Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF BRAINWAVE PATTERN IDENTIFICATION SYSTEM FOR BRAIN CONTROLLED ROBOT USING BRAINSENSE (BEEA_T37)

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Bachelor of Electrical Engineering Technology (Industrial Automation & Robotics) with Honours

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Name (if any)

Date :

DEDICATION

I would like to express my deepest gratitude towards individuals that had helped me throughout the process of writing this paper. My supervisor, Ts. Dr. Syed Najib Bin Syed Salim for her guidance for the structural development of the project, and all other lecturer and friends that might have involved directly or indirectly during the thesis development. Special thanks to my family and friends for their support, also to my enemies that inspired me to finish up my project. Last but not least, to all other party that might involve in making this paper thank you with the idea and encouragement.

ABSTRACT

BCI (Brain Computer Interfaces) is a technology that allows us to control a computer with your thoughts. Electroencephalography records brain waves so that they can be analysed by a computer. Many studies have been done using BCI, including analysing brain waves in humans. Because there are so many things that can be done with BCI, many researchers have used it to create things like robots and wheelchairs that use brain control and improvements are still being made to create the best system. In this project, the identification system will be develop to produce the brainwave data and the brain will controlling the robot movements. Neurosky device will be used for this project to detect the brainwave signal from the brain according to the signals which are transmitted and received by the neurons from the mind where the attention level and eye blink will used as a method to generate the data. After that, the brainwave pattern of the robot movements will recognize and identify from the Maltab Software. Other than that, the aim of this project to help paralyze people to make a movements by giving the signal through the brainwave signals. At the same time, by developing the robot with brainsense controlled it can help the paralyzed people to make a movement. Therefore, based from this project's, the mind wave controlling robot system is based on brain-computer interfaces (BCIs).

ABSTRAK

BCI (Brain Computer Interfaces) adalah teknologi yang membolehkan kita mengawal komputer dengan pemikiran sendiri. *Electroencephalography* merakam gelombang otak sehingga dapat dianalisis oleh komputer. Terdapat pelbagai kajian telah dilakukan menggunakan BCI, termasuk menganalisis gelombang otak pada manusia. Oleh kerana terdapat banyak perkara yang dapat dilakukan dengan BCI, banyak penyelidik telah menggunakannya untuk membuat sesuatu seperti robot dan kerusi roda yang menggunakan kawalan otak dan penambahbaikan masih dilakukan untuk membuat sistem terbaik. Dalam projek ini, sistem pengenalan akan dikembangkan untuk menghasilkan data gelombang otak dan otak akan mengawal pergerakan robot. Peranti Neurosky akan digunakan untuk projek ini bagi mengesan isyarat gelombang otak dari otak mengikut isyarat yang dihantar dan diterima oleh neuron dari minda di mana tahap perhatian dan kelipan mata akan digunakan sebagai kaedah untuk menjana data. Selepas itu, corak gelombang otak pergerakan robot akan mengenali dan mengenal pasti dari Perisian Maltab. Selain daripada itu, tujuan projek ini untuk membantu melumpuhkan orang untuk membuat pergerakan dengan memberi isyarat melalui isyarat gelombang otak. Pada masa yang sama, melalui projek ini, ia dapat membantu orang lumpuh untuk melakukan pergerakan. Oleh itu, berdasarkan projek ini, sistem robot pengendalian gelombang minda didasarkan pada antara *Brain Computer Interfaces* (BCI).

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LIST OF SYMBOLS

Hz	-	Frequency
m	-	Lenght

LIST OF ABBREVIATIONS

V	-	Voltage
Hz	-	Hertz
BCI	-	Brain Computer Interface
EEG	-	Electroencephalogram
m	-	Meter
CNS	-	Central Nervous System

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CHAPTER 1

INTRODUCTION

1.1 Background

In the early 20th century, EEG was first used. The electroencephalogram (EEG) is a dynamic non-invasive and relatively inexpensive technique used to monitor the state of the brain (He 2020). The amplitude of an EEG signal typically ranges from about 1 to 100 µV in a normal adult, and it is approximately 10–20 mV when measured with subdural electrodes such as needle electrodes (Siuly, Li, and Zhang 2016). The measurement of electrical activity in the living brain is known as electroencephalography (EEG). However, recently some research has been conducted to establish a variety of BCI applications for wheelchairs. BCI's main purpose is to translate and relay human intentions into effective motion commands for wheelchairs, robots, and other devices. BCI helps disabled people to communicate with their surroundings and improve their quality of life. In additon, brain Computer Interface (BCI) is defined as using Electroencephalogram (EEG) signals to communicate with an electronic device exclusively through the brain. EEG does not read our thoughts, but it can tell our general state. For example, EEG can show if we are playing attention or meditating. However, there have the improvement equipment that have been made to detect the signal and data of the brain such as Mindwave Mobile 2, Brainsense and others.

Besides, when we focus on something, our attention level (0-100%) goes up (Marzbani, Marateb, and Mansourian 2016) (Siuly, Li, and Zhang 2016). We can do some math, read something, or just concentrate on our fingertip. When we relax, our meditation

level goes up. For example, we can close our eyes and take deep breaths. If we can calm and focus our mind at the same time, both attention and meditation can go up to 100% (Siuly, Li, and Zhang 2016). The mindwave mobile have some possible outputs, attention levels, meditation levels, blink strength levels, EEG Band Values (Alpha, Beta, Delta and Gamma) and Raw EEG Data (Raj, Deb, and Bhattacharya 2018).

1.2 Problem Statement

Special needs people specifically those who suffering from paralysis that limited their activity and functionality. Despite their limitation, this people still a lot to offer and can contribute to society. This is where this study is significant. By developing this brain-controlled robot, it can be stepping stone to become the model and visualize a future that unlock opportunities and endless possibility for these people. Interestingly, it also branch out the application towards IR4.0 revolutions within industries.

1.3 Project Objective

The main aim of this project is to propose an identification system that can analyze brain signal pattern with systematic and effective methodology. Specifically, the objectives are as follows:

a) To generate the brainwave signal from Mindwave Mobile 2 devices for the eye blink and attention detection using Matlab
b) To control robot movements (forward, turn and rotate around) by using eye blink and attention
c) To analyze the accuracy and performance of the robot movements.

1.4 Scope of Project

The scope of this study can be generalized as follow:

a) The robot is used as a model for the wheelchair

b) The data generate is used as an input for the system which is depend on Mindwave Mobile 2 whereas the process will perform using Matlab software

c) The accuracy and persistency maybe affected by the EEG sensor sensitivity as well as the Bluetooth capability of the Mindwave Mobile 2.

d) The robot may have limited functionality focusing solely to demonstrate the brain control ability.

e) The robot design may change depends on the components used.

f) Arduino IDE Software is used for the functionality test results.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Brain Identification System

Many studies have used BCI, including studying brain waves in individuals by using an identification system as an innovation have been developed to assist the disabled and physically impaired (Permana, Wijaya, and Prajitno 2019)(Wolpaw, Millán, and Ramsey 2020). The example of identification system for brainwave that can be used are Matlab, Labview and BrainFlex software. (Permana, Wijaya, and Prajitno 2019) claimed in their thesis that Matlab GUI will process and classify brain waves signals collected from the headset. I this research will be focus on brain computer interface (BCI).

Electroencephalography (EEG) is a way to measure potentials that indicate electrical activity in the brain (Siuly, Li, and Zhang 2016). EEG is related with BCI. (Baniqued et al. 2021) claimed the phrase "brain–computer interface" refers to how a BCI recognizes user intent by measuring brain activity and translates it into executable commands that are usually carried out by a computer. The outputs of BCIs can theoretically pick a goal or direct a process. The achievement of great accuracy and reliability is likely the most difficult and pressing task now confronting BCI research and development (Wolpaw, Millán, and Ramsey 2020).

In addition, there are some different method that can be used for analyzing brainwave data depending on the identification system that we used as a data collection platform. The limitations for the system that effect the accuracy of the system such as the quality of the brain sensor and the accuracy of the signals (Tiwari, Panwar, and Tripathi 2018). Thus, this

research will analyze data from Matlab for the identification system method. After that, this research will focus on brainwaves controlled robot.

2.2 Brain Computer Interface (BCI)

A brain–computer interface (BCI) is a device that measures central nervous system (CNS) activity and converts it into artificial output that replaces, restores, enhances, supplements, or improves natural CNS output, thereby altering the CNS's ongoing interactions with its external or internal environment (Daly and Huggins 2015)(Wolpaw, Millán, and Ramsey 2020). Besides, a brain-computer interface (BCI) is a communication system in which signals or orders sent to the outside world bypass the brain's typical output pathways of peripheral nerves and muscles.

2.2.1 The parts of a BCI

A BCI, like any other communication or control system, has input (for example, electrophysiological activity from the user), output (for example, device commands), components that convert input to output, and a protocol that determines the onset, offset, and timing of operation. These elements and their main interactions are depicted in Figure 2.1 and 2.2.

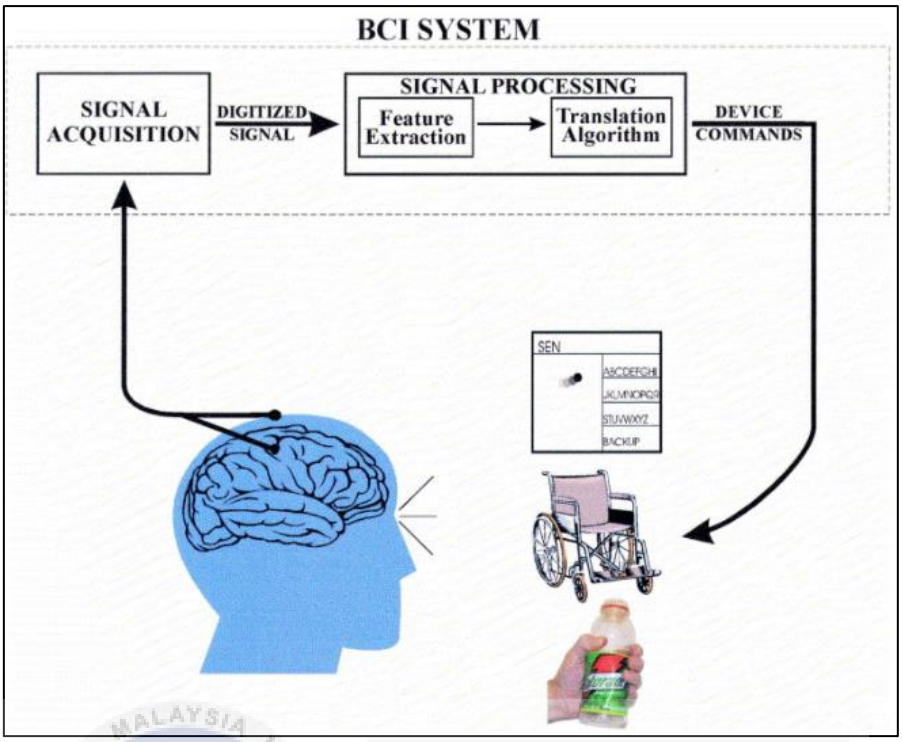

Figure 2.1 Basic design and operation of any BCI system.

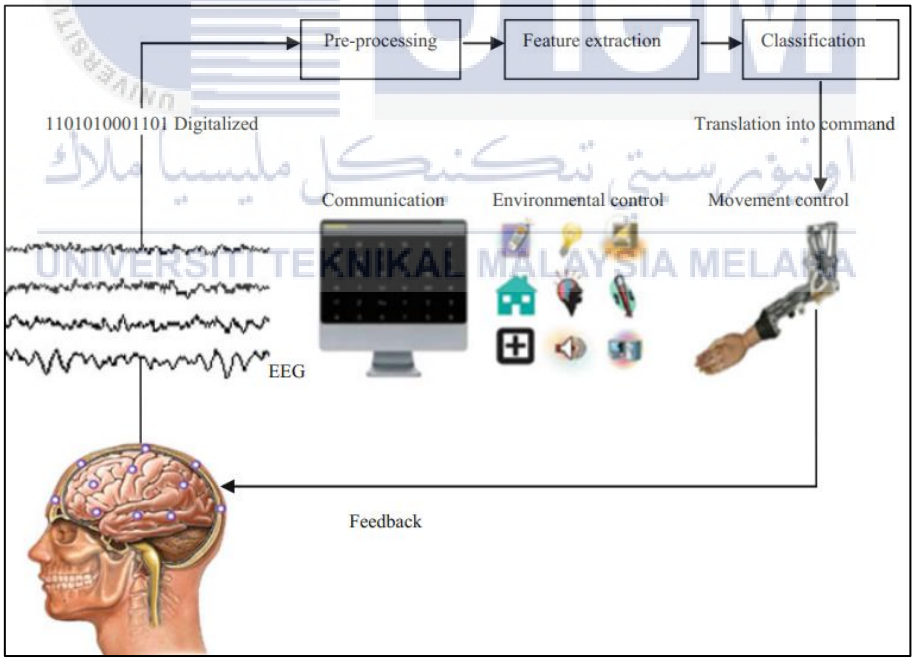

Figure 2.2 The general architecture of a BCI system.

Due to the (Siuly, Li, and Zhang 2016), electrodes on the scalp or in the head collect brain signals, which are then analyze to extract certain signal properties (e.g., evoked

potential amplitudes or sensorimotor cortex rhythms, cortical neuron firing rates) that indicate the user's intent. These characteristics were converted into commands that control a gadget (e.g. a simple word processing program, a wheelchair, or a neuroprosthesis)(Shih, Krusienski, and Wolpaw 2012). The interaction of two adaptive controllers, the user and the system, is critical to success. The user must establish and maintain a solid correlation between his or her purpose and the signal characteristics used by the BCI, and the BCI must choose and extract features that the user can influence, as well as reliably and efficiently translate those characteristics into device commands.

2.2.2 The Brainwave data

The brainwave data can be analyze through the analysis output of the recording of electrical activity along the scalp or is known as electroencephalography (EEG). EEG monitors voltage changes caused by ionic current flows in the brain's neurons. The presence of rhythmic activity that is separated into preset bands based on frequency represents (Table 2.1) the EEG signal (Abhang, Gawali, and Mehrotra 2016)(Marzbani, Marateb, and Mansourian 2016)(Permana, Wijaya, and Prajitno 2019). However, there have some method that we can used for data collecting.

Table 2.1 Main frequencies of human EEG waves.

Name	Frequency Band	Indicates
Delta	<4	slow wave sleep, continuous attention tasks
Theta	4-7	drowsiness, idling
Alpha	8-15	relaxed
Beta	16-31	active thinking, high alert
Gamma	32+	familiarity