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Epileptie Seizure Diagnosis Using EEG

A Thesis
Submitted to the Department of Computer Science\ College of Sciences\ University of Diyala in a Partial Fulfillment of the Requirements for the Degree of Master in Computer Science

By

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Supervised By

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بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ

وَقُلِ اعْمَلُوا فَسَيَرَى اللَّهُ عَمَلَكُمْ وَرَسُولُهُ وَالْمُؤْمِنُونَ ۖ وَسَتُرَدُّونَ إِلَىٰ عَالِمِ الْغَيْبِ وَالشَّهَادَةِ فَيُنَبِّئُكُم بِمَا كُنتُمْ تَعْمَلُونَ(105).

صَدَقَ اللهُ العَظِيمُ

سورة ألتوبةأيه ﴿105﴾

Dedication

To those who taught me how to stand firmly on the ground

Dear father

To the source of love, altruism and generosity

My Mother

To the closest people to myself

My faithful husband

To all of those who have received advice and support

I present to you a summary of my scientific efforts

Shahad Saad

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I am pleased to thank and show my gratitude to those who have helped me to achieve my study whether through assisting to provide resources or with guidance and presenting me advice. Firstly, I would like to thank my honorable professor "Naji Muttar Suhib" who supervised my thesis and offered me many scientific advices and guidelines, to him I give all of my appreciation.

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In addition, I want to thank my family who supported me and stood by me during my study journey.

Shahad Saad

Supervisors' Certification

I certify that this thesis entitled *"***Epileptie Seizure Diagnosis Using EEG Signals** *"* was prepared by *"**Shahad Saad Alwain*** *"*under my supervisions at the University of Diyala Faculty of Science Department of Computer Science, as a partial fulfillment of the requirements needed to award the degree of Master of Science in Computer Science.

(Supervisor)

Name: Prof. Naji M. Sahib

Signature:

Date: / / 2020

Approved by University of Diyala\College of Science\ Department of Computer Science.

Signature:

Name: Asst. Prof. Dr. Taha Mohammed Hasan

Date:

Head of Computer Science Department

(Scientific Amendment)

I certify that this research entitled "**Epileptic Seizure Diagnosis Using EEG Signals**" was prepared by "**Shahad Saad Alwain**" has been evaluated scientifically ,therefore, it is suitable for depute by examining committee .

Signature:

Name:

Date:

(Linguistic Certification)

I certify that this research entitled "**Epileptic Seizure Diagnosis Using EEG Signals**" was prepared by "**Shahad Saad Alwain**" And was reviewed linguistically. Its language was amended meet the style of English language.

Signature:

Name:

Date:

Abstract

Epilepsy is a neurological disease referred to as a central nervous system disorder characterized by loss of consciousness. Epilepsy patients suffer from epileptic seizures caused by abnormal secretions of electricity which in turn lead to countless movements, convulsions and loss of consciousness. Because of the difficulty in discovering the causes of this disease and the difference in its symptoms from one patient to another, and due to its danger to patients as it can lead to death, the difficulty in obtaining sufficient data or diagnosing it correctly and quickly, and the need to devise modern and ready-made methods to facilitate the process of data acquisition and speed of processing. There are many research and development projects in this area, but there are weaknesses, including reliance on specific recording techniques, low accuracy, and timing of implementation. In many researches, certain cases of epilepsy have been used. Not all cases of epilepsy have been used. In this thesis data collected using EEG signals were used. EEG is considered one of the most important methods that I used in diagnosing and evaluating activities and disorders of the brain and in the process of feature extracting from these signals (surrogate data method) are used. This method applies the testing of statistical hypotheses to time series, In addition it determining whether the time series has statistical significance or not. Our study used EEG signal data that includes all epileptic cases (eyes open, eyes closed, sleepwalking). After the necessary data extraction process, the resulting data were used as inputs for classification algorithms where six machine learning algorithms were used which are Logistic Regression (LR), Vector Machine Support (SVM), k-Nearest Neighbors (KNN), Gaussian Naive Bayes, Artificial Neural Networks (ANN), Principal Component Analysis (PCA)) .The results of our thesis have demonstrated that the methods used have proven to be effective in terms of reducing time spent in Data acquisition and collection, as well as the speed of its processing, as well as the classification algorithms used have proven to be effective in diagnosing people with epilepsy and that the SVM algorithm has demonstrated high accuracy and speed of up to 98% in classifying data for all epilepsy cases.

Table of Contents

List of Figures

LIST OF TABLES

List of Abbreviations

Abbreviations	Meaning
EEG	Electroencephalography
BCI	Brain Computer Interface
LR	Logistic Regression
SVM	Support vector machine
K-NN	K-Nearest Neighbors
GNB	Gaussian Naïve Bayes
ANN	Article Neural Network
PS	Power spectrum
ICA	Independent component analysis
LDA	Linear discriminate analysis
TP	True positive
TN	True negative
FP	False positive
FN	False negative
ACC	Accuracy
SE	Sensitivity
SP	Specificity
COV	Covariance
VAR	Variance

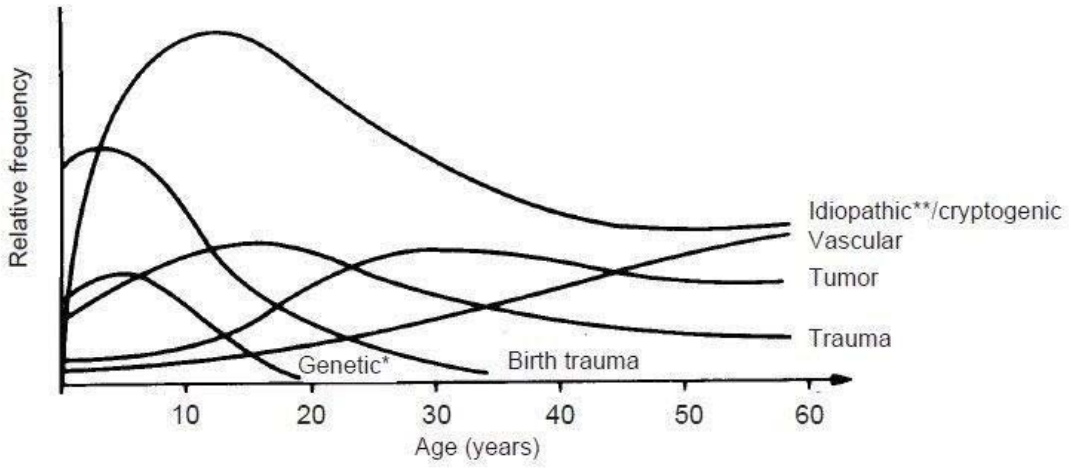
Chapter one

General introduction

Chapter one
General introduction

1.1 Overview

Recently, the increase of wars and their effects, contributed to the increase and emergence of many new and complex physical and psychological diseases. One of the most common diseases is epilepsy[1].In 1875, the English physician, Richard Canton, discovered electrical currents in the brain responsible for elliptic seizure [2]. Around 2 percent of the population worldwide is affected by epilepsy [3].Epilepsy is a serious nervous syndrome caused by transient irregular brain discharges, contributing to uncontrollable movements [4].this leads to the altered actions, such as loss of consciousness, jerky motion, temporary breath loss and loss of memories[5].There are many reasons that can lead to epilepsy, the most important of which are (Genetic injury ,head injury ,brain tumor ,birth trauma). Figure(1.1) shows us the injury recurrence rate of epilepsy for each of the above-mentioned cases over the various years[1] .

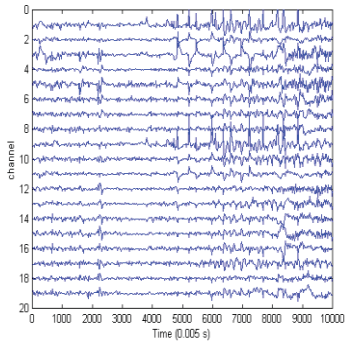


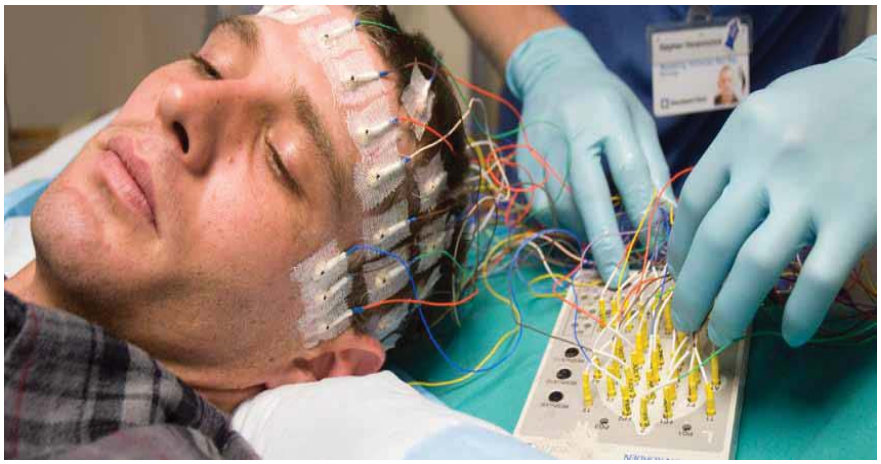
Figure(1.1):Approximate frequency of different causes of epilepsy, developing at different years[1].

General epileptic activity detection requires manual EEG(electroencephalography) recording scan, which often takes a few days to complete [2].In particular for long-term records, visual analysis of detecting EEG signals is time consuming, unreliable and expensive. [4].CAD (computer-aided diagnosis)plays an important role to evolve reliable and efficient epileptic detection techniques form EEG signals [6].EEG is extracted by inserting electrodes on the patient's scalp. The electrical activity that generated by the brain around the scalp can be documented as show in figures (1.2,1.3) [7] .In the field of medicine, computer aided diagnostics (CAD) systems are viewed as a experts and intelligence systems at the medical-informatics interface. CAD systems can use diagnostic rules to emulate the diagnostic decision by a skilled human expert [8].

Brian

EGG signals recording





Figures(1.2)&(1.3): how EEG is done to detected elliptic seizures [6 ,9].

Nowadays, many researchers have used different techniques and methods by which people with epilepsy are detected.

These methods are completely different from the way that has been used in the past, where epileptic seizures are diagnosed by clinical observation and recent changes recorded[10].EEG 's main diagnosis is to detect brain anomalies known as epileptic seizures in the clinical context. A seizure occurs when neurons generate non-coordinated, brain-wide electrical discharges and epilepsy is seizure condition caused by abnormal electrical discharges from brain cells in the brain cortex.In 1929, Hans Berg discovered the possibility of recording electrical impulses in the human brain[5],these records are called (EEG) this test is commonly used to diagnose epilepsy[10]. There are many classifications techniques are used such as(logistic regression, SVM, K-NN, Gaussian Naïve Bayes, ANN, and PCA). Classification is the process of finding a model that describes and distinguished data classes.

1.2 Related work

Several researchers have shown their interest in epileptic diagnosis using different method , The following are some of the published works that are relevant to the current thesis:

In 2004 V.Prakash and D.Graupe ,[11].were describes a method for automated detection of epileptic seizures from EEG signals using a multistage nonlinear pre-processing filter in combination with a diagnostic (LAMSTAR) Artificial Neural Network (ANN). Pre-processing via multistage nonlinear filtering, LAMSTAR input preparation, ANN training and system performance (97.2%)overall accuracy.

In 2010,R.Panda,et al,[12]. they were use a database containing five types of EEG signals and used the DWT algorithm to perform the preprocessing and for the

purpose of classification, they used a SVM algorithm where the results gave a ratio of (91.2%) in the detection of epileptic seizures.

In 2011, M.Fain, et al, [13]. they presents a novel approach for classifying the electroencephalogram (EEG) signals as normal or abnormal. This method uses features derived from the instantaneous frequency (IF) and energies of EEG signals in different spectral sub-bands. Results of applying the method to a database of real signals reveal that, for the given classification task, the selected features consistently exhibit a high degree of discrimination between the EEG signals collected from healthy and epileptic patients. The analysis of the effect of window length used during feature extraction indicates that features extracted from EEG segments as short as 5 seconds achieve a high average total accuracy of(95.3%).

In 2015, E. Juarez-Guerra, et al, [14]. they proposed using neural networks and wavelet analysis to identify epileptic seizures based on EEG signals. (DWT)and (DODWT) algorithms were use to features extract from the signals these method give accuracy of (99.26%)for the classification.

In 2017 Z.Lasefr, et al, [15]. they were using three classification algorithms (KNN, ANN, and SVM) to identify epilepsy by relying on EEG signals. They also process and apply filters to these signals to remove unwanted noise, and they get this results (K-NN= 89%, ANN=95%, SVM=96%) accuracy.

In 2017 L.wang, et al, [16]. they generated EEG sequences from EEG records by using wave transduction to describe the frequency content over time. The experimental results indicate that the representative context features can be obtained from the suggested model from a number of viewpoints and thus enhance the efficiency of EEG seizure detection the WT method achieve the best result of (100%) in terms of F1-score and Accuracy.

In 2018 R.Hussein, et al, [17]. They introduce the use of a deep learning-based approach that automatically learns the discriminative EEG features of epileptic seizures. Specifically. The results on a well-known benchmark clinical dataset demonstrate the superiority of the proposed approach over the existing state of- the-art methods. Furthermore, our approach is shown to be robust in noisy and real-life conditions. Compared to current methods that are quite sensitive to noise, the proposed method maintains its high detection performance in the presence of common EEG artifacts (muscle activities and eye-blinking) as well as white noise.. These representations are inserted into the classification and training feature Soft max. Results appear on a well-known standard clinical dataset that outperforms the proposed approach over current modern methods and achieved superior performance with classification accuracies higher than (90%).

In 2020 S.Gupta, et al,[18]. The were proposed used Discrete Wavelet Transform to convert the EEG signal into the time-frequency domain. Then, various features are extracted and then classification is carried out on a number of classifiers including convolution neural networks, random forests etc for the detection of epilepsy seizure .Results show that there processing technique and the combination of features extracted provide far superior results than those obtained by applying the classifiers on the EEG signals directly. In there work, an accuracy of 99.29 was achieved which outperformed the conventional epileptic seizure detection techniques.

1.3 Problem Statement

In the past, the traditional methods used to diagnose epilepsy which is not effective because they relied on the visual vision diagnosis (eye) to diagnosing all cases and types of epilepsy. This technique requires great effort and time to record all the symptoms associated with the patient. There are new techniques that rely on machine learning algorithms to detect and classify this disease . These techniques give power and effectiveness in diagnosing and classifying epilepsy. Many researchers have used specific cases of epileptic seizures, which has led to the inefficiency and effectiveness of these techniques in diagnosing all diseases.

1.4 Aim of The Thesis

The aim of this thesis is to design and implement a system capable of diagnosing patients with epilepsy. And by expanding the database used in previous research to include records that include all epilepsy cases (open eyes, closed eyes, recordings during a seizure, partial sleep, sleep). These recordings were taken by using the EEG signals. To facilitate the process of extracting features from EEG signals, (a surrogate data method) is used. And by relying on machine learning algorithms, these data will be diagnosed and classified to achieve higher efficiency and greater accuracy in diagnosing the injury of epilepsy patients. In addition to making a comparison between these techniques with other research techniques to determine the best between them

1.5 Thesis Organization

This chapter consist of four chapters in addition to chapter one .

Chapter Two: Theoretical Background

Defines and explains the basic concepts and related subjects. It presents an extensive overview of EEG to Diagnosis Epileptic Seizures. This chapter presents the EEG signals. in addition , it illustrates the basic principles and the scientific theories of the classifications.

Chapter Three: Proposed Method

This chapter introduced the steps of the proposed system, describes the developed algorithms to execute the system.

Chapter Four: Experimental Results and Evaluation

This chapter presented the experiments and the results that are obtained from the system running and the performance measures of the test results.

Chapter Five: Conclusions and Suggestion for Future Work

This chapter resented lists of conclusions derived from the results of our proposed system and suggestions for evaluating or thesis in the future.