Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF ELECTROMYOGRAPHY SIGNAL CLASSIFICATION FOR MUSCULOSKELETAL DISORDERS

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Bachelor of Electronics Engineering Technology with Honours

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A project report submitted
in partial fulfillment of the requirements for the degree of
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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.

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Supervisor Name : TS. DR. NORHASHIMAH BINTI MOHD SAAD

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DEDICATION

For the rest of my life, I will be grateful to my dear parents for their love, vision, and sacrifice. Without them, I doubt I would have progressed as far as I have in university. I'm at a loss for words to express my gratitude for your commitment, support, and belief in my abilities to attain my goals. Finally, I'd like to express my gratitude to everyone who helped me with my senior project, whether directly or indirectly.

ABSTRACT

Due to the extreme evolution of biomedical and healthcare applications, there are various methods for monitoring muscle health status. The electromyography signal , which has been used to detect the electrical signal produced by the muscles, is being employed in this study to detect the muscle condition of a musculoskeletal disorders (MSDs). A random sample of persons is chosen to assess their muscle health and identify if they are at risk of acquiring musculoskeletal disorders or already have them. By doing some exercises utilizing the Functional Range of Motion (FROM) task, the test can assess muscular fatigue. The data will be extracted in MATLAB, and the subjects will be separated into two groups: normal and musculoskeletal disorders. The machine learning technique which is Support Vector Machine (SVM) technique is will be used to distinguish between normal and musculoskeletal disorders as the classification method.

ABSTRAK

Oleh kerana evolusi biomedikal dan aplikasi kesihatan yang melampau, terdapat pelbagai kaedah untuk memantau status kesihatan otot. Isyarat elektromiografi, yang telah digunakan untuk mengesan isyarat elektrik yang dihasilkan oleh otot, digunakan dalam kajian ini untuk mengesan keadaan otot gangguan muskuloskletal (MSD). Sampel rawak seseorang dipilih untuk menilai kesihatan otot mereka dan mengenal pasti jika mereka berisiko mendapat gangguan muskuloskeletal atau sudah mengalaminya. Dengan melakukan beberapa latihan menggunakan fungsi Functional Range of Motion (FROM), ujian dapat menilai keletihan otot. Data akan diekstrak dalam MATLAB, dan subjek akan dipisahkan menjadi dua kumpulan: gangguan normal dan muskuloskeletal. Teknik pembelajaran mesin yang merupakan teknik Support Vector Machine (SVM) akan digunakan untuk membezakan antara normal dan gangguan muskuloskeletal sebagai kaedah klasifikasi.

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CHAPTER 1

INTRODUCTION

1.1 Background

Musculoskeletal diseases (MSDs) affect the muscles, nerves, tendons, joints, cartilage, and spinal discs. Thus, most people are unaware that lifestyle, profession, and age can all influence the risk of developing musculoskeletal disorders. Furthermore, Musculoskeletal Disorders (MSDs) are the second most prevalent cause of impairment in the workplace, causing weariness and lowering worker productivity.

Electromyography (EMG) signals can be used to examine a patient's Musculoskeletal Disorders (MSDs). Surface-EMG signals include bowing, applauding, handshaking, embracing, leaping, running, standing, sitting, walking, and waving are all types of physical behaviors that can be used to diagnose it. Electromyography (EMG) signals can therefore be utilized in clinical and biological settings. Advanced techniques are required to detect, break down, process, and categorize EMG signals collected from muscles. Moreover, the EMG signal is a biomedical signal that represents neuromuscular activities by measuring electrical currents generated in muscles during contraction. As we know, the neurological system is always in charge of muscular activity, including muscle contraction and relaxation.

Other than that, the most significant data mining for electromyography signals is the application of machine learning. The algorithms frequently identify whether a sentence is favorable or unfavorable. The retrieved characteristics were divided into four categories. In the literature, binary sentiment classification and multi-class sentiment classification are two of the most commonly used approaches for sentiment classification. Thus, k-Nearest Neighbor (k-NN), Linear Discriminant Analysis (LDA), Naive Bayes (NB), and Support Vector Machine (SVM) classifier algorithms are incorporated in EMG. Those classifiers are very often use in electromyography signal classification for musculoskeletal disorders.

1.2 Problem Statement

Musculoskeletal Disorders (MSDs) is common problem among people in society. Thus, there are some problem to detect the musculoskeletal among people. This is because there are some problem of manual screening of Musculoskeletal Disorders (MSDs) by clinician and doctors. There are many methods to classify the electromyography (EMG) signal using machine learning for musculoskeletal disorders. Besides, can the electromyography signal can be classified by using the machine learning technique for musculoskeletal disorders. Moreover, there are classifiers algorithm that implemented to electromyography (EMG) such as k-Nearest Neighbor (k-NN), Linear Discriminant Analysis (LDA), Naïve Bayes (NB) and Support Vector Machine (SVM). Thus, which classifiers algorithm that good for electromyography (EMG) signal classification for musculoskeletal disorders.

1.3 Project Objective

i. To develop electromyography signal classification by using machine learning technique.

ii. To investigate the musculoskeletal disorders performance parameters by using electromyography (EMG).

iii. To verify the performance parameters of musculoskeletal disorders classification in terms of accuracy for electromyography signal classification.

1.4 Scope of Project

To achieve the goals of this study, many requirements must be met to decide if Electromyography signals, when evaluated and classify using machine learning technique, can detect the presence of musculoskeletal disorders:

1. 10 randomly selected individuals were eligible to participate as respondents.
2. As part of a health ethics policy involving humans, respondents or subjects will be given a consent form to fill out.
3. Using Shimmer machine, each respondent must complete a series of repetitive tasks to capture the electrical signal. This study's workout programme is designed primarily for upper-limb muscles.
4. Each activity’s data is processed and interpreted after it has been obtained.
5. The effect of the electrical signal will be demonstrated using MATLAB software.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this era globalization, musculoskeletal disorders are most common problem among society. This problem commonly occurs among worker who work at the construction place. There are several techniques to identify the musculoskeletal disorders among people nowadays. The electromyography technique is very popular to detect the musculoskeletal disorders. Furthermore, there also have several machine learning techniques to classify the electromyography signal to detect musculoskeletal disorders.

2.2 Musculoskeletal disorders

Musculoskeletal Disorders (MSDs) are shared all over the world, according to (Hales and Bernard, 1996), and they are the second most common cause of disability in the workplace, reducing employees' fatigue and productivity. MSDs refer to accidents and illnesses affecting the human body's movement or musculoskeletal system, which includes muscles, tendons, ligaments, nerves, discs, blood vessels, and other structures. Workplace aches and strains may be significant and harmful for employees, causing pain and suffering ranging from mild discomfort to severe incapacity as a result of MSD issues. All of these illnesses account for 40-50 percent of the total cost of all work-related illnesses. Work-related absences account for 50% of all absences of more over three days, while MSDs account for 49% of absences of more than two weeks.

MSDs may have a complex and negative influence on one's health, and recovery may take a long period, extending beyond the treatment and rehabilitation phase. When it affects the back, lower limbs, and notably the upper limbs and neck, the new term work-related musculoskeletal condition has less etiological implications, but it may be exceedingly expensive if not managed properly. It is critical to avoid MSDs in the lower or upper limbs, which may have both direct and indirect effects on the person as well as the company's productivity. There is a clear relationship between MSD development and exposure to work-related risk factors, according to (Zawawi *et al.*, 2018).

Musculoskeletal diseases are a collection of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, peripheral nerves, and blood vessels that support them. Tendon inflammatory response and associated illnesses (tenosynovitis, epicondylitis, bursitis), nerve compression disorders (carpal tunnel syndrome, sciatica), and osteoarthrosis are among them less well-standardized conditions like myalgia, low back pain, and other regional pain syndromes not directly related to known pathology.The low back, neck, shoulder, forearm, and hand are the most typically affected body parts, while the lower extremities have lately garnered greater attention based on (Ã and Wegman, 2004).

MSDs are three to four times more common in particular sectors and vocations than in the general population. Nursing homes, air transportation, mining, food processing, leather tanning, and hard and soft industries (automobiles, furnishing, equipment, electrical and mechanical devices, textiles, clothes, and shoes) are all high-risk industries. Manual-intensive activities, such as secretarial work, mail service, housekeeping, environmental monitoring, and packing, are also high in upper extremity musculoskeletal diseases. Drivers, warehouse staff, airline baggage handlers, building trades, nurses, nursing aides, and other patient-care employees, and workers of excavators and other heavy vehicles are also at risk for back and lower limb illnesses.

2.2.1 Musculoskeletal Disorders Risk Factors

2.2.2 Ergonomic Risk Factors

In the evolution of an MSD, workplace design is critical. A worker's musculoskeletal system is placed at danger when he is required to execute work that is above his body's capabilities and limits. In these cases, an objective assessment of the work methods indicates that the worker's recovery mechanism will be unable to maintain with the weariness generated by the task. The evaluation will disclose that there are ergonomic risk factors, that the worker is at risk of developing a musculoskeletal imbalance, and that a musculoskeletal ailment is a near-certainty. Furthermore, there are three primary ergonomic risk factors that lead to musculoskeletal disorder which are high task repetition, forceful exertions and repetitive or sustained awkward postures.

According to (Middlesworth, 2019), the first ergonomic risk factor is high task repetition. As a result, many work activities and cycles are tedious due to high task repetition. Furthermore, they are frequently regulated by output targets and work processes set annually or regularly. Furthermore, Excessive work repetition can lead to MSD paired with other risk factors like excessive force and awkward postures. If the cycle time is fewer than 30 seconds, the work is deemed very repetitive. On the other hand, forceful exertions are the second ergonomic risk factor. Furthermore, many occupations need considerable amounts of energy from the human body. Muscle effort rises in tandem with higher force demands, resulting in fatigue and an increased risk of MSD.

Lastly, the third ergonomic risk factor is repetitive or sustained awkward postures. As a resultRepetitive or continuous inconvenient postures put unnecessary strain on joints and overwork the tendons and ligaments around the afflicted joint. When joints in the body are in the center of their range of motion, they are most effective. The risk of MSD rises when joints are manipulated beyond this midpoint frequently or for long periods without enough recovery time. MSD is more likely among workers exposed to specific occupational risk factors. High job repetition, intense exertions, and repetitious abnormal postures exhaust the worker's body beyond its capacity to recuperate, resulting in musculoskeletal imbalance and, ultimately, an MSD.

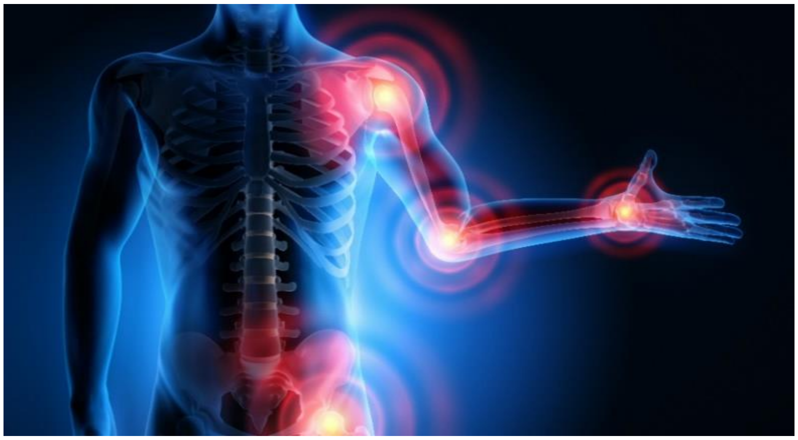

Figure 2.1 Example of musculoskeletal disorder

2.2.3 Individual Risk Factors

Moreover, based on (Middlesworth, 2019), individual risk factors another risk factors that also can lead to musculoskeletal disorder. Firstly, poor work practices are one of the individual risk factors. Besides, poor work practices are poor working conditions, body mechanics, and lifting methods expose workers to needless risk factors that may lead to MSDs. These unhealthy behaviors place unnecessary stress on their bodies, making them tired and limiting their ability to recover properly. Thus, poor rest and recovery is another individual factor that can lead to musculoskeletal disorders. MSDS happens when a worker's recovery system is overburdened, resulting in musculoskeletal imbalance. Individuals who do not get adequate rest and recovery are jeopardizing their health.

Lastly, poor nutrition, fitness and hydration is individual risk factors that may lead to musculoskeletal disorders. For a wealthy nation like the United States, an astounding number of individuals are underweight, exhausted, and physically inactive to the point that ascending one stairway leaves many individuals out of breath. Individuals who may not take care of the body increase their chances of having health problems involving the musculoskeletal system and chronic illnesses. Workers exposed to these risk factors are more likely to develop MSD.

2.3 Electromyography

According to (Zawawi *et al.*, 2013, 2018),Electromyography (EMG) is the monitoring of electrical muscle action and should be included as part of the surgical assessment. Because EMG created by muscle fibers provides an EMG signal, the nervous system will have to govern muscle activation during contraction. This methodology uses an electromyography approach to create a signal graph, which is known as electromyography. It employed electrodes to transmit or compute the electrical signal from the muscle during these processes. EMG may also be used to assess muscular strength and endurance, particularly in the lower back, which is the most practical location for muscle data collection. When various stimuli trigger muscle motor units, an electrical signal is created. The signal is non-stationary throughout, and the signal generator's frequency component is often represented in terms of signal intensity.

Furthermore, according to (Basics and Electromyography, 2005),it may also disclose a distinction between myopathic and neurogenic muscle disorders in terms of muscle atrophy and tiredness. It may identify anomalies such as persistent denervations or fasciculations in clinically stable muscles. Thus, supported by It can distinguish between focal nerve, plexus, and radicular illness by looking at the distribution of neurogenic abnormalities. It might give strong evidence for axonal degeneration or demyelination as a cause of peripheral neuropathy. EMG is necessary for a good diagnosis of motor neuron illness because it shows extensive denervation and fasciculation.

There are two kinds of EMG electrodes that are often utilized in the healthcare profession. Two kinds of electrodes are extensively employed in treatment for therapeutic purposes: the electrode and the outer layer electrode intramuscular tiny needle. Traditional EMG employs a small needle to assess muscle activity, while surface EMG employs a surface electrode. The shape and content of the EMG signal may be influenced by a variety of circumstances. Tissue qualities, geometrical changes between the muscular belly and the electrode position, physiological cross-discussion, and this mechanism, known as the Poisson process due to the neural pulse impulse process, would all alter the EMG signal.

Muscle excitation or activity creates an electromyography (EMG) signal, which is a complicated bioelectricity process. Some intricate signals occur with the biochemistry process in terms of physiology. The nerve system's anatomical and physiological features muscles influence the signal. It may be employed in clinical or biological settings, as well as for human-computer interaction. Advanced approaches for EMG signal analysis are required for signal identification, breakdown, processing, and categorization. The approach gives a quick and easy approach to comprehend the signal and its surroundings.

2.4 Electromyography (EMG) Signal Analysis

The smallest functional unit of a muscle that may be triggered by brain control is the motor unit (MU), which is made up of muscle tissue stimulated by a single -motor neuron. Activation of the -motor neuron causes tension to rise in the corresponding muscle tissue as the action potential propagates through the path of these connected fibers, culminating in muscular force generation within a MU. Relaxation occurs when the -motor neuron stops operating.

Surface electromyography (sEMG) involves putting an electrode on the overlaying skin surface or introducing an electrode into muscle tissue, the total action potentials of these muscle fiber contractions in a MU are monitored. The voltages measured by the electrode represent the overall activity of all MUs that are currently operational (the sum of the contributions of all MUPs).