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DEVELOPMENT OF A 3D EEG FEATURE EXTRACTION FOR BRAIN BALANCED INDEX (BBI) USING ARTIFICIAL NEURAL NETWORK (ANN)

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ABSTRACT

The thesis presents the development of a new three-dimensional (3D) EEG feature extraction for brain balanced index (BBI) using artificial neural network (ANN). There were five (5) indexes stated for BBI, index 1 (unbalanced condition), index 2 (less balanced), index 3 (moderately balanced), index 4 (balanced) and index 5 (highly balanced). There are four (4) sub-bands of frequency for EEG signals; δ band (0.2- 3 Hz), θ band (3- 8 Hz), α band (8-12 Hz) and β band (12-30 Hz). These sub-bands can be used to analyze human brain activities. This research involved 96 healthy subjects for EEG data collection. The EEG 3D signals are produced through signal processing and image processing techniques. The development of 3D involved preprocessing of raw EEG signals and construction of 2D EEG images or spectrograms. EEG signals are pre-processed using artifact removal and band pass filter technique. The resultant images for 2D EEG image are constructed via Short Time Fourier Transform (STFT). Power spectral density (PSD) values are extracted as features. Some techniques for data analysis like Shapiro-Wilk for data distribution analysis and Pearson correlation for data correlation analysis have been implemented. These features are analyzed to signify the pattern for brain balanced index. There are five (5) patterns found using mean relative power (MRP), difference mean relative power (DMRP), left-right slope (LR_Slope), mean relative power (MRP) ratio and difference mean relative power (DMRP) techniques. The results indicated that the proposed maximum PSD from the 3D EEG signal are able to distinguish the different levels of the brain balanced index. There are two classifiers involved for classification; *k*-Nearest Neighbor (*k*-NN) and Artificial Neural Network (ANN). The PSD values are chosen as input features to the classifier. There are 768 samples of data as inputs to classifiers. The number of training and testing ratio is assessed at 80% (615 samples) to 20% (153 samples) to find the best model based on percentage of accuracy, sensitivity, specificity as well as mean squared error (MSE). The ANN model produces overall classification accuracy of 88.89%, sensitivity within range 87.50% to 92.31% and specificity within range 94.92% to 98.82%. The classification accuracy using *k*-NN classifier is 84.96%. The sensitivity was obtained within range 83.33% to 88.88% and specificity within range 93.02% to 97.35%. The ANN model produces higher accuracy compared to *k*-NN.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Brain balanced can be defines as the usage of both brain hemispheres (right and left hemisphere). Human brain balanced is important and it is dependent on human emotion [15]. There are a lot of problems in current human life that produce the negative emotions like not fell in well-being, unhappy, insecure, unsatisfied, not relaxed and unhealthier [15]. These negative emotions will disturb the brain condition. Currently, there are interesting works on human brain condition which are related to human cognitive and potential [15-17,19,20,22]. Currently, human wants to know the condition of somebody physiology and cognitive. Therefore, this is become the intervention on this research.

Nowadays, there are a lot of researches have done by psychology and cognitive researchers in human cognitive and potential area, but for human brain balanced are still new and no proper or accurate results. Researchers have introduced qualitative and quantitative methods to recognize brain balanced, the former method normally employs self-report questionnaires while the latter method analyses human physiological signals [19]. Physiological signals such as electroencephalogram (EEG), electrocardiogram (ECG), magnetoencepdiography (MEG), galvanic skin response (GSR), electrocardiogragram (EMG), electromyogram (EMG) and respiration rate can be utilized to identify human brain balanced.

Referring to the scenario, EEG is very important. It is suitable to use because EEG signals can record from human brain. These signals can interpreted for brain state or condition [1, 29, 30, 34, 35]. EEG signals are selected to recognize human brain balanced since the signals are generated from the electrical activity in the human brain due to the change in cognitive state or any stimulation to the brain. Furthermore,