AN IMPLEMENTATION OF LEAST SQUARE SUPPORT VECTOR MACHINE (LS-SVM) FOR REHABILITATION BIO-SIGNAL ANALYSIS USING SURFACE ELECTROMYOGRAPHY (SEMG) SIGNAL

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This report is submitted in partial fulfilment of the requirements for Bachelor of Computer Science (Artificial Intelligence)

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
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2014

DECLARATION

I hereby declare that this project report entitled

AN IMPLEMENTATION OF LEAST SQUARE SUPPORT VECTOR MACHINE (LS-SVM) FOR REHABILITATION BIO-SIGNAL ANALYSIS USING SURFACE ELECTROMYOGRAPHY (SEMG) SIGNAL

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DEDICATION

Bismillah

I dedicate this thesis to my beloved Mom and Dad and Dr. Choo.

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ABSTRACT

This study are discussing about an implementation of LS-SVM for rehabilitation bio-signal analysis using surface slectromyogram (sEMG) signal. The sEMG has been widely used in clinical rehabilitation for its strong relationship with human muscle movement characteristics. The sEMG have been used in numerous studies for classification and have been successful implemented mostly on biofeedback system. But, the sEMG signal that obtains in the muscle is lost due to mixing with the high noise. Therefore, the goal of this study is to design the LS-SVM algorithm for muscle fatigue classification to enhance the accuracy and robustness in the classification process even though the present of high noise. The sEMG signal captured from the multifidus muscle and at flexor carpi radialis muscle is then will go through the features extraction process to obtain the root mean square (RMS), median frequency (MDF) and mean frequency (MF) features for better classification. The proposed LS-SVM that are been introduced by Suykens and Vandewalle in 1999 for classifies the muscle fatigue signal. Besides, many studies in support vector machine that was implement to classifies classes of different force intensity from the sEMG signal and validity are been carry out. The k-nearest neighbour (k-NN) and artificial neural network (ANN) will be the benchmark to the LS-SVM due to the widely use in the classification of bio-signal analysis. At the end of this experiment, the result shows that the accuracy and ROC value of LS-SVM have significant better than two other benchmarking technique and more robust.

ABSTRAK

Kajian ini membincangkan tentang pelaksanaan LS-SVM untuk analisis pemulihan bio-signal menggunakan surface slectromyogram (sEMG) signal. SEMG yang telah digunakan secara meluas dalam pemulihan klinikal untuk hubungan yang kukuh dengan ciri-ciri pergerakan otot manusia. SEMG yang telah digunakan dalam banyak kajian untuk classification dan telah berjaya dilaksanakan kebanyakannya pada sistem biofeedback. Tetapi, sEMG signal yang mendapat dalam otot hilang akibat bercampur dengan noise yang tinggi. Oleh itu, matlamat kajian ini adalah untuk mereka bentuk algoritma LS-SVM untuk pengelasan muscle fatigue untuk meningkatkan ketepatan dan kemantapan dalam proses classification walaupun mempunyai noise yang tinggi. Signal sEMG yang diperolehi dari otot multifidus dan pada otot flexor carpi radialis kemudiannya akan melalui proses features extraction untuk mendapatkan root mean square (RMS), median frequency (MDF) dan mean frequency (MF) bagi mempunyai pengelasan yang lebih baik. LS-SVM yang dicadangkan telah diperkenalkan oleh Suykens dan Vandewalle pada tahun 1999 untuk classification muscle fatigue. Selain itu, banyak kajian dalam LS-SVM yang dijalankan untuk mengelaskan kelas intensiti tenaga berbeza daripada signal sEMG dan kesahihan telah diperolehi. k-nearest neighbour (k-NN) and artificial neural network (ANN) akan menjadi penanda aras kepada LS-SVM kerana penggunaannya secara meluas dalam klasifikasi analisis bio-signal. Pada akhir eksperimen ini, hasilnya menunjukkan bahawa accuracy dan nilai ROC bagi LS-SVM adalah yang terbaik daripada dua teknik penanda aras yang lain dan lebih stabil.

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LIST OF ABBREVIATIONS

LS-SVM	-	Least Square Support Vector Machine
SVM	-	Support Vector Machine
k-NN	-	K nearest Neighbour
ANN	-	Artificial Neural Network
RBF		Radial Basis Function
LBP	-	Low Back Pain
EMG	-	Electromyogram
sEMG	-	Surface electromyogram
RMS	-	Root Mean Square
MDF	-	Median Frequency
MF	-	Mean Frequency
ROC	-	Receiver Operating Characteristic
AUC	-	Area Under Curve

CHAPTER I

INTRODUCTION

1.1 Introduction

Surface Electromyogram (sEMG) has been widely used in clinical rehabilitation, sport sciences fields and etc. for its strong relationship with human muscle movement characteristics. sEMG also have been used in numerous studies for classification and have been successful implemented mostly on biofeedback system. In this study, two experiments are carried out for capturing sEMG data from the multifidus muscle and at flexor carpi radialis muscle. From the multifidus muscle signal collected, RMS, MDF and MF features were extracting from the signal, meanwhile for flexor carpi radialis muscle, the RMS and MDF are been extracted. In this study, I am proposed the least square support vector machine (LS-SVM) that are been introduced by Suykens (Chattamvelli, 2009) and Vandewalle in 1999 (Suykens et al, 1999) for classifies these two datasets to classes. Other researcher, they do many studies in support vector machine (Xu et al, 2012) that was implement to classifies classes of different force intensity from the sEMG signal and validity are been carry out. Nevertheless, neural network (Shi et al, 2012) also is one of the popular methods that are use in sEMG classification analysis despite of others. Equally important to note, validity of measurement is in term of receiver operating characteristic (ROC) curve the true positive rate (Sensitivity) is plotted in function of the false positive rate (100-Specificity) for different cut-off points and accuracy whereby when the values are nearest or more to 1 (1) are better. One means no error. The ROC and accuracy value of LS-SVM will be compared to k-nearest neighbour (k-NN) and artificial neural network (ANN) as benchmark.

Nowadays, Malaysian are been bound with the serious low back pain (LBP) and fatigue that causes from the different heavy task for a long time. LBP ranks into second in neurological problems (nervous system), according to Spine Surgeon, Dr Siow Yew Siong. LBP indicates there is something wrong with nerves system in human body. Healthy nerve should move freely within the body to ensure the blood supply, the exchange of body fluids and nutrients to the perfect place.

Therefore, to detect the LBP problem from the early stages, the Surface Electromyogram (sEMG) has been used to analyze the characteristic of the normal and the LBP or fatigue person. Based on the previous studies, the sEMG have a very high noise cause of the several factors such as skin resistance, noise interruption, muscle involved and electrode location will directly influence the dominant EMG signals.

At the end of these experiments, it will show that LS-SVM classifier can be implemented to the RMS, MDF, and MF features giving more true positive rates in ROC and higher accuracy and been proved with statically analysis.

1.2 Problem Statement

The using of single channel electrode for collected the muscle activity are because of the low cost, compact and easy to use. We don't need to use many electrodes to collecting the muscle activity. Nevertheless, there are having the limitation of the using the only single channel for collecting the sEMG signal. Later, it will give the high influence in collecting the raw data. This can cause of the miss placed of the electrode location and the signal collected will be mixed up with noise. The noise is still in the signal even though the pre-processing for cleaning the data has been done, it is not confirmed that the signal are 100% clean. Therefore, in order to classifies the mixed signal with noise, to propose a good classifier is a very important thing. In addition, there were a few studies that use only single channel electrode for classifies the muscle fatigue signal. Therefore, this is the one of the factors that I want to purpose this project.