

## UNIVERSITI TEKNIKAL MALAYSIA MELAKA

# DEVELOPMENT OF NEURO EPILEPSY RECOGNITION SYSTEM USING ARTIFICIAL NEURAL NETWORK (ANN)

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

by

# NURUL AMALIA BINTI M.SALEH B071610271 940728-08-5888

## FACULTY OF ELECTRICAL AND ELECTRONIC ENGINEERING

TECHNOLOGY

2019



## UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: Development of Neuro Epilepsy Recognition System using Artificial Neural Network (ANN)

Sesi Pengajian: 2019

Saya **NURUL AMALIA BINTI M.SALEH** 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.
- Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
- Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
- 4. \*\*Sila tandakan (X)

ii

	Mengandung	i maklum	at yang	berdarjah	keselamatai	n atau
SULIT*	kepentingan	Malaysia	sebagain	nana yang	g termaktub	dalam
SULIT	AKTA RAHSIA RASMI 1972.					

Mengandungi maklumat TERHAD yang telah ditentukan olehTERHAD\*organisasi/badan di mana penyelidikan dijalankan.



 $\square$ 

TIDAK

TERHAD

Yang benar,

Disahkan oleh penyelia:

NURUL AMALIA BINTI M.SALEH Alamat Tetap: .....

ENCIK KHAIRUL AZHA BIN A AZIZ

Cop Rasmi Penyelia

PT.151, Dataran Serdang Permai 12,

RPT Kampung Serdang Permai,

31300 Kampung Kepayang, Perak

Tarikh:

Tarikh:

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

iii

## DECLARATION

I hereby, declared this report entitled Development of Neuro Epilepsy Recognition System using Artificial Neural Network (ANN) is the results of my own research except as cited in references.

Signature:	
Author:	NURUL AMALIA BINTI M.SALEH
Date:	

## 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 member of the supervisory is as follow:

## ABSTRAK

Pada masa ini, kira-kira 65 juta orang di seluruh dunia mempunyai epilepsi. Epilepsi adalah penyakit neurologi yang memberi kesan kepada manusia dari semua peringkat umur dan punca penyakit ini adalah disebabkan kerana aktiviti tidak normal di dalam otak. Penyakit ini telah dicirikan oleh pergerakan yang tidak terkawal dan kehilangan kesedaran dan konvulsi yang boleh menyebabkan kecederaan serius. Hasilnya, kajian ini telah membangunkan sistem pengecaman epilepsi neuro menggunakan rangkaian neural buatan (ANN). Rangkaian neural buatan (ANN) digunakan dalam pembelajaran mesin sebagai salah satu alat utama dan ia adalah sistem yang diinspirasi daripada otak yang bertujuan untuk meniru cara manusia berfikir. Kajian ini menggunakan rangkaian pengenalan corak yang merupakan salah satu teknik rangkaian neural umpan balik dan mencadangkan kaedah pengecaman epilepsi yang akan dilaksanakan menggunakan perisian MATLAB. Tambahan pula, kajian ini juga menggunakan isyarat elektroensefalogram (EEG) untuk mendiagnosis dan mengakses aktiviti otak dan gangguan dengan menggunakan data yang ditetapkan dari Universiti Bonn yang digunakan secara meluas dalam kebanyakan kajian mengenai pengecaman epilepsy. Isyarat EEG juga boleh didapati dengan menggunakan sensor EEG NeuroSky MindLink. Sensor ini digunakan untuk memperoleh isyarat EEG data luaran untuk menguji dalam rangkaian saraf. Keputusannya menunjukkan sistem ini berjaya dilaksanakan dengan mendapat 75.8% untuk ketetapan keseluruhannya dengan latihan, pengesahan dan ujian masing-masing mendapat 76.3%, 70.7% dan 78.7%.

### ABSTRACT

Currently, about 65 million of people around the world have epilepsy. Epilepsy is neurological disease that affects people of all ages and the cause of this disease is because of abnormal activity in the brain. This disease has been characterized by the uncontrollable movement and loss of consciousness and convulsions that can lead to serious injuries. As the result, this study has developed a neuro epilepsy recognition system using artificial neural network (ANN). Artificial Neural Network (ANN) are used in machine learning as one of the main tools and it is brain-inspired systems which are meant to replicate the way human being think. This study uses pattern recognition network which is it is one of feedforward neural network techniques and proposes epilepsy recognition method that will be implemented using MATLAB software. In addition, this study also used electroencephalogram (EEG) signal in order to diagnosis and accessing brain activity and disorder by using the dataset from University of Bonn which is widely used in the most of research regarding to epilepsy. EEG signal are also can be obtained by using NeuroSky MindLink EEG sensor. This sensor is used to acquire external data EEG signal to test in neural network. As a result, this system was successful implemented with 75.8% for overall accuracy with training, validation and testing respectively get 76.3%, 70.7% and 78.7%.

vii

## **DEDICATION**

This thesis is dedicated to my parents M.Saleh bin M.Taib and Teh Hawa binti Mohd Yusoff, my siblings, my friends for their unconditionally support to complete this final year project and my supervisor and lecturer, Encik Khairul Azha bin A Aziz and Encik Ahmad Fauzan bin Kadmin for the guidance and encouragement.

viii

#### ACKNOWLEDGEMENTS

First and foremost, all praise and gratitude to Allah SWT for giving me strength to went through all difficulties and hardship to successfully finishing up this research. I would like to express my sincere gratitude to my supervisor, Encik Khairul Azha bin A Aziz and Encik Ahmad Fauzan bin Kadmin for continuous encouragement, guidance and constant support in making this research possible. I really appreciate their guidance because they help me from start until the finished that enable me to develop more understanding about this project thoroughly. It would be a lot of tougher to complete this research without their advice and assistance. I also sincerely thanks for the time spent to proofreading and correcting my mistakes.

I also want to thanks to all lecturers and members of the staff of the Department of Electronic and Computer Engineering Technology, Universiti Teknikal Malaysia Melaka (UTeM), who helped me in many ways and made my education journey at UTeM pleasant and unforgettable. Thanks also to BEEC Kohort 6 colleagues for their excellent co-operation, inspirations and supports during this study. This fourth year experience with them will be remembered as an important memory for me to face the new chapter of life as an engineer.

Lastly, I also want to acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life. I am really thankful for their sacrifice, patience and understanding that was inevitable to make this research possible.

ix

## **TABLE OF CONTENTS**

ABST	<b>TRAK</b>	vi	
ABSTRACT		vii	
DEDI	ICATION	viii	
ACK	ACKNOWLEDGEMENTS ix		
TABI	TABLE OF CONTENTSx		
LIST	LIST OF TABLES xiii		
LIST	LIST OF FIGURES xiv		
LIST	LIST OF ABBREVIATIONS xvii		
CHA	PTER 1 INTRODUCTION		
1.1	Introduction	1	
1.2	Project Background	1	
1.3	Problem Statement	4	
1.4	Problem Objectives	5	
1.5	Scope of Project	5	
1.6	Project Methodology	6	
1.7	Thesis Organization	6	

## CHAPTER 2 LITERATURE REVIEW

2.1	Epilepsy	8
2.2	Artificial Neural Network (ANN)	10
2.3	EEG Sensor	12
2.4	Neuro Epilepsy Recognition Systems	14
2.5	Summary	25
2.6	Project Aims	26

## CHAPTER 3 METHODOLOGY

3.1	Project Description and Block Diagram	28
3.2	Methodological Procedures	32
3.3	Hardware Implementation	35
3.4	Software Implementation	36
3.5	Experiment, Testing and Measurement	41
3.6	Stating Outcome	43

## CHAPTER 4 RESULT AND DISCUSSION

4.1	Project Result	44
4.2	Result Real-Time Brainwave Data Using NeuroSky MindLink EEG Sensor	47
4.3	Analysis Before Transform Dataset Into Sub-Band Using Discrete Wavelet	
	Transform	49

4.4	Analysis by Changing the Number of Neurons in Pattern Recognition	
	Network's Hidden Layer in MATLAB R2019a	50
4.5	Analysis by Testing the Real-time Brainwave Data from EEG sensor by	
	Trained using EEG Dataset	54
4.6	Discussion	55
СНА	PTER 5 CONCLUSION AND FUTURE WORK	
5.1	Conclusion	57
5.2	Future Work and Recommendations	57
REF	ERENCE	59
APP	ENDIX	61

## LIST OF TABLES

## **CHAPTER 2**

- Table 2.1: The different wavebands from EEG Signal
- Table 2.2: Comparison of the literature review of neuro epilepsy recognition system

### **CHAPTER 3**

- Table 3.1: The epilepsy dataset detail of University of Bonn
- Table 3.2: The coefficient of DWT and its EEG waveform
- Table 3.3: The set and subset of EEG signals with their target vectors

## **CHAPTER 4**

- Table 4.1: Colour use that indicate type of brainwave in Brainwave Visualizer
- Table 4.2: The brainwave wavelength in the range of ten minutes
- Table 4.3: Summary for different number of hidden neurons with its training, validation,

   testing and overall accuracy

xiii

## **LIST OF FIGURES**

#### CHAPTER 1

Figure 1.1: The epilepsy brain states

Figure 1.2: EEG signal during pre-seizure and seizure activity

Figure 1.3: EEG recording are mixed of electrical activities of different brain parts

### **CHAPTER 2**

- Figure 2.1: The type of epilepsy seizure
- Figure 2.2: Model of neuron in artificial neural network
- Figure 2.3: Architecture of artificial neural network
- Figure 2.4: Pattern recognition neural network by using neural network training toolbox

#### In MATLAB

- Figure 2.5: The connection of EEG sensor using Arduino Uno and Bluetooth Module
- Figure 2.6: Home and sign in screen
- Figure 2.7: Dismiss and first aid screen
- Figure 2.8: The architecture proposed
- Figure 2.9: The patient's kit scheme and MCC architecture
- Figure 2.10: Wearable Device (WD) frontal view and Heart Rate (HR) sensor detail
- Figure 2.11: System architecture of the smart headband
- Figure 2.12: Application scenario of the proposed system
- Figure 2.13: Main pages of the corresponding application
- Figure 2.14: Smart headband
- Figure 2.15: Block diagram of smart epilepsy detection and alert system

xiv

Figure 2.16: Pulse oxy meter and its principle of operation

- Figure 2.17: Epilepsy kit with Arduino and GSM module
- Figure 2.18: Sign up or login screen
- Figure 2.19: Alarm notification
- Figure 2.20: Mind Wave Mobile EEG Headset

#### CHAPTER 3

- Figure 3.1: The epilepsy phase
- Figure 3.2: The general block diagram of epilepsy recognition system
- Figure 3.3: Flow chart of project implementation
- Figure 3.4: The connection of NeuroSky MindLink EEG sensor with Arduino Uno and HC05 Bluetooth module
- Figure 3.5: NeuroSky MindLink EEG sensor
- Figure 3.6: Flow chart of EEG sensor process
- Figure 3.7: Pattern recognition in artificial neural network
- Figure 3.8: Flow chart of process in MATLAB R2019a
- Figure 3.9: Arduino IDE
- Figure 3.10: Icon of Brainwave Visualizer application
- Figure 3.11: PLX-DAQ

#### **CHAPTER 4**

- Figure 4.1: The brainwave reading data display on Serial Monitor in Arduino IDE
- Figure 4.2: The visualization of brainwave display in Brainwave Visualizer application

Figure 4.3: Confusion Matrix with ten hidden neuron

XV

Figure 4.4: The graph of brainwave wavelength in the range of ten minutes

- Figure 4.5: Confusion matrix using eighteen hidden neuron
- Figure 4.6: Confusion matrix using fifteen hidden neuron
- Figure 4.7: The graph of accuracy different number of hidden neuron
- Figure 4.8: Some output shows according to target and indices of the real-time data after simulate using same network with EEG dataset

## LIST OF ABBREVIATIONS

ANN	- Artificial Neural Network
EEG	- Electroencephalography
MATLAB	- Matrix Laboratory
ROC	- Receiver Operating Characteristics
GPS	- Global Position System
CC	- Cloud Computing
MCC	- Mobile Cloud Computing
ІоТ	- Internet of Thing
WD	- Wearable Device
HR	- Heart Rate
ESDT	- Epileptic Seizure Detection Tag
MiWi	- Microchip Wireless Networking
MEMS	- Micro-Electromechanical System
NI	- National Instruments
GSM	- Global System for Mobile communication
PIC	- Peripheral Interface Controller
KEIL	- Knowledge Engineering Integration Laboratory
SQ	- Structured Query
SDK	- Software Development Kit
APP	- Application
SMS	- Short Message Service
I/O	- Input or Output

xvii

SVD	- Singular Value Decomposition
IDE	- Integrated Development Environment
PLX-DAQ	- Parallax Data Acquisition tool
TP	- True Positive
TN	- True Negative
FP	- False Positive
FN	- False Negative
DWT	- Discrete Wavelet Transform

xviii

#### **CHAPTER 1**

### **INTRODUCTION**

### 1.1 Introduction

This chapter was describing the introduction to the project that consists of background of the project, problem statement, the objective, scope of the project and thesis organization. The development of neuro epilepsy recognition system using artificial neural network (ANN) was briefly explain in more detail in this paper including the method used to complete the project. In this chapter also describes how idea of the project was developed, why this project should take place in community and what problem that needs to be solved. It also includes the reason why this project needs to implement and explain the current situation and its problem. The objective of this project was stated will solve problem statement that is declared on this chapter. Understanding on the overall description of the project can be gain through this chapter.

## 1.2 Project Background

Brain is the important organs of the human body that serves as the center of the nervous system which is located in the head. So that, the brain can cause many disorder such as epilepsy. Epilepsy is one of the most common disorder of central nervous system or also called as neurological disease that affects people of all ages and this disease caused by abnormal activity in the brain. About 65 million of people around the world have epilepsy. The main reason of this disorder still remain unknown but the cause of this disorder maybe because of genetic influence, stroke, traumatic brain injury

1

or brain infections. Seizure patient are categorized when the seizure happen more than two in a lifespan of a person.

The effect of the epileptic seizures can impact the quality of life for patients and his or her family and even can lead to death. It also shows the symptoms such as the uncontrollable movement and loss of consciousness and convulsions that can lead to serious injuries. This symptom is depending on the type of the seizure. In the most cases, the epilepsy patients have the same symptoms if seizure that they occur is in the same type. The quality life of the patient able to improve if there is a system that able to predict of epilepsy seizure at an early stage which also will increase the effect of medication and many patient able to treat accordingly. Figure 1.1 below display the epilepsy brain states.

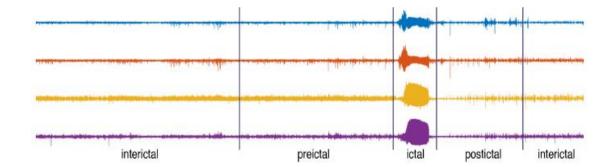


Figure 1.1: The epilepsy brain states

The main target of this project is the result neural network using EEG dataset from University of Bonn will be compared with real-time brainwave data. This project used electroencephalography or EEG signals for diagnosis of epilepsy that able to capturing the changes in neuronal activity that happen during epilepsy seizures. Recently, analysis of EEG signal has been used with the goal of predict epilepsy seizures in order to reduce or eliminate the risks associated with it. EEG also used to confirms if it detect the presence of abnormal activity and record the data in order to identify the properties of the seizure. Figures 1.2 below illustrate the EEG signal during pre-seizure and seizure activity.

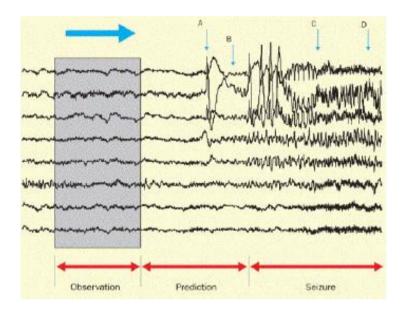


Figure 1.2: EEG signal during pre-seizure and seizure activity

This project also use artificial neural network. Artificial neural network are used in machine learning as one of the main tools and it is brain-inspired systems which are meant to replicate the way human being think. This network consists of input and output layers and in the most cases, it also have hidden layer which is consists of units that converts the input into something that can be used by the output layer. It also excellent tools to identify patterns that are far too complicated or numerous to be understood by a human programmer. This project also used EEG sensor to obtained real-time brainwave data from EEG signal.

## **1.3** Problem Statement

Nowadays, epilepsy seizures which reoccur at random times able to disrupt the patient cognitive and emotional state such as the ability to work and drive, social and economic situation. If there is a system able to recognize data between healthy person and epilepsy patient, the researcher able to rearrange the data and put in the correct set or classes. This system has been need for an efficient and accurate recognition of epilepsy.

Currently, neuro-physiologists or trained neuro-clinicians experienced only visual inspected with EEG recordings for epilepsy recognition system. It will hinder the diagnosis procedure and also the EEG recording process required several hours or more. An expert is required to analyse the entire length of EEG recordings to detect epileptic activity. The patient will tire because they have to wait several hours. Figure 1.3 shows the EEG recordings are mixed of electrical activities of different brain parts.

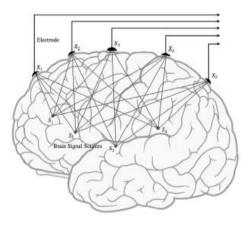


Figure 1.3: EEG recording are mixed of electrical activities of different brain parts Besides that, they need a system because of both huge amount and expanded use of long-term EEG records for effective neurological disease assessment and treatment,

including epilepsy. It would also narrow the ability of the expert to misread the data and fail to make a proper decision

## 1.4 **Project Objectives**

The objective has been stated in order to overcome the problem stated in the problem statement and to attain the purpose of this project. The key objectives are:

- a) To developed a neuro epilepsy recognition system using Artificial Neural Network (ANN) by using MATLAB.
- b) To analyse the system whether it can recognize between healthy person and epilepsy patients successfully using an EEG dataset from University of Bonn.
- c) To compare real-time brainwave data from EEG sensor using Artificial Neural Network (ANN) that had been trained using EEG dataset from University of Bonn.

### **1.5** Scope of Project

The scope of this project is implementing a neuro epilepsy recognition system using artificial neural network (ANN) by recognize between normal person and epilepsy patient. Besides that, this project used Matrix Laboratory (MATLAB) as the main software to develop the artificial neural network system. This system will recognise whether each of set from dataset of University of Bonn that contain of EEG signal is belong to normal person or epilepsy patient and will produce the result based on its accuracy, sensitivity or specificity. Furthermore, this project will also analyse from the confusion matrix. In addition, this project can analyse the comparison between real-time brainwave data from EEG sensor using Artificial Neural Network (ANN) and training data by using EEG dataset from University of Bonn.

## 1.6 Project Methodology

Project methodology indicates that this project will be successful if it follows the correct method and procedures. This methodology was done to ensure the project finished within the required time given and smoothly executes while the outcomes are being observed.

The development of this project is based on the idea and the definition of the project and the purpose why this project is chosen. The process or method of this project includes the flow chart. The flow chart shows the steps by steps to do in completing the project with a successful achievement. It also purposely to ensure the development of the project is successful with a systematically and smoothly method. In this methodology also will describe the measurement that had to be done in order to test to ensure there is no error occurs.

## 1.7 Thesis Organization

In the thesis organization, the structure of the report for this project consists of five chapters that are shown below:

#### **Chapter 1: Introduction**

Describe the introduction to the project that consists of five subtopic include project background, problem statement, and project objective, scope of project and thesis organization.