is the square root of the arithmetic mean (average) of the squares of the original values (or the square of the function that defines the continuous waveform).

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