ANALYSIS OF BRAIN SIGNAL FOR THE DETECTION OF EPILEPTIC SEIZURE

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ABSTRACT

The electroencephalogram (EEG) signal is very important in the diagnosis of epileptic seizure. Long-term EEG recordings of an epileptic patient contain a huge amount of EEG data. The detection of epileptic activity is, therefore, a very demanding process that requires a detailed analysis of the entire length of the EEG data, usually performed by an expert. This paper describes a classification of EEG signals for the detection of epileptic seizures using high pass filter and comparing the results with low pass filter through Matlab software. The proposed methodology was applied on EEG data sets that belong to three epileptic subjects during a seizure. The results confirmed that the proposed algorithm has a potential in the classification of EEG signals and detection of epileptic seizures, and could thus further improve the diagnosis of epilepsy.

Keywords: Introduction, EEG Signal and Epilepsy, EEG waves, Positioning of electrodes, Material and methods, Results, Conclusion

1.INTRODUCTION

Epilepsy is a series of neurological disorders caused by epileptic seizures. Epileptic seizures are basically neurological dysfunction that occurs due to abnormal electrical activity of the brain. Paroxysm, are sometimes linked with seizures. Some kind of seizures does not have external expressions. These non-paroxysm seizures can be discovered only by analyzing electrical signals occurring in the brain at that time. These electrical activities of the brain can be detected by recording scalp potential. The recorded potential (signal) is called electroencephalogram.

EEG Signals and Epilepsy

Electroencephalogram (EEG) is the most commonly used method for epileptic seizure detection. An EEG recording device usually consists of a set of electrodes to carry potential from scalp to amplifier, storage unit to store the recorded signal for analysis and future use, and a display unit that is usually a CRT. Epilepsy in a person can be detected through electroencephalogram (EEG) signal analysis. EEG signal recorded from epilepsy patients during a seizure gives patterns that are different from the normal brain signal in time and frequency. The electroencephalogram is obtained by applying the electrodes to the head using standard international 10/20 electrode placement system as discussed later in this paper. The electrodes that are located on the scalp records the event of abnormal electrical activity on the cortex. EEG is an easiest way of detecting brain diseases because of its high resolution giving results in real time (scale of milliseconds). It is used in cases of epileptic seizures or to detect brain tumors and other brain diseases.

The EEG detects the potential difference between a reference (active) electrode located at the place of the neural activity, and other electrodes, located at a certain distance from the rest. It depends on the activity of neurons involved. Normally potentials recorded from scalp ranges from 20 to 100microvolt and its frequency ranges from 1 to 60 hertz.

EEG Waves

- **Delta waves** have frequency less than 4Hz. These cycles are associated with deep sleep or in morbid conditions such as coma.
- **Theta waves** ranges from 4-7Hz and are recorded during sleep states. Theta waves have the greatest amplitude compared in all EEG waves/rhythms.
- **Alpha** wave ranges from 8-13Hz and are associated with relaxed states, recorded from occipital and parietal lobes.
- **Beta/ Gamma waves** have frequencies above 14 Hz. Beta waves (14-30Hz) and gamma waves (>30 Hz) are recorded from frontal areas or other cortical regions

Positioning Of the Electrodes: The International System 10/20

Recording of EEG helps to detect brain diseases so it should be recorded with great precision, this can be achieved by correct positioning of electrodes on the scalp. Nowadays, the most commonly accepted system for electrode placement is the international system 10/20. The standard positions of electrodes on scalp are denoted by a letter and a number.

The letters are:

F = frontal
T = temporal
C = central
P = parietal
O= occipital
A = ear

Letters described above have suffix that contains numbers (even or odd). Even numbers refers to the right hemisphere and odd number refers to the left. Letter Z refers to the center line and A_1 and A_2 are used as reference.

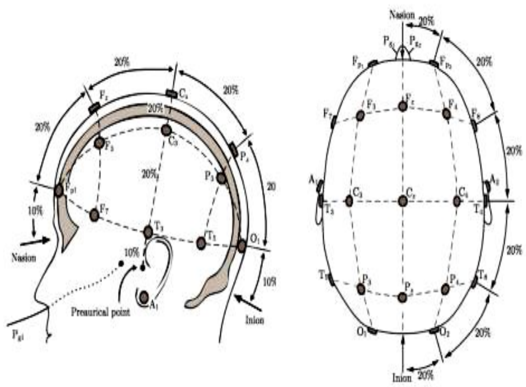

Fig 1: 10-20 Electrode system

Electrode connections are of 3 types namely unipolar, bipolar, and media connection.
In unipolar connection one electrode A1 or A2 is chosen as common reference for all others.
In media connection, averages of all electrode potential are connected to a resistive network and output of the network is taken as common reference.
Bipolar connections don't have any reference electrode. It uses the voltage difference between two electrodes. This type of connection provides flexible localization of electrodes at the areas of activity.

Materials and Methods

Dataset

Dataset used in this paper is CHB-MIT scalp that is publically available on physionet.org that contains 686 scalp recordings of 22 patients at the Children's Hospital in Boston. Dataset consists of 23 sets of EEG recording from22 patients (5 males and 17 females), age ranging from 1.5 to 22 years. Mostly the recordings are one hour long. Those recordings having at least one seizure are classified as seizure records and those not having any seizure are classified as non-seizure records. Out of total 686 records only 198 contains seizure. All the recordings were captured using the international 10/20 system of electrode placement, but some dataset had different channels so those data are not taken for analysis. Signals were recorded through23 different channels. In the CHB-MIT scalp database, each signal was sampled at 256 Hz. Signals were recorded at the same time subjects. All signals were sampled at 256 samples per second with 16-bit resolution. Most files contain 23 EEG signals (24 or 26 in a few cases).This paper involves the step for analyzing and extracting required channels from the EEG datasets that belong to three epileptic subjects during a **seizure followed by these steps:**

(a) Load the EEG signal database,
(b) Plot total number of channels present in certain EEG dataset,
(c) cut the required channel from dataset,
(d) Design of low pass and high pass filter.

Recordings were grouped into several cases but we have considered the data of female
through 23 different channels (FP1-F7, F7-T7, T7-P7, P7-O1, FP1-F3, F3-C3, C3-P3, P3-O1, FZ-CZ, CZ-PZ, FP2-F4, F4-C4, C4-P4, P4-O2, FP2-F8, F8-T8, T8-P8, P8-O2, P7-T7, T7FT9, FT9-FT10, FT10-T8, and T8-P8), via 19 electrodes and a ground attached to the surface of the scalp.
We have worked on three female subject dataset but for convenience results of only one dataset are shown in this paper

Results

Original Data 1:

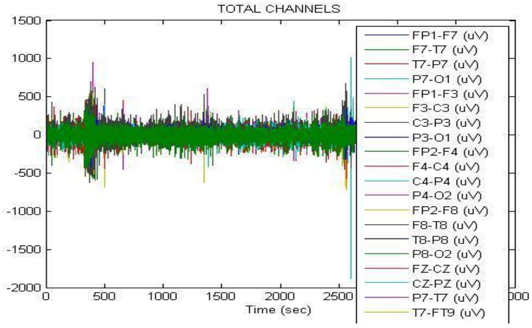

Fig 2: Complete EEG signal with all channels

Design of high pass filter

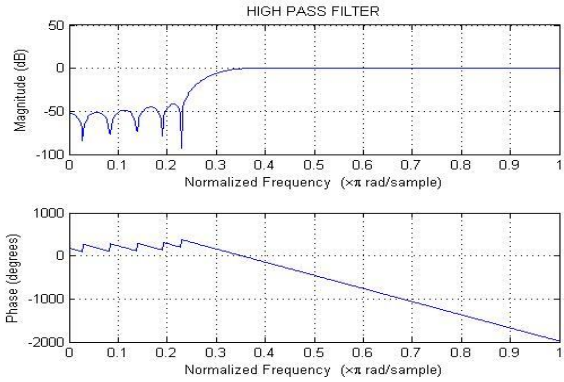

Fig 3: High pass filter

Design of low pass filter

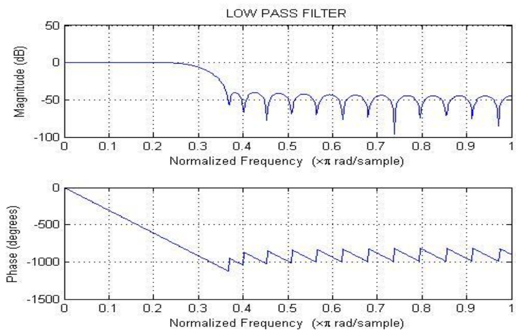

Fig 4: Low pass filter

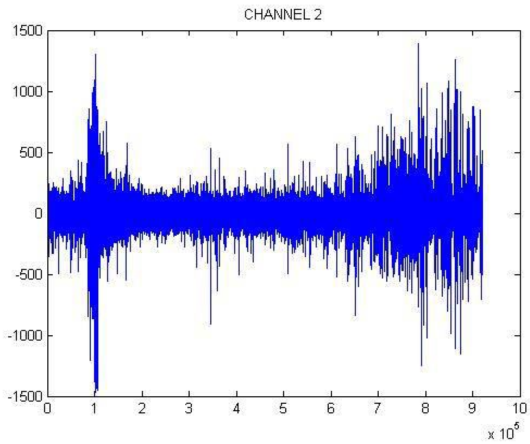

Fig 5: Data 1: Channel 2

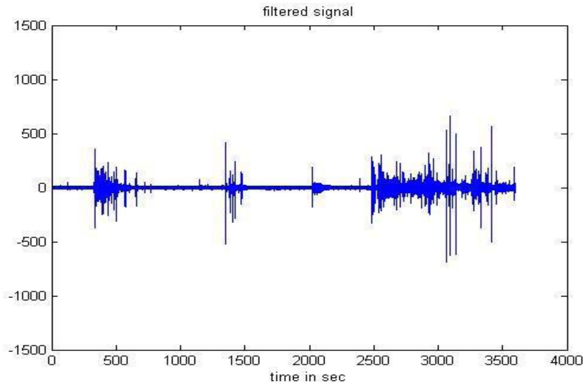

Fig 6: Result of High Pass Filter on Data 1: Channel 2

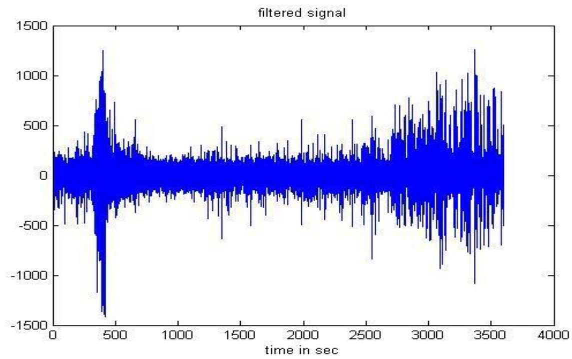

Fig 7: Result of Low Pass Filter on Data 1: Channel 2

2.CONCLUSION

Epilepsy is the most common neurological disorder and one that is least understood. Epilepsy's usually characterized by seizures affects the life of sufferer's and it also increases the risk of injuries and even causes death. This paper suggests that epileptic seizures can be easily detected by analyzing EEG recordings (that is passing it through filters). This paper has focused on detecting seizures using data from individual patients from CHB-MIT database.

Future work will include the use of window method and calculation of Power spectral density which will help to improve the accuracy of our results and compare them more precisely. This would also help to predict the early signs of seizure and not at the time when it happens. The comparison of features like fractal dimension and spectrum analysis has also not been performed.

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