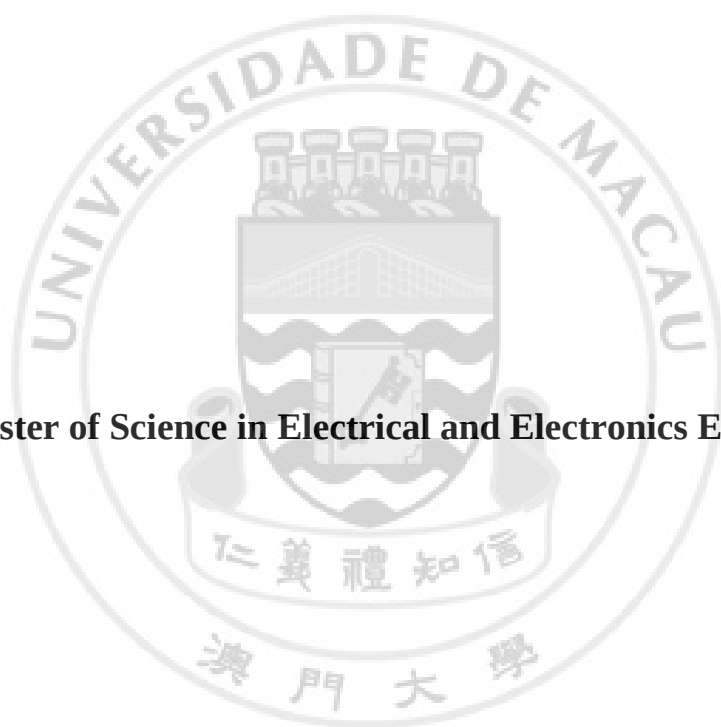


**Electroencephalogram Analysis Based on
Empirical Mode Decomposition**

by

Ng Cheng Man

Master of Science in Electrical and Electronics Engineering



2011



**Faculty of Science and Technology
University of Macau**

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A thesis submitted in partial fulfillment of the
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Supervisor

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Abstract

ELECTROENCEPHALOGRAM ANALYSIS BASED ON
EMPIRICAL MODE DECOMPOSITION

by Ng Cheng Man

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In recent years, several researches and developments have been made in biomedical engineering, which aim to improve the healthcare diagnosis and treatment. Signal analysis methods such as Fourier transform and Wavelet transform are widely used in this field. However, these methods are limited to the linear and stationary signal analysis. As a result, they are not well adaptive methods for biomedical signals, which in fact are mostly nonlinear and non-stationary signals.

Empirical Mode Decomposition (EMD) is a novel technique that has been widely applied in the signal processing. EMD has been demonstrated as a method for the data processing of nonlinear and non-stationary signals. This method is to decompose a signal into a sum of finite number of “intrinsic mode functions” (IMF). In this thesis, EMD scheme is applied to analyze the steady-state visually evoked potentials (SSVEP) in electroencephalogram (EEG). Based on the EMD, the oscillatory activities of the decomposed SSVEP signal are analyzed. It drives us to focus on the investigation of the very low frequency of the SSVEP signal. Based on the observation of the IMF, this thesis proposes a method to detect the transition response when a person turns from an attentively focusing stage into an unfocused attention stage during the experiment. As a consequence, this may be used for detecting the idle period of a SSVEP based Brain-Computer Interface (BCI) system. After the evaluation, the attention-to-rest transition is detected with an accuracy of 82.6%. The

occurrence of the very low frequency can be explained that the attention-to-rest transition will enhance the delta wave in EEG.

Keywords: Electroencephalogram (EEG), Empirical Mode Decomposition (EMD), Intrinsic Mode Functions (IMF), Steady-State Visually Evoked Potentials (SSVEP), Brain-Computer Interface (BCI)



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LIST OF ABBREVIATIONS

BCI. Brain-Computer Interface

EEG. Electroencephalogram

EMD. Empirical Mode Decomposition

ERP. Event-Related Potentials

FT. Fourier Transform

FFT. Fast Fourier Transform

IF. Instantaneous Frequency

IMF. Intrinsic Mode Functions

STFT. Short-time Fourier Transform

SSVEP. Steady-State Visually Evoked Potentials

WVD. Wigner-Ville distribution

WT. Wavelet Transform



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