THE DEVELOPMENT OF A WIRELESS NEURO SENSOR-BASED LIE DETECTOR

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

by

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I hereby, declared this report entitled THE DEVELOPMENT OF A WIRELESS NEURO SENSOR-BASED LIE DETECTOR is the results of my own research except as cited in references.

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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 Electronics Engineering Technology (Industrial Electronics) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Teknologi kini berkembang dengan majunya saban hari. Ini membantu dan memberi motivasi kepada masyarakat untuk menghasilkan dan mencipta inovasi baharu. Inovasi dan teknologi baharu telah menghasilkan sebuah produk yang dikenali sebagai elektroensefalogram (EEG) dimana inovasi ini digunakan untuk mengesan isyarat pada otak manusia. Tesis ini menggunakan kaedah pengukuran tidak invansif dimana signal elektrik daripada otak dapat dikesan melalui elektrod yang diletakkan pada bahagian dahi subjek. Menipu adalah satu lakonan untuk menutup sesuatu kebenaran dimana hanya mereka yang mengetahui kesahihan sesuatu perkara. Kemajuan analisis EEG sains kognitif dan neurosains memberikan pemahaman yang lebih baik mengenai fungsi otak. Rangkaian Neural Buatan (ANN) digunakan sebagai Teknik pembelajaran mesin untuk menganalisis isyarat EEG. Terdapat dua jenis data yang digunakan didalam tesis ini iaitu dataset yang diambil daripada data Neurosky MindWave manakala data sebenar daripada Neurosky Mindlink. menggunakan kaedah Ujian Pengetahuan Bersalah (GKT) dimana sesi soal jawab berlangsung. Terdapat tiga ciri didalam ujian ini dimana ciri pertama ialah jawapan kebenaran, diikuti jawapan dusta dan akhirnya soalan asas. Seterusnya, bagi dataset, projek ini menggunakan data mentah yang diperolehi menerusi peranti Neurosky MindWave dimana ciri soalan yang digunakan untuk memperoleh data ini adalah menerusi permainan kad dimana proses memperolehi data berjalan secara natural. Peranti yang digunakan untuk tesis ini adalah Neurosky MindLink EEG dimana Persian MATLAB digunakan untuk memproses data. Selain itu, kaedah sisihan piawai telah dipilih untuk mengekstrak ciri data di dalam kertas kerja ini dimana rangkaian saraf tiruan (ANN) digunakan untuk pengkelasan ciri untuk menganalisis isyarat EEG. Keputusan yang diperolehi apablia subjek berbohong akan menunjukkan indeks 2 dimana subjek

yang bercakap benar akan menunjukkan indeks 1. Ketepatan yang diperolehi untuk set data ialah 95% berdasarkan matriks kekliruan dalam pengelasan dimana bagi data sebenar, ketepatan yang diperolehi ialah 80% berdasarkan keputusan akhir yang tercapai.

ABSTRACT

Technology nowadays are growing rapidly. This helps to increases the motivation for the community to be able to produce and continue new innovations. The new innovations and technology produces is known as electroencephalogram (EEG) where this innovation is used to detect brain signals. This thesis uses the non-invasive measurement method where the electrical signals from the brain will be obtained by the placement of multiple electrodes on the forehead. Lie is an act of covering up something that only those who lies knows the correct situation or statements. The advancement of cognitive science and neuroscience EEG analysis gives a better understanding of brain function. An Artificial Neural Network (ANN) is used as a machine learning technique to analyses the EEG signals. There are two types of data uses in this thesis which is dataset from Neurosky MindWave while real data that are gained form Neurosky MindLink Sensor. In real data, the Guilty Knowledge Test (GKT) method is used as a question to ask to the subject where it consists of three types of questions which are the truth questions, the lie questions and finally the baseline questions. Dataset is gained from Neurosky MindWave sensor by inviting subject in playing game card so that the process is done naturally. The sensor used for this project is Neurosky MindLink EEG Sensor where MATLAB software is used to process the data achieved. Next, Standard Deviation Method is being chosen as an input for training neural network of this thesis while Artificial Neural Network (ANN) is used as a classifier to analyses the EEG signals. The results achieved is when the subjects are lying, it will show and index of 2 while when a subject is telling the truth, it will show and index of 1. The accuracy of dataset is 95% based on results of confusion matrix in classifier while for real data, the accuracy achieved is 80% based on the results obtained.

DEDICATION

This project is wholeheartedly dedicated to my caring and loving parents Mr Norman Bin Mansor and Mrs Puan Azura Bin Sulaiman whom always been my source of inspirations and gave me strength when I am almost giving up. It is dedicated to them as they never fail to provide their moral, spiritual, emotional, and also in financial support to ensure this project will be a success.

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%	-	Percentage
β	-	Beta
θ	-	Theta
δ	-	Delta
ms	-	Milliseconds
γ	-	Gamma

LIST OF ABBREVIATIONS

ANN	Artificial Neural Network
GKT	Guilty Knowledge Test
Arduino IDE	Arduino Integrated Development Environment
PLX-DAQ	Parallax Microcontroller Data Acquisition
EEG	Electroencephalogram
SVM	Support Vector Machine
MATLAB	Matrix Laboratory
IoT	Internet of Thing
CQT	The Control Question Test
DLT	The Directed Lie Test

CHAPTER 1

INTRODUCTION

1.1 Overview

Firstly, this chapter is about the explanation for the core of the project. The content that involves in this chapter is the project Background, Problem Statement, Objective, Project Scope and also the Project Outline. Therefore, by going through this chapter, the reader will be able to understand the concept of the project.

1.2 Background

Lie detector is a commonly used tools to detect liars nowadays. There are varieties of lie detector which uses blood pressure, pulse, respiration, skin conductivity also there are lie detectors that uses sensor such as EEG and ECG sensors. Most of lie detector uses MATLAB, and polygraphs as results which was connected with varieties of microcontroller such as Arduino and PIC. Century by century, the lie detector method changes from measuring the emotional disturbance in early 90's to image processing from human pupils in 20's. The method keeps changing and it became more advance from time to time.

Nowadays, lie detector is being used widely in USA, and other successful country by the police, CIA, NSA, also LAPD. Most of the investigator uses lie detector to find the villain from their investigated cases which the Q&A method is basically used and the answer will be direct answerable by either "Yes" or "No". Besides, the graph like polygraphs is widely used which it will be checked every time the question is answered to get the results

in either the offender is guilty or innocent. The results obtained as mostly guilty person will be more anxious and scared compared to the innocent. However, there are test that will be conducted first before this tool being used to ensure there are no errors occur. Japan, as example will conduct a test named Guilty Knowledge Test (GKT) where this test is usually conducted by someone who did not commit any crime or circumstance in questions. When this test is done, it can actually find the lie detector accuracy by the lie classifications. EEG or also known as Electroencephalogram lie detector is basically one of the new technologies used to detect liars where this method is used by placing some electrodes to the subject's forehead where it helps in recorded the activity of the brain. There are many types of EEG products can be found with various numbers of electrodes used. This method is helps in measure the electrical activities generated by firing of neurons along the scalp within the brain. It is a non-invasive, cost effective and well-established products that are being used to diagnose brainwaves and activities. Hence, the EEG signal data collected is send to the main EEG system and saves the signal produced. Therefore, EEG method also being used to detect a liar as the brainwave of a person who is telling the truth will be less active compared to the one who lies.

1.3 Problem Statement

There are many different innovations of the lie detector in this modern era. Where due to the importance of the lie detector, there are several methods that had been done which is being categorized in psychological or behavioral. On average, across 206 scientific studies, people can separate truth from lies just 54% of the time. However, the lie detector is being used widely around the world. The research made up for this project is constructing a wireless neuro sensor-based lie detector by using EEG sensor. EEG is an equipment used to identify the level of activity in the human brain by using electrodes.