Faculty of Electrical and Electronic Engineering Technology

DEVELOPMENT OF MATLAB BASED EEG DATA ACQUISITION FOR MEDICAL APPLICATION

ZAMRY BIN ZAKARIA

Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

2023

DEVELOPMENT OF MATLAB BASED EEG DATA ACQUISITION FOR MEDICAL APPLICATION

ZAMRY BIN ZAKARIA

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
PROJEK SARJANA MUDA II

Tajuk Projek :

Sesi Pengajian :

Saya **ZAMRY BIN ZAKARIA**. mengaku membenarkan laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (✓):

☐	**SULIT***	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐		(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☑	**TIDAK TERHAD**	

Disahkan oleh:

(TANDATANGAN PENULIS)

(COP DAN TANDATANGAN PENYELIA)

Alamat Tetap:
No 25 Jalan KJ 18,
Taman Krubong Jaya,
75250, Melaka.

Ts. KHAIRUL AZHA BIN A AZIZ
Pensyarah Kanan
Jabatan Teknologi Kejuruteraan Elektronik Dan Komputer
Fakulti Teknologi Kejuruteraan Elektrik Dan Elektronik
Universiti Teknikal Malaysia Melaka

Tarikh: 22 February 2023

Tarikh: 22 February 2023

*CATATAN: Jika laporan ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh laporan ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I declare that this project report entitled "Development Of MATLAB Based EEG Data Acquisition For Medical Application" is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Student Name : ZAMRY BIN ZAKARIA

Date : 22 FEBRUARY 2023

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPROVAL

I approve that this Bachelor Degree Project 2 (PSM2) report entitled “Development Of MATLAB Based EEG Data Acquisition For Medical Application” is sufficient for submission.

Signature :

Supervisor Name : Ts. KHAIRUL AZHA BIN A AZIZ

Date : 22 February 2023

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electronics Engineering Technology (Industrial Electronics) with Honours.

Signature :

Supervisor Name : Ts. KHAIRUL AZHA BIN A AZIZ

Date : 22 February 2023

Signature :

Co-Supervisor Name (if any) :

Date :

اونيورسيتي تيكنيكل مليسيا ملاك
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEDICATION

This thesis is dedicated to Zakaria Bin Ayob and Ramlah Binti Puteh, beloved parents for their constant love, encouragement, and inspiration. To dearest wife Wan Norasikin Binti Wan Ali, My Son Muhammad Zharfan, Muhammad Zakwan, Muhammad Zahiruddin, Muhammad Zharif, Muhammad Zuhair and My Daughter Zaara Sofia who sacrificed a lot of time and gave unceasing encouragement. My supervisor Mr Khairul Azha Bin A. Aziz who never gave up on teaching and guiding me to prepare me thesis. To the friends who help a lot, give guidance and share knowledge, a million thanks are said. 'Jazakumullah Khairan Katsiran Wa Jazakumullah Ahsanal Jaza'(جَزَاكُمُ اللهُ خَيْرًا كَثِيْرًا وَجَزَاكُمُ اللهُ اَحْسَنَ الْجَزَاء).

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ABSTRACT

The electroencephalogram (EEG) is a recording made from the scalp of the brain's electrical activity. The objective of this study to develop of EEG data acquisition for medical application using MATLAB in this project using a medical application to detect epilepsy that is usually not detected in the early stages and is only detected when the patient has had a seizure because the seizure detection test requires a high cost., determine which kind of input data should be used to explore epilepsy seizures detection and achieve the best results for use with a neural network also to test and compare real brainwave data , obtained from EEG sensor by using Artificial Neural Network (ANN) using Bonn University dataset. By using hardware such as MindLink EEG Sensor, Bluetooth Module and Arduino Uno as a medium to take data from the patient's brain and send it to MATLAB software to analyze and get answers. In MATLAB software, the neural network Train and Test programs were developed to carry out operations using patternnet neuron value 25 after the experiment was conducted and found that this neuron value 25 can produce an accuracy of 83% which will produce an Artificial Neural Network (ANN) as a function test for assessing how well a trained ANN performs on a collection of test data. GUI (Graphical User Interface) in MATLAB are helpful for developing interactive tools and data visualization has been developed to make it easier for users to use the TEST program. The result reveals that all signals received from the EEG Sensor were successfully analyzed with a time rate according to the data value entered into the GUI Software. The results found that normal and abnormal results were successfully displayed on the GUI Software which took 20.86 seconds for 20 data, 50.73 seconds for 50 data, 1.42 minutes for 100 data, 17.10 minutes for 1000 data, 51.18 minutes for 3000 data and 4097 data took 67.18 minutes.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ABSTRAK

Elektroensefalogram (EEG) ialah rakaman yang dibuat daripada kulit kepala aktiviti elektrik otak. Objektif kajian ini untuk membangunkan pemerolehan data EEG untuk aplikasi perubatan menggunakan MATLAB, menentukan jenis data input yang harus digunakan untuk meneroka pengesanan sawan epilepsi dan mencapai keputusan terbaik untuk digunakan dengan rangkaian saraf juga untuk menguji dan membandingkan data gelombang otak sebenar , diperoleh daripada sensor EEG dengan menggunakan Rangkaian Neural Buatan (ANN) menggunakan dataset Universiti Bonn. Dengan menggunakan perkakasan seperti Penderia MindLink EEG, Modul Bluetooth dan Arduino Uno sebagai medium untuk mengambil data dari otak pesakit dan menghantarnya ke perisian MATLAB untuk menganalisis dan mendapatkan jawapan. Dalam perisian MATLAB, program neural neywork Latih dan Uji dibangunkan untuk menjalankan operasi menggunakan nilai patternnet 25 selepas eksperimen dijalankan dan mendapati nilai 25 ini boleh menghasilkan ketepatan 83% yang akan menghasilkan Rangkaian Neural Tiruan (ANN) sebagai fungsi. ujian untuk menilai prestasi ANN terlatih pada koleksi data ujian. GUI (Antaramuka Pengguna Grafik) dalam MATLAB membantu untuk membangunkan alat interaktif dan visualisasi data telah dibangunkan untuk memudahkan pengguna menggunakan program TEST. Hasilnya mendedahkan bahawa semua isyarat yang diterima daripada Penderia EEG telah berjaya dianalisis dengan kadar masa mengikut nilai data yang dimasukkan ke dalam Perisian GUI. Keputusan mendapati keputusan normal dan abnormal berjaya dipaparkan pada Perisian GUI yang mengambil masa 20.86 saat untuk 20 data, 50.73 saat untuk 50 data, 1.42 minit untuk 100 data, 17.10 minit untuk 1000 data, 51.18 minit untuk 3000 data dan 4097 data. 67.18 minit.

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Ts. Khairul Azha Bin A Aziz for their precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) for the financial support which enables me to accomplish the project. Not forgetting my classmates, Muhammad Fadhil, Maizatul Hanim, Noor Ainun Nabihah, Nur Aina Insyirah and Afiqah Fatini for sharing their views and ideas on the project.

My deepest appreciation goes to my parents, parents-in-law and family members for their love and prayers throughout my studies. Respectful mention also goes to the wife, Wan Norasikin binti Wan Ali and children for all the motivation and understanding.

Finally, I would like to thank all the Lecturers at UTeM, colleagues at ILP Tangkak and classmates, Faculty members, as well as other individuals not listed here for their cooperation and help.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TABLE OF CONTENTS

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF TABLES

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF FIGURES

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UTeM
اونيۆرسيتي تيکنيکل مليسيا ملاك
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

UTeM
اونيۏرسيتي تيكنيكل مليسيا ملاك
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF SYMBOLS

V - Voltage

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF ABBREVIATIONS

V	-	Voltage
NN	-	Neural Network
EEG	-	Electroencephalography
AI	-	Artificial Intelligence
GUI	-	Graphical User Interface

اونيۏرسيتي تيكنيكل مليسيا ملاك
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF APPENDICES

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

CHAPTER 1

INTRODUCTION

1.1 Background

A hardware and software system known as a DAQ (Data Acquisition) system is used to gather, measure, and analyse data from multiple sources. A DAQ system may be used to gather data from medical devices like electrocardiograms (ECGs), electroencephalographs (EEGs), and other physiological monitoring devices in the context of collecting medical data. The system would normally include of software for managing the data gathering procedure as well as hardware for specialised data capture, such as amplifiers, filters, and analog-to-digital converters. DAQ systems can be used to gather and evaluate vast amounts of medical data in research, clinical, and diagnostic settings.

An EEG (electroencephalography) data collecting system would normally be utilised in a hospital setting to monitor brain activity. Typically, electrodes are attached to the scalp in order to detect the tiny electrical currents that the brain's neurons produce. A DAQ (data acquisition) system receives the information gathered by these electrodes and transforms it into digital signals so that a computer may examine them. The system would normally consist of specialised hardware for data acquisition, including amplifiers, filters, and analog-to-digital converters, as well as software to manage the data collection procedure, record and store the data, and analyse the data. In the hospital context, EEG is frequently used to identify and keep track of neurological diseases such epilepsy, brain tumours, and head injuries.

An electrogram of the brain's spontaneous electrical activity can be captured via electroencephalography (EEG). It has been demonstrated that the biosignals picked up by EEG are postsynaptic potentials of pyramidal neurons in the neocortex and allocortex. The International 10-20 system, or variants of it, is commonly used to implant the EEG electrodes along the scalp, making it a minimally invasive procedure. The term "intracranial EEG" is occasionally used to refer to electrocorticography, which involves surgically implanting electrodes. Visual inspection of the trace or quantitative EEG analysis are the two methods used most frequently in clinical interpretation of EEG.

The EEG bioamplifier and electrodes' voltage measurements enable the assessment of typical brain activity. The recordings made by the electrodes on the scalp's surface vary depending on their direction and proximity to the source of the electrical activity, which is a group of neurons in the underlying brain tissue. Additionally, intermediate tissues and bone, which behave similarly to resistors and capacitors in an electrical circuit, affect the value reported. This indicates that not all neurons will contribute equally to an EEG signal, with an EEG mostly reflecting the activity of cortical neurons close to the scalp electrodes.

A healthy human EEG will display specific patterns of activity that are related to a person's level of alertness. One may detect frequencies between 1 and 30 Hz, and amplitudes can range from 20 to 100 V. The detected frequencies are classified into several groups, including theta (0.5–4 Hz), alpha (8–13 Hz), beta (13–30 Hz), and delta (0.5–4 Hz) (4-7 Hz). When a person is awake but calm, alpha waves can be seen. These waves are especially noticeable across the parietal and occipital regions of the brain. Beta waves are more pronounced in frontal areas as well as other locations during periods of strong mental engagement. When a person in a calm state is instructed to open their eyes, alpha activity is seen to decline and beta activity to rise.

Systems for data acquisition (DAQ) have existed since the beginning of electronic measurement and control. A data acquisition system (DAQ) is a set of hardware and software tools for gathering, measuring, and analysing data from diverse sources. The system's hardware typically consists of sensors, signal conditioners, and data collecting tools including analog-to-digital converters (ADCs). Drivers, libraries, and application programming interfaces (APIs), which are used to regulate the data acquisition procedure and evaluate the data, are often included in the system's software component.

Numerous applications, including scientific research, industrial control, and medical diagnostics, have made use of DAQ systems. Demand for DAQ systems that can process huge volumes of data quickly has increased over the past few years. As a result, more sophisticated DAQ systems using high-speed ADCs, high-resolution sensors, and quicker data transport technologies have been created.

The DAQ systems can be embedded, standalone, PC-based, USB-based, or stand-alone. Stand-alone systems are independent, whereas embedded systems are built into the device. PC-based DAQ systems utilise a computer to handle the data acquisition process and analyse the data, USB-based systems use a USB interface to connect to the computer.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Due to their capacity to deliver precise and dependable data as well as their flexibility to interface with a wide range of sensors and devices, DAQ systems have grown in popularity in recent years. In order to acquire crucial information for patient diagnosis and monitoring, they are frequently utilised in research, industrial settings, and the medical industry.

The basic unit of a neural network is a neuron, which may be found in MATLAB's Neural Network Toolbox. It is based on biological brain neurons, which take information from other neurons, process that information, and then transmit that information back to other neurons as output. A neuron in a neural network gets numerical input from other neurons (or from outside sources) and processes that input using an algebraic operation called an activation function. The network's ultimate output or other neurons in the network receive the neuron's output after that.

The activation function, which typically takes the weighted sum of the inputs and produces an output that is subsequently sent to next layer neurons, is a non-linear function. To provide non-linearity to the model and enable it to represent complicated data and relationships, activation functions are used.

There are many activation functions available in the Neural Network Toolbox, including sigmoid, hyperbolic tangent, and rectified linear unit (ReLU) functions. Additionally, the toolbox offers capabilities for visualising and assessing the performance of the network, as well as for training the neural network using a variety of techniques, including backpropagation.

In a nutshell, a neuron in a MATLAB-based neural network is a mathematical model that receives input, processes it using an activation function, and then outputs a result that can be communicated to other neurons in the network or to the network's ultimate output.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

1.2 Problem Statement

Epilepsy is a neurological condition in which seizures occur often. Seizures are sudden bursts of electrical activity in the brain that cause it to stop working normally. Epilepsy may affect people of any age, although it is more frequent in youngsters and those over the age of 60. It's typically permanent, although in rare circumstances, it might improve gradually over time. Seizures can impact people in a number of ways depending on which part of the brain is affected. Strange feelings in the gut, strange odours or tastes, tingling in the arms or legs, and collapse are all possible symptoms.