EFFECT OF TRANSCRANIAL MAGNETIC STIMULATION ON ELECTROENCEPHALOGRAM ACTIVITY AND EMOTIONS

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DEDICATION

This work is dedicated to my dear family and friends and continues support and assistance through my life.

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ABSTRACT

Transcranial magnetic stimulation (TMS) is one of the current approach to stimulate the neurons in the brain, by changing the magnetic fields in that area using electromagnetic induction, neurons with weak signals amplified. Many studies showing that this stimulation can enhance the brain activity, therefore it became one of the trending approaches to study the brain conductivity and excitability, in term of safety many studies has shown that this type of stimulation can be applied with no risk of side effect in normal subjects. In the meantime, there are many theories and many studies about thoughts and physiological behaviour and the origin of emotions and it is agreed to be the brain, and the efficiency of integrating transcranial magnetic stimulation to the brain activity and emotions remains not clearly established. The main objective of this project is to evaluate the effect of transcranial magnetic stimulation of healthy subjects to electroencephalogram (EEG) in response to emotions. Therefore, in this research, sixteen subjects exposed to visual stimulus to induce their emotions is carried out, these emotions measured by using electroencephalogram (EEG) recorder, and the signal amplified by applying transcranial magnetic stimulation (TMS). After that, the data has been recorded and multiple filtering techniques has been applied to filter out the noises, and then followed by feature extraction method to extract the statistical information from the signal using power spectral density, and finally the results classified by using LDA and kNN classifiers. The results of this study showed that transcranial magnetic stimulation could enhance the brain signal and amplify the emotion intensity. Morover, it also help improve the classification accuracy of emotions and the highest emotion effect was afraid 79% using LDA classifier and followed by happy emotion 67% using kNN classifier, and overall classification improved the results also shows that the temporal and occipital lobe mainly invloves in emotion which support previous studies outcome.

ABSTRAK

Rangsangan magnet transkranial (TMS) merupakan salah satu pendekatan semasa untuk merangsang neuron di otak, dengan menukar medan magnet di kawasan itu menggunakan induksi elektromagnet, neuron dengan isyarat lemah diperkuatkan. Banyak kajian menunjukkan bahawa rangsangan ini dapat meningkatkan aktiviti otak, oleh sebab itu ia menjadi salah satu pendekatan tren untuk mempelajari kekonduksian otak dan keceriaan, dari segi keselamatan banyak kajian telah menunjukkan bahawa jenis rangsangan ini dapat diterapkan tanpa risiko efek sampingan dalam mata pelajaran biasa. Sementara itu, terdapat banyak teori dan banyak kajian mengenai pemikiran dan perilaku fisiologi dan asal emosi dan disepakati menjadi otak, dan kecekapan mengintegrasikan stimulasi magnet transkranial kepada aktiviti otak dan emosi masih tidak jelas. Objektif utama projek ini adalah untuk menilai kesan rangsangan magnet transkranial subjek yang sihat kepada isyarat otak dan electroencephalogram (EEG) sebagai tindak balas kepada emosi. Oleh itu, dalam kajian ini, enam belas mata pelajaran yang terdedah kepada rangsangan visual untuk mendorong emosi mereka dijalankan, emosi ini diukur dengan menggunakan perakam electroencephalogram (EEG), dan isyarat yang diperkuat dengan menggunakan stimulasi magnet transkranial (TMS). Selepas itu, data telah direkodkan dan pelbagai teknik penapisan telah digunakan untuk menyaring bunyi-bunyi, dan kemudian diikuti dengan kaedah pengekstrakan ciri untuk mengeluarkan maklumat statistik dari isyarat menggunakan ketumpatan spektrum kuasa, dan akhirnya hasilnya diklasifikasikan dengan menggunakan LDA dan pengelas kNN. Keputusan kajian ini menunjukkan bahawa rangsangan magnet transkranial dapat meningkatkan isyarat otak dan meningkatkan intensitas emosi. Morover, ia juga membantu meningkatkan ketepatan klasifikasi emosi dan kesan emosi tertinggi adalah takut 79% menggunakan pengeluar LDA dan diikuti oleh emosi gembira 67% menggunakan pengeluar kNN, dan klasifikasi keseluruhan memperbaiki keputusan juga menunjukkan bahawa lobus temporal dan occipital terutamanya invloves dalam emosi yang menyokong hasil kajian terdahulu.

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LIST OF ABBREVIATIONS

ANN	-	Artificial Neural Network
DEAP		A Database for Emotion Analysis using Physiological Signals
EEG	-	Electroencephalogram
Hz	-	Hertz
IAPS		International Affective Picture System
kNN	-	k-Nearest Neighbours
LDA	-	Linear Discriminant Analysis
PSD	-	Power Spectral Density
SVM	-	Support Vector Machine
TMS	-	Transcranial Magnetic Stimulation
UTM	-	Universiti Teknologi Malaysia

LIST OF SYMBOLS

α	-	Alpha band
β	-	Beta band
γ	-	Gamma band
θ	-	Theta band
δ	-	Delta band
Ω	-	Ohm Impedance
%	-	Percentage
μ	-	Mean
σ	-	Standard Deviation

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CHAPTER 1

INTRODUCTION

1.1 Problem Background

Transcranial magnetic stimulation (TMS) is one of the noninvasive procedures to improve physiological symptoms like depression; it works by delivering repetitive pulses to the brain and activates it. Therefore, current trends tend to combine it with other measurement technique like EEG to investigate its effect.

TMS can enhance the physiological state of the brain which includes emotions and emotion recognition one of the most topics that widely discussed for various reasons that could minimize the difference between humans and machines and provide higher interaction (1). Emotions also can help with anti-stress therapy and in physiological diagnoses, studies show that using EEG emotion recognition used as an application for healthcare to treat and diagnose patients with mental health (2).

Emotions can also play a major role in human behavior and actions and it has a high impact on marketing and decision making, and emotions is an important factor that is being neglected by the mangers (3). Another study shows that emotions can help influence the virtual reality experience where the interaction of similar virtual environments can generate the same emotions (4).

Emotions defined as the feelings that involve a complex process of thoughts, physiological changes, and expression. And its complex process, which involves many physiological and physical factors like stress, depression, heart rate, and it, can be provoked by a stimulus. The psychoactive effects of these emotions can be recorded by EEG measurement and can be represented in terms of amplitude and frequency waves. In this study, the relationship between emotions to the brain will be investigated by measuring the EEG activity and evoke it using Transcranial Magnetic Stimulation (TMS) and to observe if it can help to increase the amplitude of the brain activity.

1.2 Problem Statement

During the past decade, emotions have been investigated by many studies to evaluate it, Transcranial Magnetic Stimulation (TMS) has been proven to unlock and access to regions in the cortex unable to be accessed by the regular EEG method (5).

However, Transcranial Magnetic Stimulation (TMS) uses an electromagnetic pulse to activate the deep brain neurons, which cause a severe noise in the form of speckles and artifacts to the signal. Moreover, one of the main challenges in physiological behaviors is a distinction between emotions; emotions can vary and does not have a unique form or shape. There are many studies and method to differentiate emotions, and limited evidence conducted regarding the effect of TMS on emotion recognition topic.

Therefore, the effect of Transcranial Magnetic Stimulation to EEG signals and emotions will be investigated and evaluated; it can be measured by designing an appropriate protocol and placing the electrode cap on the scalp of the participants to record the signals of the brains.

1.3 Motivation

Nowadays with the technology advancement, the computer able to mimic the human ability and perform intelligent tasks with more efficiency and less time, with the aid of human emotion recognition computers will be able to perform many tasks. For example, it can be used to identify human mode and motive to choose appropriate tasks and enhance efficiency (1); also, it will improve the human-computer relationship and provide better decision-making and problem solving. It also can be used in healthcare where it can identify a physiological state that cannot be measured by physical signals and help the therapist during their task, in entertainment emotions can also apply where it could enhance the player experience and provide a higher level of entertainment (2).

1.4 Research Objectives

The objectives of the research are:

(a) To analyze the effect of Transcranial Magnetic Stimulation (TMS) to the encephalogram (EEG) signals.

(b) To design an experimental protocol to differentiate between emotions.

To analyze the features based on emotions reaction to Transcranial Magnetic Stimulation using machine-learning method.

1.5 The scope of the Study

A couple of emotions and visual stimuli have been selected to study the characteristic of the brain. The participants for this study are healthy engineering students from Universiti Teknologi Malaysia (UTM); the ages of the participants are between 20-24 years old from different years. Four emotions investigated and two sessions applied where each session is 7 minutes long with the different type of emotions (more details in Chapter 3). One of these sessions while the Transcranial magnetic stimulation (TMS) applied to the temporal lobe and the other is without TMS. The three parts of electroencephalogram (EEG) activity are measured, Alpha, Beta, and Gamma. MATLAB version 9.2 program used to analyze the raw data taken from the EEG recorder.

1.6 Thesis Organization

In this thesis, it will be five chapters explained as follows, Chapter 1 is a brief introduction to the project is given, and the importance of Transcranial Magnetic Stimulation with some application that can be applicable in, also in this chapter the problems of this project is identified and explained with the aims of this project and scope. Chapter 2 reviews of the literature been written and the information from the previous researchers presented with an explanation about how the emotions generate, the brain signals, transcranial magnetic stimulation, and EEG signal processing. Chapter 3 explains the methodology in details that applied in this project with a clear presentation of the data collection protocol. It begins with choosing the subjects, experimental equipment and materials during the data collection stage, experimental protocol, and signal preprocessing. Chapter 4: provides the results that generated from this project, and what are the findings that accomplished with the presentation of the results in term of understandable figures and tables. Lastly, Chapter 5 presents a conclusion of this project is given and with recommendation and contributions.

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