ELECTRICAL APPLIANCES SWITCHING CONTROLLER USING WEARABLE BRAINWAVE SPECTRUM EEG SENSOR

'EIZZA NOOR SABRINA BT A RAZAK
B071710798

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2020

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ELECTRICAL APPLIANCES SWITCHING CONTROLLER USING WEARABLE BRAINWAVE SPECTRUM EEG SENSOR

This report is submitted in accordance with the requirements of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Computer Engineering Technology (Computer System) with Honours

by

`EIZZA NOOR SABRINA BINTI A RAZAK

B071710798

980930045376

FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING

TECHNOLOGY

2020

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: ELECTRICAL APPLIANCES SWITCHING CONTROLLER USING WEARABLE BRAINWAVE SPECTRUM EEG SENSOR

Sesi Pengajian: 2020

Saya **`EIZZA NOOR SABRINA BINTI A RAZAK** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (X)

☐ SULIT* Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam

AKTA RAHSIA RASMI 1972.

☐ TERHAD* Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan.

☒ TIDAK TERHAD

Yang benar,

.....

`EIZZA NOOR SABRINA BINTI A RAZAK

Alamat Tetap:

JA 8219

Lorong Pahlawan 6A

Taman Pahlawan 77300

Merlimau Melaka.

Tarikh: 12 Februari 2021

Disahkan oleh penyelia:

.....

EN SHAMSUL FAKHAR BIN ABD GANI

Cop Rasmi Penyelia

SHAMSUL FAKHAR BIN ABD GANI
Penyelaras Program BEEC / Pensyarah
Jabatan Teknologi Kejuruteraan Elektronik dan Komputer
Fakulti Teknologi Kejuruteraan Elektrik dan Elektronik
Universiti Teknikal Malaysia Melaka

Tarikh: 12 Februari 2021

*Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini

DECLARATION

I hereby declare this report titled ELECTRICAL APPLIANCES SWITCHING CONTROLLER USING WEARABLE BRAINWAVE SPECTRUM EEG SENSOR is the results of my own research except as cited in the references.

Signature:

……

Author : 'EIZZA NOOR SABRINA BINTI A RAZAK

Date: 12th February 2021

APPROVAL

This report is submitted to the Faculty of Electrical and Electronic Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Computer Engineering Technology (Computer Systems) with Honours. The supervisory members are as follows:

Signature:

……

Supervisor: EN SHAMSUL FAKHAR BIN ABD GANI

SHAMSUL FAKHAR BIN ABD GANI
Penyelaras Program BEEC / Pensyarah
Jabatan Teknologi Kejuruteraan Elektronik dan Komputer
Fakulti Teknologi Kejuruteraan Elektrik dan Elektronik
Universiti Teknikal Malaysia Melaka

Signature:

……..

Co-Supervisor: EN NADZRIE BIN MOHAMOOD

Ts. NADZRIE BIN MOHAMOOD
Jurutera Pengajar Kanan
Jabatan Teknologi Kejuruteraan Elektronik
dan Komputer Fakulti Teknologi
Kejuruteraan Elektrik dan Elektronik
Universiti Teknikal Malaysia Melaka

ABSTRAK

Kajian ini membincangkan mengenai alat kawalan peralatan elektrik dengan menggunakan sensor electroencephalogram (EEG) spektrum gelombang otak yang boleh dipakai. Sensor EEG telah menjadi kaedah yang paling sering digunakan di antara kaedah antaramuka komputer otak non-invasif (BCI) kerana ia menawarkan tindak balas pantas, kos rendah dan mempunyai kemampuan untuk dilaksanakan dalam aplikasi mudah alih. Pada asasnya, dalam penyelidikan projek ini, sistem sensor EEG bertujuan untuk membantu individu kurang upaya dan warga tua dalam kehidupan seharian mereka. Dengan menggunakan sistem ini, pengguna dapat menghidupkan dan mematikan peralatan elektrik secara bebas dengan menggunakan tahap perhatian dan meditasi. Arduino digunakan sebagai pengawal mikro dalam penyelidikan projek ini. Modul Bluetooth HC 05 digunakan untuk bertindak sebagai media komunikasi antara papan Arduino Uno. Keseluruhan sistem ini menawarkan kos rendah, kerumitan yang lebih rendah dan kecekapan masa.

ABSTRACT

This paper discusses on electrical appliances switching controller by using wearable brainwave spectrum electroencephalogram (EEG) sensor. EEG sensor has become the most used method among the non-invasive brain computer interface (BCI) methods as it offers faster response, simplicity, low cost and could be easily implemented in other portable applications. Basically, in this project research, EEG sensor system is used to assist elderly and disabled individuals in their daily life. By using this system, user can independently switch off and on the electrical appliances by using attention and meditation levels. Arduino acts as the microcontroller in this project research. Other than that, HC-05 Bluetooth module is used to act as communication medium with Arduino Uno board. These entire system offers low cost, lower complexity, and time efficiency.

DEDICATION

I dedicate my project research to my families and my circles. A special feeling of gratitude to both of my parents who is constantly giving words of encouragement and supports. Special thanks go to Mr Shamsul Fakhar Bin Abd Gani, Mr Nadzrie Bin Mohamood and all the lecturers for giving their best to guide me throughout this project. Finally, thank you to my circle of friends for helping me completing this wonderful project.

ACKNOWLEDGEMENTS

On the very outset of this report, I am blessed to the Almighty Allah S.W.T for lend me the opportunity to accomplish my Bachelor's Degree Project (BDP) 1.

I am ineffably indebted to my project supervisors, Mr Shamsul Fakhar bin Abd Gani and Mr Nadzrie Bin Mohamood for their encouragement and conscientious guidance to complete this challenging yet wonderful project. A huge thanks to them for giving me trust, offering valuable advices and giving knowledgeable ideas throughout the Bachelor's Degree Project (BDP) 1.

In conjunction with that, I also would love to extend my heartfelt obligation to all my lecturers and my fellow friends for their thoughtful help and support throughout this entire project. Without their help, this project would be full of challenges and obstacles.

I would also extend my appreciation and sincere gratitude to both of my project evaluation panel, Dr Fara Ashikin Binti Ali and Madam Rosziana Binti Hashim for their constructive criticise, advises to change the way of approaching the problem wherever required and also for constant inspiration.

Lastly, my sincere thanks to my parents and families for constantly giving me supports and encouragement throughout the project completion phase.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATION

EEG	Electroencephalogram
SMS	Short Message Service
GPS	Global Positioning System
BCI	Brain Computer Interface
WSN	Wireless Biomedical Sensor Network
IoT	Internet of Things
GUI	Graphical User Interface
WWW	World Wide Web
CSS	Cascading Style Sheets
HTML	Hypertext Mark-up Language
PHP	Hypertext Pre-processor
IR	InfraRed
GSM	Global System for Mobile Communication
HaaS	Cloud Home as a Service
PSG	Polysomnography
IDE	Integrated Development Environment
ICSP	In Circuit Serial Programming
mAh	milliampere hour

CHAPTER 1

INTRODUCTION

1.1 Research Background

A global statistic proved that more than 500 million individuals in this world are disabled because of sensory, mental or physical impairment and the elderly population is increasing rapidly worldwide. Furthermore, most of the disabled individuals and elderly population especially those who are having fully movement impaired ones, live like burdens and had to bear with severe depression. This is because they must depend on others for regular movement task and not be able to contribute to the community. Even though we cannot remove their disabilities, we should strive to ease their burden and give some happiness with the help of modern technologies (Habiba et al. 2016), (Hu et al. 2015), (Rahman et al. 2019)). As electroencephalogram (EEG) acts as catalyst in healthcare system, this project is meant to ease the burden of disabled and elderly people independently switching on and off the electrical appliances by using wearable brainwave spectrum EEG sensor.

1.2 Problem Statement

In most of the cases, individuals who are already in elderly phase or having diseases such as stroke will have the limitations to perform their daily routines at home. For example, individual who having limitations to move their body parts, must depends on their caretaker at home. The modernisation of technology system which assigned to help elderly person could be a problem as they are unfamiliar with the advanced technology. Besides that, elderly and disable person must depend on themself when there is no presence of caretaker at home.

1.3 Objectives

1. To develop a wearable smart electrical appliance switching controller system by using brainwave spectrum EEG sensor.
2. To determine the overall functional capabilities, and effectiveness of the developed system.

1.4 Scope Research

This project will use wearable brainwave spectrum Mind Link EEG sensor that allow readings of brainwave to be done completely without undergoing invasive surgery from the comfort of user's home. This project will use Arduino UNO as the brain of the whole program system that acts as the microcontroller. The main target for this project is disable and elderly individuals who having difficulties in moving their body freely. The user does not have to undergoes invasive method such as electrode attachments and needles to the scalp anymore. Furthermore, this project is limited to analyse only attention levels and meditation levels from user's brainwaves. In conjunction with that, this project enables the user to switch on and off their home electrical appliances.

1.5 Thesis Organisation

This project research will consist of five chapters which are introduction, literature review, the third one is methodology, followed by result discussion and last chapter is conclusion and recommendation.

Chapter 1: Introduction

Chapter 1 mainly providing the introduction of the project through this thesis. The ingredients for this chapter are research background, problem statements, objectives, and research's scope.

Chapter 2: Literature Review

Chapter 2 focuses on previous works and theory of components that relates with the project. The theories related such as EEG sensor will be briefly explained, and the summaries of other researchers' previous works will be made in a form of table.

Chapter 3: Methodology

Chapter 3 basically explain the strategies and methods used in order to fulfil project's objectives. The development process of EEG sensor system will be covered, and every step of process and flowchart will be included.

Chapter 4: Result and Discussion

In chapter 4, it consists the results of the projects where it will be presented in many forms such as in tables, figures, drawings, or graphs. These results or findings will be discussed in this chapter.

Chapter 5: Conclusion and Recommendation

The last chapter is responsible to summarise the results from the project and the project's objectives that need to be achieved. This chapter also will recommend any further improvement that can be made in order to achieve optimum system.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will focus the theoretical aspects of brainwave system and overview of the healthcare system through elaborations regarding EEG sensor which acts as the main component in this project also will be included. Besides, the evolution of brainwave system as well as researchers' previous invention that related with this project will be stated in this chapter.

2.2 Elderly and Stroke

In this project, elderly and disable individuals are our main user target. The rapid growth of the elderly population has caused a massive increase in demand for personal care, especially for those people with critical conditions such as stroke diseases. Stroke is the top five diseases with the greatest burden, and the third leading cause of mortality in Malaysia after pneumonia and heart disease (Loo et al. 2012). The population density in 13 states in this country is illustrated in Figure 2.2.2. In the year 2009 until 2014, 7830 patients with stroke were registered. The patients with haemorrhagic stroke are significantly younger compared to patients with ischemic stroke (Aziz et al. 2015). Individuals who aged 65 years and above, categorise in older population, growing at a rate of 5.1% annually. They are most likely need the long term of healthcare supports. In conjunction with that, patients who get the permission to discharge early from hospitals will have to spend most of their time at home. Besides, discharged patients who have partial or full paralysed body will have limitations to move their body parts. The presence of caretaker at home would be a huge help to the patients. But there are times the patients must be independent during the absence of their caretaker. The patients will have the difficulty to perform simple task such as switch on or switch off electrical appliances.

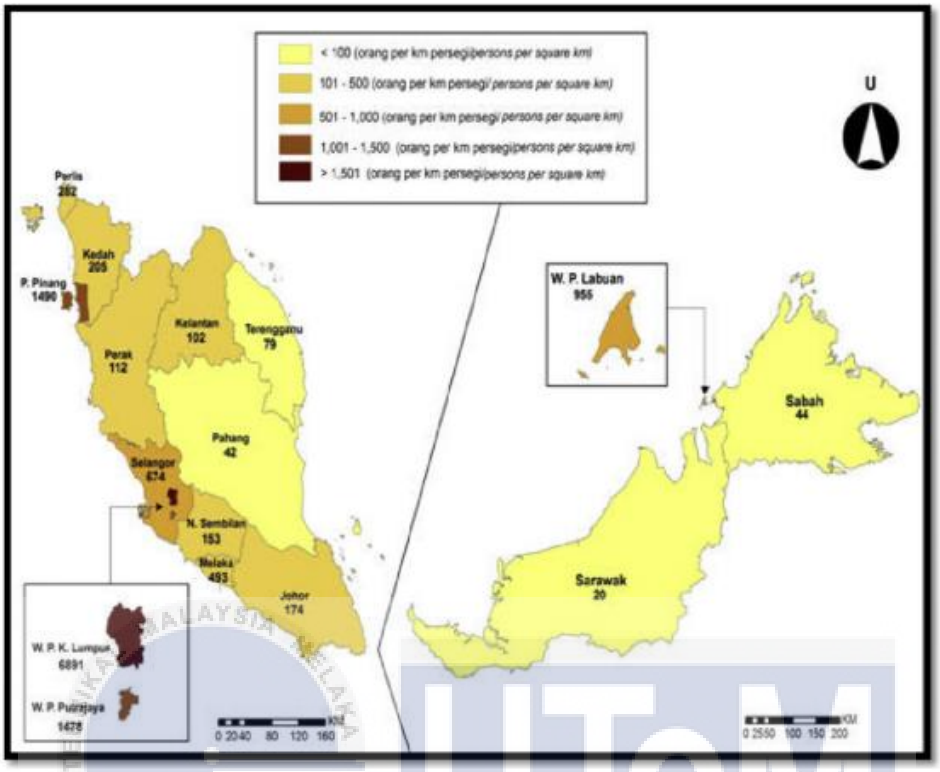

Figure 2.2.2: Population density in Malaysia

Source: *https://doi.org/10.1016/j.jstrokecerebrovasdis.2015.07.025*

2.3 Brain Computer Interface Overview

Brain computer interface technology transforms brainwave signals into commands which can control external devices, facilitate rehabilitation, or even communicate with others. As the world undergoes evolution of technologies, few brain computers interfaces (BCI) systems undergo improvement and getting more advanced. This system plays an important role in improving the life of countless disabled individuals especially when it combined with an existing technology. The elderly or disabled individuals could get huge advantage from the technology advancements in BCI. Basically, there are four application areas that gave benefits to those individuals, which are motor recovery, entertainment, motor substitution, communication, and control (Millan et al. 2010). In conjunction with that, BCI methods divided into two parts which are non-invasive and invasive. Invasive BCI method refers to implantation of electrodes inside or on the cortex while non-invasive BCI method does not require such surgeries. EEG method is

widely used method compare than other methods under non-invasive BCI method such as deoxyhaemoglobin concentration and magnetoencephalogram (Nafea et al. 2018).

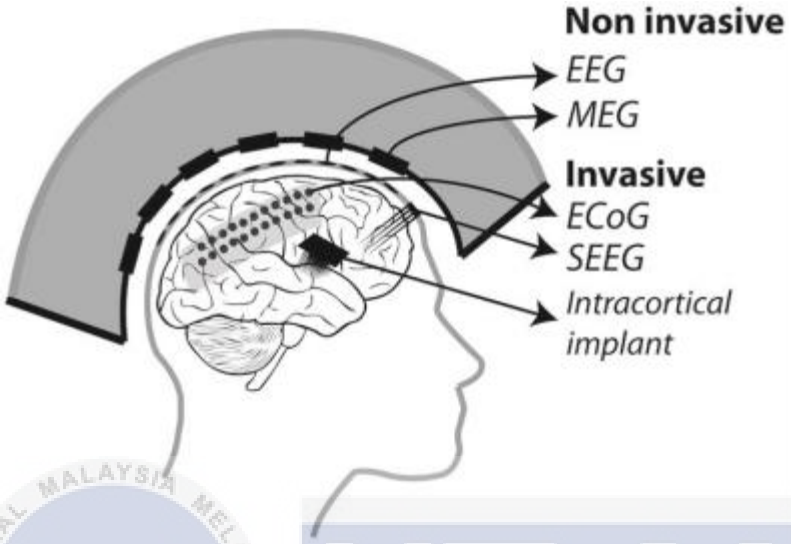

Figure 2.2.3: Comparison between non-invasive and invasive BCI

2.4 EEG Overview

Electroencephalography (EEG) is one of the techniques for non-invasive continuous recording of the electrical activity and response of the brain. EEG became preferable non-invasive BCI method because it directly reflects real brain function in real time. Generally, EEG signals will be varied for each user as it is depending on individual state. One of the good features of EEG recording is the real measurement of electrical potential on the scalp. The improvisation of EEG sensor has been made, from wet electrodes into dry contact electrodes. In recent years, the wearable EEG has shown increasing potential values in many aspects such as in mind control technologies, sports training, and health care systems. EEG method offers a long-lasting patient's monitoring outside the clinical environment. In addition, this non-invasive and unobtrusive method offers cost efficiency and satisfy diagnostic demands.

2.5 Previous Research

Various technologies have been invented in order to assist those people to live their daily life. For instance, U. Habiba et. Al (2016) proposed a third hand where it is a system device to assist disabled and elderly person. This system capable in helping an individual to switch off or on their common home loads for example lamp by simply using voice commands. Besides that, this system also can track the user's location whenever the user's travels outside alone. In this system, a command using voice recognition module EASY_VR. The recognizable commands of control are delivered to an Arduino for better system control and later delivered to a Bluetooth module. In the Global Positioning System (GPS) tracking system, both GPS and short message service (SMS) in android mobile will be used where it supports the clients to track the user whenever the user travels outside alone. This system offers the user a safe system of switching appliances and offer supports for user to travel by themselves in a safe mode (Habiba et al. 2016).

In another effort, H. Lim et al. (2005) presented a healthcare system for disabled person by performing eye blinking. An eye blinking sensor is designed which its based are transmitter and receiver. These based are needed to ensure for obtaining the correct signals from patients. Generally, there are two parts in this system which are hardware part and software part. The hardware section is responsible for getting the correct signal from the patient while the software section is to select the right option click by clicking their eyes. As in healthcare, doctors can look on the patients and patients themselves can provide personal data to their doctor which related with their health condition. This system enabled patients to share their feelings and communicate with the world (Lim et al. 2005).