Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF COMPUTER AIDED DESIGN FOR EEG SIGNALS EPILEPSY DIAGNOSIS USING ARTIFICAL NEURAL NETWORK

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Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

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DEVELOPMENT OF COMPUTER AIDED DESIGN FOR EEG SIGNALS EPILEPSY DIAGNOSIS USING ARTIFICAL NEURAL NETWORK

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DEDICATION

This thesis is dedicated to Ahmezul Bin Ahmad and Dawinah@Jaslina Bte Jugok, my beloved parents for their constant love, encouragement, and inspiration. To my supervisor Encik Khairul Azha Bin A. Aziz who never giving up to taught and guide me to complete my project. To my helpful classmate and hoursemate always keep supporting me.

ABSTRACT

Epilepsy is a brain condition that affects the whole brain nervous system and is characterised by high-frequency and high-voltage brain waves called seizures. This disorder is identified as one of the uncontrolled movements shown by epilepsy patients during an outbreak, resulting in loss of consciousness and convulsions. As a result, the purpose of this thesis is to construct an EEG Epilepsy Recognition System using Artificial Neural Networks (ANN). Their principal tool is the Cascade-Forward Neural Network technology, which their system designed to perform a process similar to that of a human brain. This brain-inspired technology was designed to mimic how human brains think. This thesis offers an epilepsy detection process implemented in MATLAB utilising Cascade-forward Neural Networks. Additionally, this study employed the Electroencephalogram (EEG) signal to diagnose and access human brain activity and disturbance by using a dataset collected from the University of Bonn (Bonn), which has been extensively used by other researchers doing epilepsy research. The MindLink EEG Sensor is used to collect external EEG data, which is subsequently utilised to test the neural network. As for the result, this Artificial Neural Network successfully carried out with 77.1% for training, 77.3% for validation, 74.7% for testing and lastly the overall accuracy is 76.2% by using 15 hidden neuron network.

ABSTRAK

Epilepsi adalah keadaan otak yang menjejaskan keseluruhan sistem saraf otak dan dicirikan oleh gelombang otak frekuensi tinggi dan voltan tinggi yang dipanggil sawan. Gangguan ini dikenal pasti sebagai salah satu pergerakan tidak terkawal yang ditunjukkan oleh pesakit epilepsi semasa wabak, mengakibatkan kehilangan kesedaran dan sawan. Hasilnya, tujuan tesis ini adalah untuk membina Sistem Pengecaman Epilepsi EEG menggunakan Rangkaian Neural Tiruan (ANN). Alat utama mereka ialah teknologi Rangkaian Neural Cascade-Forward, yang sistem mereka direka untuk melakukan proses yang serupa dengan otak manusia. Teknologi yang diilhamkan oleh otak ini direka untuk meniru cara otak manusia berfikir. Tesis ini menawarkan proses pengesanan epilepsi yang dilaksanakan dalam MATLAB menggunakan Rangkaian Neural Cascade-forward. Selain itu, kajian ini menggunakan isyarat Electroencephalogram (EEG) untuk mendiagnosis dan mengakses aktiviti dan gangguan otak manusia dengan menggunakan set data yang dikumpul dari Universiti Bonn (Bonn), yang telah digunakan secara meluas oleh penyelidik lain yang melakukan penyelidikan epilepsi. Penderia MindLink EEG digunakan untuk mengumpul data EEG luaran, yang kemudiannya digunakan untuk menguji rangkaian saraf. Hasil dari penyelidikan ini, rangkaian Neural Tiruan ini berjaya dijalankan dengan 77.1% untuk latihan, 77.3% untuk pengesahan, 74.7% untuk ujian dan akhir sekali ketepatan keseluruhan ialah 76.2% dengan menggunakan 15 rangkaian neuron tersembunyi.

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LIST OF SYMBOLS

µV	Microvolts
α	Alpha
β	Beta
γ	Gamma
Δ	Delta
θ	Theta
Hz	Hertz
V	Volt
dB	Daubechies
ψ	Wavelet coefficients
ττττ	Tau
VCC	Voltage Common Collector
GND	Ground
RX	Receiver
TX	Transmitter
a	Scaling Parameter
b	Location of the Parameter
%	Percentage

LIST OF ABBREVIATIONS

EEG	Electroencephalogram
MIT	Massachusetts Institute of Technology
CNN	Convolutional Neural Network
CHB	Children's Hospital Boston
CWT	Continuous Wavelet Transform
BoW	Bags-of-Words
SVM	Support Vector Machine
DWT	Discrete Wavelet Transform
FFT	Fast Fourier Transform
AR	Autoregressive or Autoregression
MLPNN	Multilayer Perceptron Neural Network
ANFIS	Adaptive Neuro-Fuzzy Interference System
KDD	Knowledge Discovery in Database
RNN	Recurrent Neural Network
LSTM	Long-Short-Term Memory
GRU	Gated-Recurrent Unit
STFT	Short-time Fourier Transform
WT	Wavelet Transform
GPS	Global Positioning System
ANN	Artificial Neural Network
UBonn	University of Bonn

CHAPTER 1

INTRODUCTION

1.1 Background

Seizures, odd behaviour, feelings, and even loss of consciousness are all symptoms of epilepsy, a neurological disorder. Patients who experience seizures are at a greater risk of several different kinds of trauma, including falls, head trauma, cuts, and burns. Patients may be unaware that seizures happen without warning, which increases their risk of harm. Epilepsy affects an estimated 4-5% of the world's population, according to current research[1]

Electroencephalography is a critical technique for diagnosing and analysing epilepsy (EEG). To diagnose brain illnesses such as epilepsy, autism, brain tumours, and depression, an electroencephalogram (EEG) is used. The EEG is a noninvasive, low-cost, well-established, and precise technique used to record brain activity. When electrodes are put on essential points on the patient's skull using proper mechanical and electrical support, the EEG detects the variations in brain electricity between the electrodes. To diagnose epileptic seizures, neurologists have typically relied on visual analysis of EEG recordings. However, this technique may be time-consuming and labour-intensive, especially when dealing with long-term recordings, and it is also subjective. A new method to automated diagnostics is therefore required as a result [2].

We utilized data from the University of Bonn in this study. A conventional electrode replacement procedure of 10-20 electrodes was used for the recording. The datasets are divided into five sets, each with 100 channels and labelled A through E. Data is digitalized at 173.61Hz sampling rate and 12bit A/D resolution using a 128-channel amplifier setup [1]

A Computer Program based on Artificial Neural Networks replicates human brain functions. This particular methodology incorporates human biology, which results in the ANN's, a mathematical model that can calculate, make decisions, and learn. [3] The Neural Network Toolbox in MATLAB will be used to examine EEG data using ANN in this project. This study is designed to illustrate how the information from an EEG may be used to distinguish epilepsy and normal patients.

1.1.1 Problem Statement

Seizures and behavioural abnormalities that recure often are indicators of epilepsy, a neurological condition that occurs when there is too much electrical activity in the brain. That shows that seizures will result from this abnormally high electrical activity in the brain. Seizures may cause unconsciousness and tremors. Seizures happen regularly, but the epilepsy sufferer does not know when or how they will occur. During a seizure, an EEG scan may reveal a particular pattern of brain activity changes. EEG measurements are used to examine the impact of epilepsy on the brain.

Due to the complex, pure, and direct nature of the oscillation, EEG recordings are seldom observed. Furthermore, because it is essential to use an algorithm to quantify EEG signals properly, the interpretation has not been extensively verified by analytics. As a preprocessing stage for an Artificial Neural Network (ANN) based on EGG disassembled data, the capabilities of the wavelet transform for data manipulation are examined in this recommended research. To ensure that the data meets specifications, the data is created using the MATLAB Neural Network toolbox, which utilises the Neural Network routine. Based on the data used, the ANN's capacity may be estimated.

Due to a large number of hospitalised people due to their epilepsy, the EEG recordings are exceedingly challenging to deal with since they comprise an enormous amount of time-to-day information. That will require an enormous quantity of data to be collected. As a consequence, the design and operation of this system must be optimised. Auto-Regression techniques minimise the amount of processing time required by setting out to collect as little data as possible.

Due to time consuming to load the EEG data, a MATLAB-based GUI (Graphical User Interface) platform have to be create to detect the existence of a brain disease and to provide a clear comparison between the afflicted and normal brain

1.2 Project Objective

The purpose of this project is as follow :

a) To develop a computer aided design for EEG signals epilepsy diagnosis using artifical neural network.

b) To analyze whether its able to recognize between healthy person and epilepsy person by evaluating EEG parameters.

c) To evaluate genuine brainwave data, acquire it from an EEG sensor and train it using an Artificial Neural Network (ANN) using data from the University of Bonn's EEG dataset.

1.3 Scope of Project

The scope of this project are as follows:

a) The Dataset for this Epilepsy Test is from Department of Epileptology at the University Hospital of Bonn.

b) To categorise healthy and epileptic EEG data using the Matlab Neural Network toolkit.

c) Use Neurosky Mindlink to monitoring signals generated by neural activity in brain.

d) Use App designer (Matlab) to take out the wave from the Dataset.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The number of people who have epilepsy varies, but the worldwide total is estimated to be approximately 1 per cent. A very severe CNS disorder that increases a person's risk of having frequent seizures. A seizure is a sudden, involuntary alteration in behaviour, movement, feeling, or consciousness in the brain detected by a doctor. Changes in clinical behaviour are preceded and followed by waves in the electroencephalogram (EEG) which include single-frequency (monomorphic), multifrequency (polymorphic), and spike and sharp wave complexes.

2.2 EEG Brain Sensor

2.2.1 NeuroSky Mindset Sensor

The NeuroSky Mindset Sensor is utilised in interpreting EEG data in several ways. The gadget will gather and transmit brain signals, which will then be translated into movements. The system will assess the size of the wave and modify the sensitivity such that the system will recognise it. NeuroSky monitors electrical activity in the human brain by attaching electrodes to the forehead and ears and applying unique thinking to this information. [5]. The design shown in Figure 2.1 fits snugly within the ear and has a probe at the end.

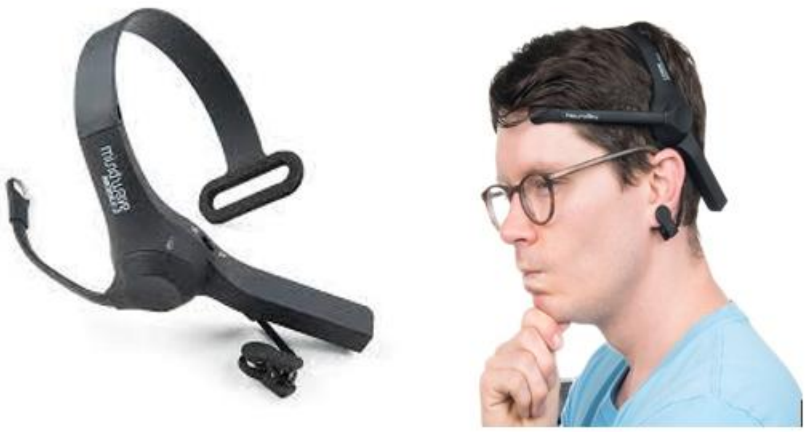

Figure 2.1: Neurosky Mindset Sensor

The NeuroSky Mindwave Mobile consists of eight pieces: an ear clip, an ear arm, a battery compartment, a power switch, an adjustable headband, a sensor tip, and a sensor arm. This electronic device has two sensors that measure and filter electroencephalogram (EEG) data. The sensor picks up the electrical signal on the forehead implanted in the brain's frontal lobe. Another sensor that is used to filter out electrical noise is an ear clip. NeuroSky Mindwave Mobile is very resistant to noise, and before transmitting the signal, it has been digitally coded. Additionally, it broadcasts unencrypted brain waves, also known as Emotive and Muse waves, without encryption. [6]

The NeuroSky method is used to characterise mental state by using the residual signal received after noise and muscle movements of raw brain wave data have been filtered. Two eSense signals are generated in this programme: attention and meditation signals. These signals indicate the attention and relaxation of the individual. This signal has a value of 0 to 100, with nil showing low concentration or relaxation and 100 signallings high concentration or relaxation. To function with Arduino, the EEG or NeuroSky Mindset sensors must be modified. The Arduino can only read input values of 0V to 5V, whereas the sensor outputs 0V to 5V. One example is the MindLink Sensor, which functions like the NeuroSkyMindset Sensor. The comparison of the kind of brain signal is provided in Table 2.1.

Table 2.1: Comparison of Brain Signal Type

Waveband	Frequency (Hz)	Condition
Delta	0.1 - 3	Deep Dreamless, Sleep or Unconsious
Theta	4 - 7	Drowniness, deep relaxion, daydreaming
Alpha	8 – 13	Relaxtion, medidation ,quiet and conscious
Low Beta	12 – 15	Relaxed but concentrated, constructive attention, daydreaming and solving problem
Mid-range Beta	16 – 20	Thought, self awareness and surroundings
High Beta	21 – 30	Alert and restless

This sensor will turn brain impulses into directions that change human intellect into an electrical signal, and processors need to be installed to order mobile, medicinal, or even engineering applications. The EEG sensor communication may be linked to a phone or a computer using Bluetooth or a wireless unit. To connect an EEG sensor, the Arduino Uno and Bluetooth module were utilised.

2.3 Types of Signal Processing

2.3.1 Discrete Wavelet Transform (DWT)

Discrete Wavelet Transformation (DWT), epileptic electroencephalography (EEG) computer-assisted signal analysis has recently become a powerful temporal frequency technique for seized identification. In earlier research, the DWT parameters selected randomly or experimentally are among the main hurdles to DWT deployment. In addition,