UNIVERSITI TEKNOLOGI MARA

ADVANCED SIGNAL PROCESSING OF EEG SUB-BAND FREQUENCIES IN CHARACTERIZING PSYCHO-PHYSIOLOGICAL CALMNESS

SITI ARMIZA BINTI MOHD ARIS

Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Electrical Engineering

April 2016

CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 5th October 2015 to conduct the final examination of Siti Armiza Mohd Aris on her Doctor of Philosophy thesis entitled "Advanced Signal Processing of EEG Sub-Band Frequencies in Characterizing Physco-Physiological Calmness" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examiners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

Zaiki Awang, PhD
Professor
Faculty of Electrical Engineering, UiTM
(Chairman)

Rozita Jailani, PhD
Senior Lecturer
Faculty of Electrical Engineering, UiTM
(Internal Examiner)

Hj Mohd Alauddin Mohd Ali, PhD
Professor
Faculty of Engineering & Built Environment, UKM
(External Examiner)

Hema C.R, PhD
Professor
Engineering Research,
University of Karpagam, India
(External Examiner)

SITI HALIJJAH SHARIFF, PhD
Associate Professor
Dean
Institute of Graduates Studies
Universiti Teknologi MARA
Date: 11 April 2016

AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

Name of Student	:	Siti Armiza Binti Mohd Aris
Student I.D. No.	:	2008572485
Programme	:	Doctor of Philosophy (Bio-Medical Engineering)
Faculty	:	Faculty of Electrical Engineering
Thesis Title	:	Advanced Signal Processing Of EEG Sub-Band Frequencies in Characterizing Psycho-Physiological Calmness
Signature of Student	:	....
Date	:	April 2016

ABSTRACT

Electroencephalographic signals or EEG signals are very closely related to psycho-physiological. At present, many types of diseases caused by the psycho-physiological have risen in the society. Early detection of psycho-physiological related problem such as stress, hypertension, depression and others has now become very important. This is due to the modern society lifestyle which contributes to major psycho-physiological problems. The existing practice to patients, who have been detected with psycho-physiological problem, used the assessment methods such as questionnaires and interviews which need expertise to handle the case and resulted in time consuming. Thus, a quick, reliable and simple method to determine the level of psycho-physiological condition is necessary during the treatments which can abridge the time needed to diagnose individuals. This study aim is to demonstrate some mental characteristics related to calmness can be grouped and categorized, hence produced EEG calmness index. To materialize this, asymmetry index was chosen as EEG feature in distinguishing unique characteristics of EEG signals from different brain behaviours named as relaxed state and non-relaxed state. The EEG signals were pre-processed through Fast Fourier Transform and were segmented before the energy spectral density (ESD) was derived. The asymmetry index was calculated using the derived ESD. The different data behaviour between relaxed state and non-relaxed state were verified by means of linear regression method to confirm the data discrepancy. In the EEG calmness categorization subtractive clustering was used to identify the total number of EEG behaviour existed within the data features. The Fuzzy C-Means (FCM) was used to place the data features into the same group and the classification was proven through k-Nearest Neighbour (k-NN). Statistical analysis was also employed to confirm the group selected by the FCM provides significant cluster selectivity. Model of Z-score was used to label the calmness indices and set the Z-value equal to 2σ as the minimum level to become EEG calmness index. From the statistical analysis and Z-score results, three indices can be proposed as calmness indices. This was supported with the k-NN performance measures which confirmed the selection for the three indices with 100% accuracy. Therefore, the number of calmness indices which could be used to represent the EEG calmness is three. The results obtained in this study also suggested that the EEG behaviour during calmness can be categorized. The chosen techniques used in the study and the calmness index have brought a novel finding in the EEG research. It is expected that the established EEG calmness index can be projected for the psycho-physiological diagnosis.

TABLE OF CONTENTS