UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Development of IoT Smart Home Controller Using Biosensor

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electronic Engineering Technology (Telecommunication) with Honours.

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunication) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Biosensor adalah peranti analisis yang digunakan untuk menukar tindak balas biologi ke dalam isyarat elektrik. Manakala, electroencephalogram (EEG) adalah ujian mengukur dan merekodkan isyarat elektrik dari kulit kepala otak selepas meletakkan elektrod logam. Rumah pintar menggunakan biosensor adalah satu system yang membenarkan komunikasi secara langsung antara otak manusia dengan peralatan rumah, mikropengawal atau komputer. Objektif utama dalam projek ini adalah untuk membangunkan sistem kawalan rumah pintar menggunakan visualisasi data biosensor dan Internet of Thing (IoT) dan menganalisis prestasi sistem dari segi prestasi biosensor dan IoT. Bagi mencapai objektif tersebut, isyarat EEG boleh diperolehi dengan menggunakan kos rendah EEG biosensor iaitu peranti Neurosky Mindflex. Selepas itu, signal EEG dianalisis dan dikelaskan melalui monitor bersiri Arduino (IDE). Seterusnya, signal yang dikelaskan akan digunakan untuk mengawal masa sebenar peralatan rumah dengan menghantar arahan untuk NODEMCU ESP8266. Oleh yang demikian, komunikasi antara peranti Neurosky Mindflex dengan mikropengawal atau komputer dapat dibina untuk menghidupkan dan mematikan peralatan rumah. Selain itu, visualisasi data biosensor dan kegunaan peralatan rumah dapat dilihat melalui platform IoT iaitu ThingSpeak menerusi internet. Akhir sekali, kualiti hidup dapat ditingkatkan disamping dapat membantu golongan kurang upaya.

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ABSTRACT

Biosensor is an analytical device that used to convert a biological response into an electrical signal. While, electroencephalogram (EEG) is a test that measures and records electrical signal from the scalp of the brain after placed a metal electrode. Smart home controller using biosensor is a system that allows a communication human brain and home appliances, microcontroller or computer. The main objective of this project is to develop smart home control system using biosensor and IoT data visualization, and to analyze system performance in terms of biosensor and IoT performance. To achieve the objective, EEG signal can be acquired by using low cost EEG biosensor which is Neurosky Mindflex device. After that, EEG signal was analyzed and classified through Arduino (IDE) serial monitor. Next, classified signal will be used to control a real-time home appliance by sending a command to NODEMCU ESP8266. Therefore, a communication between Neurosky Mindflex device with microcontroller or computer are developed to turn on and off home appliances. Besides, biosensor data visualization and home appliance usage can be observed through IoT platform which is ThingSpeak via the internet. Finally, quality of life can be improved as well as to help disabled people.

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DEDICATION

Specially dedicate to my beloved parents and sibling and also my friends who give support and encouragement for me to complete this project. Not forget to my supervisor, Ahmad Fauzan Bin Kadmin who gave me a lot of advices and guidance during this project until successfully. Thank you very much to all of you.

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TABLE OF CONTENT

ABSTRAK ..... **i**
ABSTRACT ..... **ii**
DEDICATION ..... **iii**
ACKNOWLEDGEMENT ..... **iv**
TABLE OF CONTENT ..... **v**
LIST OF TABLES ..... **viii**
LIST OF FIGURES ..... **ix**
LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE ..... **xii**

CHAPTER 1: INTRODUCTION **1**
1.1. Introduction 1
1.2. Project Background 1
1.3. Problem Statement 4
1.4. Objective 5
1.5. Scope 5
1.6. Project Methodology 5
1.7. Thesis Structure 7

CHAPTER 2: LITERATURE REVIEW **9**
2.1 Introduction 9
2.2 Electroencephalogram (EEG) vs Electrocardiogram (ECG) 10
2.2.1. Electroencephalogram (EEG) 10
2.2.2. Electrocardiogram (ECG) 13
2.3. Brain Wave Classification 15
2.3. Brain Attention 17
2.4. Brain Meditation 19
2.5. Smart Home 20
2.6. Brain – Computer Interface (BCI) 23
2.7. Biosensor mindset 25
2.8. Internet of Thing (IoT) 27

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2.8.1. IoT Platform 28
2.9. Microcontroller Board 29
2.9.1. Arduino 29
2.9.2. Raspberry Pi 30
2.9.3. NodeMCU 31

CHAPTER 3: METHODOLOGY 32
3.1. Introduction 32
3.2. Overview of the system 33
3.3. Architecture 34
3.3.1. 10-20 EEG System 34
3.3.2. Neurosky Mindflex Headset 36
3.3.3. Arduino (IDE) 38
3.3.4. NodeMCU ESP8266 40
3.3.5. ThingSpeak 41
3.3.6. Home appliances controller system 42
3.4. Methodology Procedures 42
3.4.1. Flowchart of Project 42
3.4.2. EEG device setup 44
3.4.3. Configure Microcontroller 46
3.5. Test & Measurement 50
3.5.1. Detection measurement 50
3.5.2. Subject Test 50
3.5.3. Controller System 51
3.6. Expected Outcomes 51
3.6.1. EEG device 51
3.6.2. NodeMCU ESP8266 52
3.6.3. Controller system 52
3.6.4. Data visualization on IoT platfrom 52

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CHAPTER 4: RESULTS AND DISCUSSION 54
4.1. Brain Grapher using Processing software 54
4.2. Serial Monitor on Arduino (IDE) 56
4.3. Home Controller 57
4.3.1. Control Light using Attention 57
4.3.2. Control Fan using Meditation 59
4.4. Data Visualization using ThingSpeak (IoT).....60
4.4.1. Display Attention Value and Light State on ThingSpeak.....61
4.4.2. Display Meditation Value and Fan State on ThingSpeak.....62
4.4.3. Display Date Visualization (ThingSpeak) on Mobile Phone.....64
4.5. Overall Graph on Microsoft Excel 65
4.6. Discussion 68

CHAPTER 5: CONCLUSION AND RECOMMENDATION 70
5.1. Conclusion.....70
5.2. Recommendation and Future Works 71
REFERENCES 72

APPENDICES.....74

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LIST OF TABLES

3. 1	The letter and the lobe of the area of the brain	35
3. 2	Type of Brain state and its condition	50
3. 3	Controller ways and Home appliance state	51
4. 1	The values from serial monitor	57
4. 2	Attention value to control the light	58
4. 3	Meditation to control the fan	59
4. 4	The result of attention, meditation, light state and fan state	65

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LIST OF FIGURES

1. 1	Mindflex Duel used by 2 persons to move an object	2
1. 2	People with physical disabilities	4
1. 3	Project flowchart	6
2. 1	Hans Berger	10
2. 2	An early EEG recording done by Berger	10
2. 3	Electrode attached to the scalp	11
2. 4	Silver chloride (AgCl) flat electrode	11
2. 5	Willem Einthoven	13
2. 6	An early ECG device	14
2. 7	A typical ECG waveform for one cardiac cycle measurement	15
2. 8	Delta wave	16
2. 9	Theta wave	16
2. 10	Alpha wave	17
2. 11	Beta wave	17
2. 12	Positron Emission Tomography (PET)	18
2. 13	Functional Magnetic Resonance Imaging (fMRI)	19
2. 14	Part of the brain during meditation	20
2. 15	Smart home of wireless control	21
2. 16	The statistic of smart home market	21
2. 17	Example of interaction between human brain and computer	24
2. 18	Example of non-invasive BCI	24
2. 19	Neurosky MindWave Mobile	25
2. 20	IoT will consist of about 30 billion objects by 2020	27
2. 21	Arduino logo	29
2. 22	Raspberry Pi logo	30
2. 23	NodeMCU logo	31
3. 1	Overall concept of Smart Home Controller using Biosensor	33
3. 2	Location of electrodes on scalp	35

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3. 3	Mindflex duel is used by 2 users to force the ball	36
3. 4	Neurosky Mindflex EEG headset device design	37
3. 5	T pin on ThinkGear chipset have been soldered	38
3. 6	Arduino software IDE	39
3. 7	NodeMCU pin layout	40
3. 8	AT command mode	41
3. 9	Flowchart of the system	43
3. 10	T pin on ThinkGear chipset have been soldered	44
3. 11	Power and ground are soldered to share with Bluetooth module	44
3. 12	Connection between NodeMCU and HC-05 Bluetooth module	45
3. 13	Coding to read brainwaves activity	45
3. 14	Listing the most recent brain data	46
3. 15	Directory to save the Brain Library	46
3. 16	Preferences Tab on Arduino (IDE)	47
3. 17	Tools tab on Arduino (IDE)	48
3. 18	Tools tab on Arduino (IDE)	48
3. 19	Coding to send data to ThingSpeak	49

4. 1	Real-time Brain Grapher using Processing software	55
4. 2	The connection quality and packets received	55
4. 3	readCSV to display the data on serial monitor	56
4. 4	Serial monitor in Arduino (IDE)	56
4. 5	LCD display the value of attention and light on	58
4. 6	LCD display the value of attention and light off	58
4. 7	LCD display the value of meditation and fan on	59
4. 8	LCD display the value of meditation and fan off	59
4. 9	ThingSpeak website	60
4. 10	The coding to record the data to the ThingSpeak	60
4. 11	Attention value against time	61
4. 12	Light state either ON (1) or OFF (0)	62
4. 13	Meditation value against time	63
4. 14	Fan state either ON (1) or OFF (0)	63
4. 15	ThingView on Android mobile phone	64

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4. 16 Attention and Meditation values against time 67

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

IoT	-	Internet of Thing
EEG	-	Electroencephalogram
ECG	-	Electrocardiogram
IDE	-	Integrated development environment
AgCl	-	Silver Chloride
σ	-	Delta
τ	-	Theta
α	-	Alpha
β	-	Beta
Hz	-	Hertz
PET	-	Positron Emission Tomography
fMRI	-	Functional Magnetic Resonance Imaging
HD	-	High Definition
BCI	-	Brain Computer Interface
EMG	-	Electromyogram
EOG	-	Electrooculogram
GSR	-	Galvanic skin response
HRV	-	Heart rate variability
IDC	-	International Data Corporation
HPPT	-	Hypertext Transfer Protocol
API	-	Application Programming Interface
IC	-	Integrated Circuit
RAM	-	Random Access Memory
LED	-	Light Emitting Diode

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CHAPTER 1
INTRODUCTION

In this chapter will brief idea of the project is introduced. It focused on the project background, the detail in objectives, the problem statement, project scope, and methodology of the project.

1.1. Introduction

Development of IoT Smart Home Controller using Biosensor is a system that allows the communication between brain signal with the microcontroller processor to generate commands for controlling home appliances such as light, fan, plug and etc. The aim of this project is to develop a smart home controller using biosensor which able to improve life quality. In addition, this project works on cost savings concept as home appliances can be turn on when needed and turn off when no one use.

1.2. Project Background

Biosensor is an analytical device that used to convert a biological response into an electrical signal. Typically, biosensors must be highly specific, independent of physical parameters such as pH and temperature and should be reusable. Production of biosensors, its materials, transducing devices, and immobilization methods requires multidisciplinary research in chemistry, biology, and engineering. EEG bio amplifier is the one of the biosensor applications. EEG stand for electroencephalogram is a test that measures and records electrical signal from the scalp of the brain after placed a metal electrode. This electrode connected by wires to

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a computer. The computer records the brain‟s electrical activity and display it on the screen. Electrical signal consists of alpha waves, beta waves, theta waves and delta waves. All this have own frequency (in Hz) and mental condition. There are six most common applications for EEG which is neuromarketing, human factors, social interaction, psychology and neuroscience, clinical and psychiatric studies and brain computer interfaces (BCI).

Now, some low cost non-invasive EEG system in the market that provide a new feature to explore human brain with affordable and worth it with the price. Mindflex Duel by Neurosky. Neurosky (founded in 2004) is company that develop in electroencephalogram (EEG) biosensors devices especially in consumer-level brainwave monitoring. Mindflex Duel is the one of the device made by Neurosky as a game where moving an object with mind. Utilizing EEG technology, the wireless headset reads user brainwave activity and moving and object. The device used a variation of EEG technology to "read" the intensity of these brainwaves via sensors positioned on forehead and ear. The sensors do not generate or interfere with brainwaves, they only read what is already there.

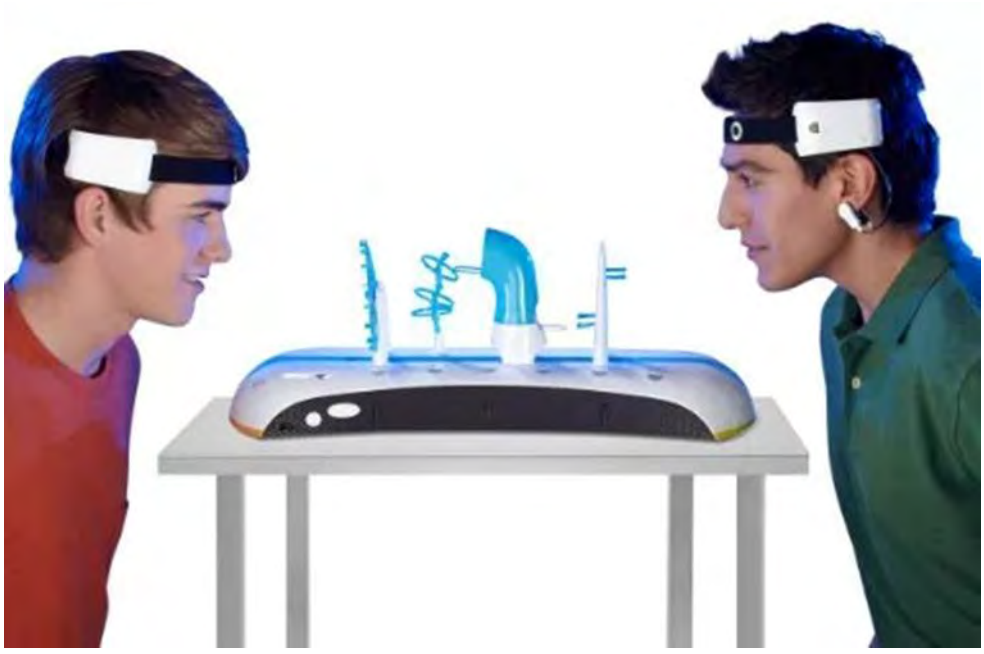

Figure 1. 1: Mindflex Duel used by 2 persons to move an object

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Lately, many researchers developed product based on EEG that can commercialize to bring convenience to every people especially disable people in the daily life. This situation can be seen by the existence of smart home applications is very awesome. There are various of smart home especially in controller such as automation of light, heating, ventilation, security and etc. Mostly all this system need active mental command by users to control home appliances and devices.

In this project, NodeMCU is used to give a command after executed to control smart home appliances. NodeMCU Lua ESP8266 WiFi Board is an open source IoT platform. In it already built-in ESP8266 (WiFi module) and many open source projects related with IoT development projects. An attractive graphical user interface is developed by using ThinkSpeak where every brain activity is measured and recorded from EEG biosensor device (Mindflex) can be displayed in web view and the data also saved in cloud.

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1.3. Problem Statement

Today, disabled people with stroke patient or other physical disability is hard to do something by themselves when they at home. They cannot reach fan switch, light switch, television remote and other home applications.

Figure 1. 2: People with physical disabilities

Figure 1.2 shows a person with physical disabilities means his/her body cannot move or handicapped. Hence, with this invention, its can assists disabled people to do some works while at home. And this project also related with electroencephalogram (EEG) sensor with Internet of Things (IoT) features. The purpose of this project also is recorded and saved every brain electrical analysis, interaction or interaction like fan speed, time, usage performance and brain radio frequency in database or cloud in web view to shows how often they used the command in their daily routines.

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1.4. Objective

The objectives of this development project are:

- To develop smart home control system using biosensor and IoT data visualization
- To analyze system performance in terms of biosensor and IoT performance

1.5. Scope

The focus of this project will be on developing a prototype of smart home system that can be controlled by EEG signals. At the very beginning, the communication between the low-cost brain computer interfacing device EEG biosensor (Mindflex) with NodeMCU Lua ESP8266 Wifi Board will be established. The EEG signals will be acquired by the EEG biosensor device and process with simple signal processing by using Arduino.IDE software to perform feature extraction to extract the most suitable feature as a command to control the home appliances. Finally, a reliable and friendly database and web view will be developed to allow user to have a clear visualization on the interface.

1.6. Project Methodology

This project will be a successful project as it follows the correct method and procedures. The methodology ensures the project is done within the require time and smoothly executes as the outcomes are observed. This flowchart shows the overview project method and procedure so that this project is successful as predicted. This flowchart also shows the selection of hardware and software used in this project after doing analysis about all the microcontroller. The methodology is purposely to ensure the development of the project is successfully than with a systematically and smoothly method.

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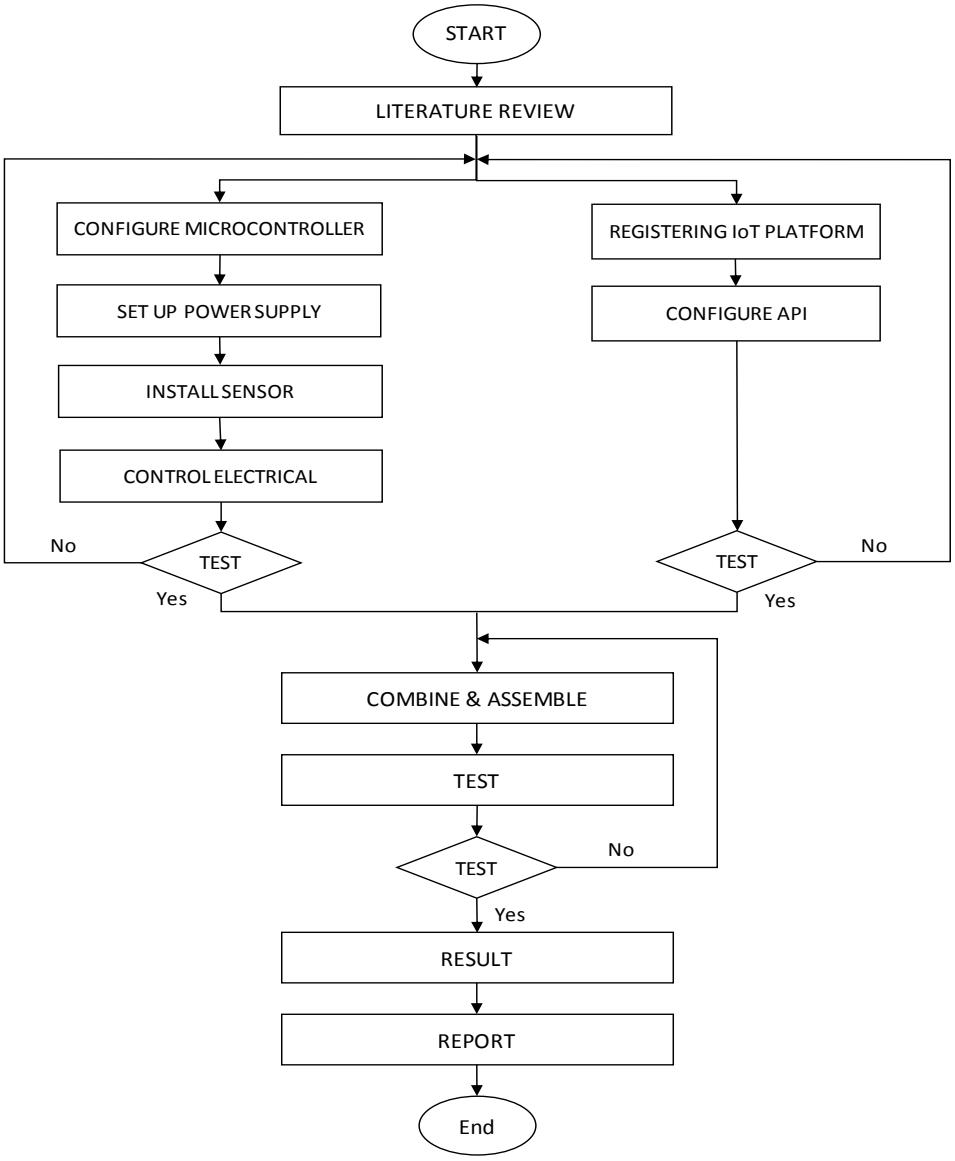

Figure 1. 3: Project flowchart

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1.7. Thesis Structure

This thesis is a combination of five chapters that contain the introduction, literature review, methodology, result and discussion and the last chapter is the conclusion and recommendation of the project.

a) Chapter 1:

The brief idea of the project is introduced. It focused on the project background, the detail in objectives, the problem statement, project scope, and methodology of the project.

b) Chapter 2:

The literature review of the Development of Smart Home Controller using Biosensor will be mentioned in this chapter. The concept, theory, and characteristic of component and hardware that cover in this project are included.

c) Chapter 3:

Explain about the project methodologies of this project. This chapter will show the step and procedure of this project. The project flow of the application working principle will be demonstrated in detail. Detailed reports of studies and accordance with objective achievement also included in this chapter.

d) Chapter 4:

This chapter will discuss about result of this project. The discussion will involve the result of the EEG signal that acquired from human and the result of signal processing method that applied on the real-time EEG signal. Final discussion will be the how the EEG signal will be transform as command to trigger the home appliances.

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e) Chapter 5:

The final chapter which is Chapter 5 will explain about the conclusion and recommendation of this project. In this chapter also concluded about what the project have done and followed by a recommendation on how to improve the performance of the system based on the desired results.

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