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Eeg signal classification for epileptic seizure using MATLAB

Amita Shukla, R. P. Narwaria

Abstract: ***Epilepsy is explained as a group of neurological disorder which may be characterized by epileptic seizure within some consequence of unconstraints because of peculiar cortical nerve cell activities in the brain. The manual detection of this disorder by a neurologist is expensive and time consuming also and there may be some loss of accuracy because of fatigue, computer aided approach etc. This work has proposed a method which is highly efficient and gives accurate results over electroencephalogram signals for epilepsy. MATLAB is a very popular, powerful, general-purpose system or it can be said that it is an general purpose environment for matrix algebra calculations and many other more specific computations. It has various applications in Aerospace, Biology, Finance, data acquisition, etc. Here Matlab is used to classify the EEG signals over some parameters. Here a program is developed in MATLAB to check the condition of signal whether it is healthy or unhealthy.***

Index Terms: EEG signals, Epileptic seizure, Matlab, Mean, Kurtosis, Seizure detection, Standard deviation.

I. INTRODUCTION

A seizure because of abnormally excessive neuronal activity in the brain is practically called an epileptic seizure. Which can affect any person at any age. It is characterized by repeated events over a period of time. The indications of these seizures can vary from vigorous shaking movements to a fugitive loss of control. There isn't any clear symptom of seizure before its onset, because of this reason it has been a major threat to the lives of epileptic patients in certain conditions such as driving etc. The Outward effects of these seizures changes from powerful shaking movements in which most of the body involves with unconsciousness, which is called as tonic-clonic seizure, to the shaking movements in which only one part of the body is involved with variable degree of consciousness, called as focal seizure, to the brief loss of consciousness which is known as absence seizure. Most probably, these episodes take absolute 2 minutes and it may take a few interval of time to return to normal condition. In this condition, loss of bladder control is also possible.

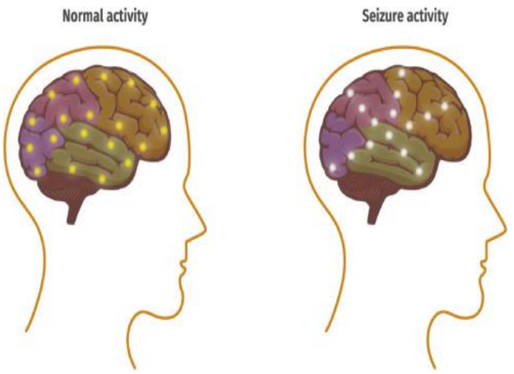

Figure 1: **A pictorialization of normal & seizure activity in the brain.**

ELECTROENCEPHALOGRAM: t is a very high complex signal which contains huge information in relation to the person brain functionality and all of the neurological diseases. The repeated discharge from the cerebral cortex that result in random commotion in brain function is a set of disorder which is known as epileptic seizure. Disclosure of epileptic seizure by optical scan of EEG signal is a long time taking process and may be mistaken, mainly for lengthy recordings. Here we are using this method for EEG signal classification for better result accuracy with less duration of time.

II. EEG DATA

An EEG is usually narrated in terms of transients and rhythmic activity. These recurring activities are splited in bands by frequency. For a few degrees, these frequency bands are the substance of terminology. These designations appeared because of symmetric activities in some frequency range was acclaimed to have an assertive circulation over the scalp. Frequency bands are generally extracted using spectral methods are implemented in EEG software such as EEGLAB or the Neurophysiologic Biomarker Toolbox.

Mostly an analytical signal recognized in the scalp EEG falls in the range between 1–20 Hz. The waveforms can be further classified into several bandwidths, which are known as beta, alpha, theta, and delta to involve the bulk of the EEG used in analytical observation.

Delta waves

The frequency range up to 4 Hz is termed as delta. Which are slowest waves with highest amplitudes. This can be seen commonly in adults in drowsy and kids.

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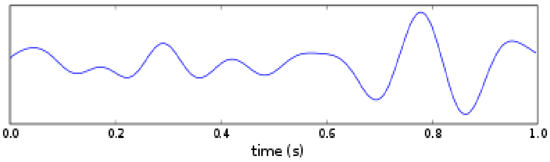

Figure 2: Sample delta waves

Theta waves

The freuency falling in the range 4 Hz to 7 Hz is termed as Theta. Theta is observed commonly in growing children. These waves might be seen in sluggishness in growing children and youths. It might be observed in contemplation.

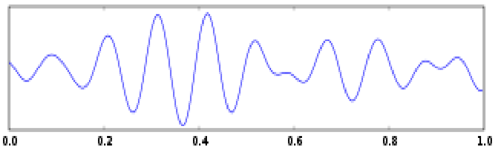

Figure 3: Sample Theta waves

Alpha waves

The frequency falling in the range 7 Hz to 13 Hz is termed as Alpha. Hans Berger coined 'alpha waves' when he observed the first rhythmic activity of EEG signal.

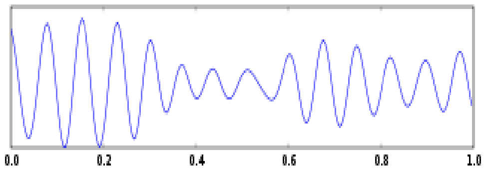

Figure 4: Sample alpha waves.

Beta waves

Frequency spectrum from 14 Hz to 30 Hz is termed as Beta waves. It is observed usually on one and other side in certain distribution and also it is most visible frontally. This activity is sharply related toward motor behavior. These waves are commonly vitiated at the time of active movements.

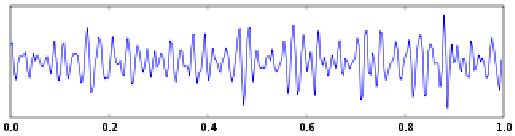

Figure 5: Sample beta waves.

III. DATA ACQUISITION FROM SUBJECTS

A **dataset** is basically a group of data. Nearly all data set consist of statistical data matrix which consist of a single database table, where each column shows a particular variable, and each row fits to a given section of the data set in question. EEG segments used in this work are those assemble by www.physionet.org. There is a total of 106 EEG signals in this dataset. Each data is a single EEG signal with duration of 10 seconds. In which we have 100 signals of epileptic patients & 20 signals of healthy subjects.

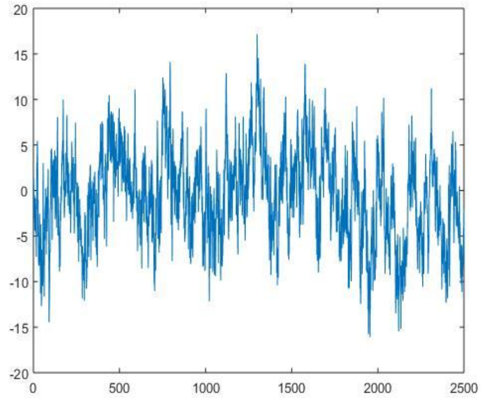

Figure 6 : Sample normal EEG signal.

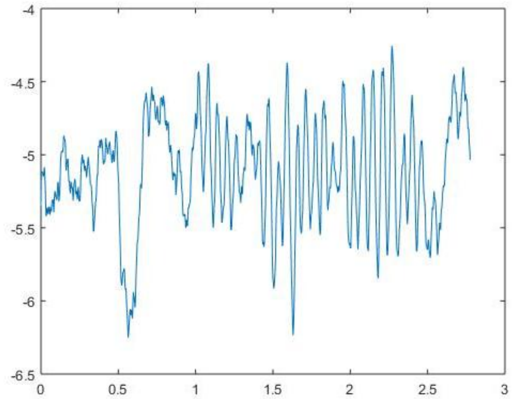

Figure 7: Sample epileptic EEG signal.

IV. PARAMETERS USED:

Mean: Mathematical expectation or average is the average mean which is the central value of a given data set of numbers. Mathematically it is equal to the sum of the values divided by the number of values.

$$\bar{X} = \frac{\sum X}{n} \qquad \textbf{(1)}$$

Standard Deviation: The standard deviation is a calculation by which the variation or deviation of the given data set from the average mean value. If standard deviation value is less, that means all the values in the data set are close to mean values.

The formula for the standard deviation is:

$$SD = \sqrt{\frac{\sum |x - \bar{x}|^2}{n}} \qquad \textbf{(2)}$$

Kurtosis: Kurtosis is a measure for the degree of flatness or peakedness in the variable distribution.

$$\textbf{Kurt[x]} = \frac{[(X-\mu)^3]}{[(X-\mu)^2]^2} \qquad \textbf{(3)}$$

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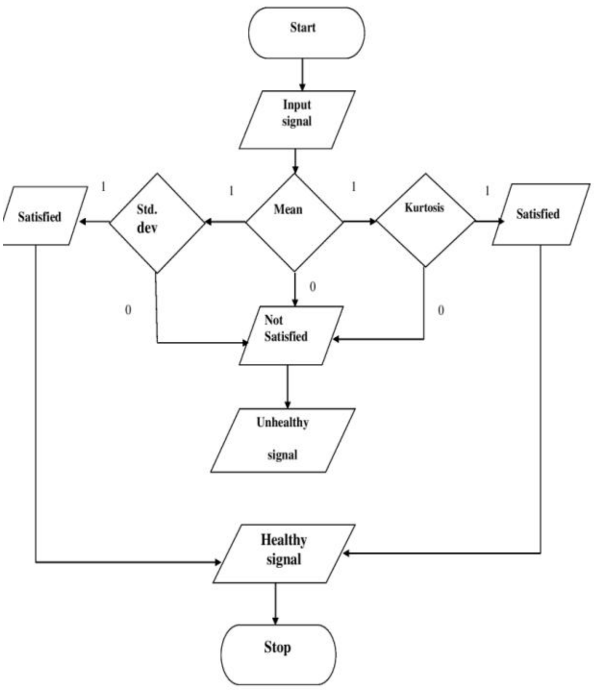
V. METHODOLOGY:

The methodology constitutes of the following three main stages as:

1. Data acquirement.
2. Parameter analysis
3. Classification in MATLAB.

In this work, few parameters are used over some EEG signals, those signals were healthy and non healthy signal. The parameters which are been used are Mean, kurtosis and standard deviation. Here a program is developed in Matlab to check the condition of signal whether it is healthy or unhealthy. Firstly find out the mean, std. dev and kurtosis of each signal which are going to classify. Then some criteria have been fixed to each signal for each parameter to check whether the signal is healthy or unhealthy. These criteria have been assured after the analysis of various healthy EEG signals.

VI. FLOW CHART



Flow chart explanation:

Firstly find out the mean, kurtosis and standard deviation of the following given signal which is included in the algorithm. The program which is developed will run over the fixed criteria.

After running the program it will seen that if the given signal parameters are coming in that criteria then it will give 1 else 0 which will decide whether the signal is healthy or unhealthy.

VII. CONDITIONS FOR RESULT:

Stages	Mean	Kurtosis	SD	Result
Condition 1	Satisfied	Satisfied	Satisfied	Healthy signal
Condition 2	Not satisfied	Satisfied	Satisfied	Unhealthy signal
Condition 3	Satisfied	Not Satisfied	Satisfied	Unhealthy signal
Condition 4	Satisfied	Satisfied	Not satisfied	Unhealthy signal

VIII. RESULT:

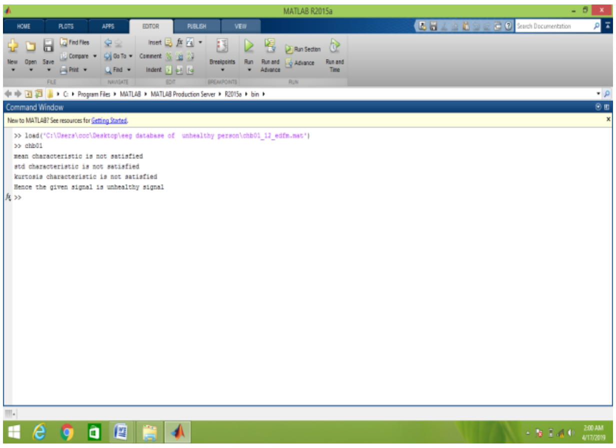


Figure: Results for a unhealthy signal.

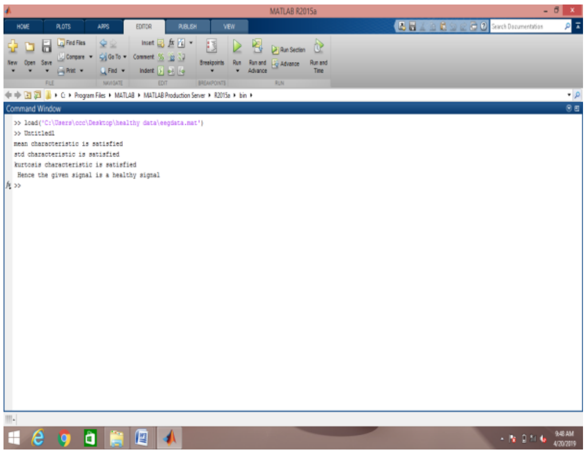


Figure: Results for a healthy signal.

IX. CONCLUSION:

All the conclusions are based on the parameters described in the previous headings. We have observed 100 unhealthy signals and 20 healthy signals and it was seen that all the healthy signals have close relation in their mean,SD and kurtosis, whereas the unhealthy signals have huge variations in the values of given parameters. Visual classification between a healthy signal and unhealthy signal relies on human factor which may not have exact precision rather classification through this method generates better classification , which is less dependent on human factor.

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With the help of this method epileptic seizure can be detected at its early stages.

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