UNIVERSITI TEKNOLOGI MARA

EEG SIGNAL CLASSIFICATION AND CORRELATION ANALYSIS FOR ACTUAL AND IMAGINARY HAND MOVEMENT

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ABSTRACT

Brain-Computer Interface (BCI) is a new emerging technology that provides an alternative medium of communication where the human brain (via electroencephalography signals) can communicate with the computer and other electronic peripherals. In this particular domain, various studies have been conducted to analyse and decode Electroencephalography (EEG) signals. This study aims to identify and adopt suitable methods and analyses to distinguish distinct brainwave patterns with the occurrence of actual and imaginary hand lifting movements. Another aim of this study is to find a correlation between actual and imaginary EEG triggered data, specifically on lifting left and right hand. Scoping down into a more specific area, this research focuses on using different types of feature extraction methods by experimenting with Artificial Neural Network (ANN) and Support Vector Machine (SVM) for classification. While correlation analysis was performed to find the relationship between different events. For data collection purpose, an experimental procedure is designed especially to record EEG signals from the subjects while doing either the actual or imaginary hand movements. The recorded raw EEG signals were first preprocessed before they can be analysed. Coefficient values obtained from the extracted features i.e. Energy Spectral Density (ESD) and Power Spectral Density (PSD) were fed as inputs to the ANN and SVM classifier for classification purpose. For SVM classifier the analysis is divided into three types of kernel function i.e. Linear Kernel, Quadratic Kernel and Polynomial Kernel. Based on the obtained results, it is shown that the extracted PSD features can work well with ANN and SVM classifier. The average accuracy to differentiate between actual movements of lifting the left and right hand was obtained at 93% when using ANN classifier, while in average the accuracy measure obtained for SVM classifier was more than 70%. The average accuracy for differentiating between imaginary lifting left and right hand was acquired at 76.25% by the ANN classifier and, 77.5% by the SVM classifier. While for the combined dataset of both actual and imaginary, the average accuracy values were 85.65% by the ANN classifier and 82.9% by the SVM classifier. From the results, it is shown that PSD is the best method to extract useful EEG features for classification analysis in this research context. In finding the relationship between actual and imaginary hand movement, a correlation analysis was performed. The result shows that there is a positive correlation between imaginary and actual right-hand events with 0.564 value, which indicates moderate correlation. Having done all of this analyses, the positive outcomes of this research are expected to be useful contributions towards the development of a BCI platform especially to effectively decode the EEG signals interpreted as commands from the brain.

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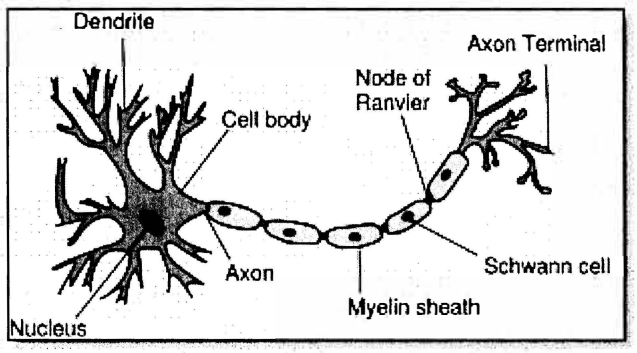
CHAPTER ONE
INTRODUCTION

1.1 Research Background

To provide the right context, this section will start with an explanation of the basic structure and functions of the human brain and what electroencephalography is. In this chapter, we will cover the aims and scope of this research, the problem statements, objectives, and significance of this study.

1.1.1 Human Brain

The brain is the most important part or organ of the human body. It controls all activities in the human body. There are specialised cells found in the brain called neurons (refer to Plates 1.1) and they come in many different shapes but share some common features. The brain is made up of billions of neuron cells that are interconnected with each other that form a larger network called neural networks. A common feature of neurons is that each of them has a cell body (or soma), an axon and one or more dendrites. The cell body contains the nucleus which controls all the activities inside the cell. The axon carries electrical impulses generated by the cell body and transmits the information to other neurons. Dendrite is the part where all the information is received from other neurons, often from many different sources. A neuron cell uses an electrical impulse to transmit information to other neurons.



Plates 1.1 Common Features of a Neurons Cell

The human brain can be divided into three main parts: the cerebellum,