Use of Mathematical Concept of Recurrence in Detecting Epilepsy

Mohd. Suhaib Kidwai[1], Ayan M. Khan[2]
[1, 2] Department of Electronics and Communication
[1, 2] Integral University, Lucknow

Abstract- *This paper aims at presenting an efficient algorithm for the diagnosis of epilepsy A mathematical concept of recurrence is used and the realization of algorithm or its simulation is done on MATLAB tool.*

Keywords- Cloud computing, Load balancing, Energy efficiency, Green computing.

I. INTRODUCTION

Epilepsy disease is of great concern nowadays. It is a neurological disorder which can happen at any age. It is characterized by fits in patients. The frequency of fits depends on the severity of this disease.

Taking into account the consequences of this disease, it is very important to have efficient methods for diagnosis of this disease, because diagnosis paves the way for further research in understanding the disease

II. THEORY

This work is all about developing an algorithm for the detection or diagnosis of epilepsy,by using MATLAB as a tool.

The mathematical concept of recurrence is the crux of the algorithm.

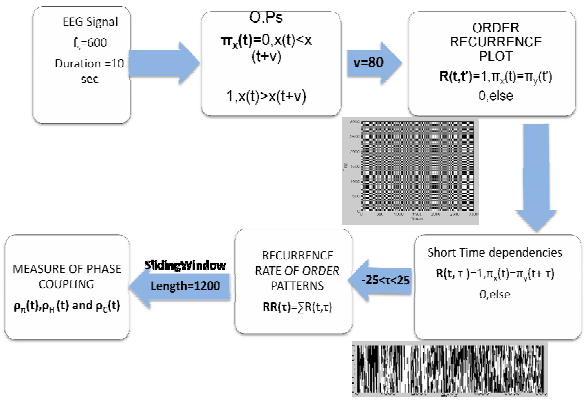
The EEG signals from various channels of EEG machine are taken as an input which is then used by the program in MATLAB. This program basically compares the synchronism between the EEG signals of any two channels. This comparison is done by using the concept of recurrence[1][2].

Second thing is to find the degree of recurrence which is found out by using the formula of synchronization indexρπ. .The advantage of this algorithm is that it serves two purposes, firstly it helps in understanding the synchronization between the two signals from EEG channels and secondly it allows the user to find the degree of synchronization.[3]

Using the plot command of MATLAB, this synchronization index can be shown in form of graphs .If the graph shows increasing pattern, it shows high amount of synchronization between the two signals else the low synchronization.

This approach can be used for the detection of epilepsy because it mainly compares the signals from different regions of brain, and during epilepsy signals from various part of brain seems to exhibit a kind of phase locking and hence this locking or repetition can be detected by using the recurrence relation which compares the present sample of signal with the previous one.

Block Diagram



The steps of above algorithm can be defined as follows:

1. The signals from the channels of EEG machines are taken and put in a form of array so that it can be used as an input in MATLAB program based on this algorithm.

$$\pi_x(t) = \begin{cases} 0 \; if \; x(t) < x(t+\upsilon) \\ 1 \; if \; x(t) > x(t+\upsilon) \end{cases}$$

2. pie x " refers to the order pattern and it is found out by comparing samples by their respective values at different intervals. Similarly "pie y" is found.

3. Once we have the values of pie x and pie y in form of matrices next step is to find order pattern. It is found as follows:

$$ORP(t,\tau) = \begin{cases} 1 \; if \; \pi_x(t) = \pi_y(t+\tau) \\ 0 \qquad otherwise \end{cases}$$

4. Next step is to find out the recurrence rate and its normalized value. This is done by following formulas:

$$RR(\tau) = \sum_t R(t,\tau)$$

$$rr(\tau) = RR(\tau) / \sum_t RR(\tau)$$

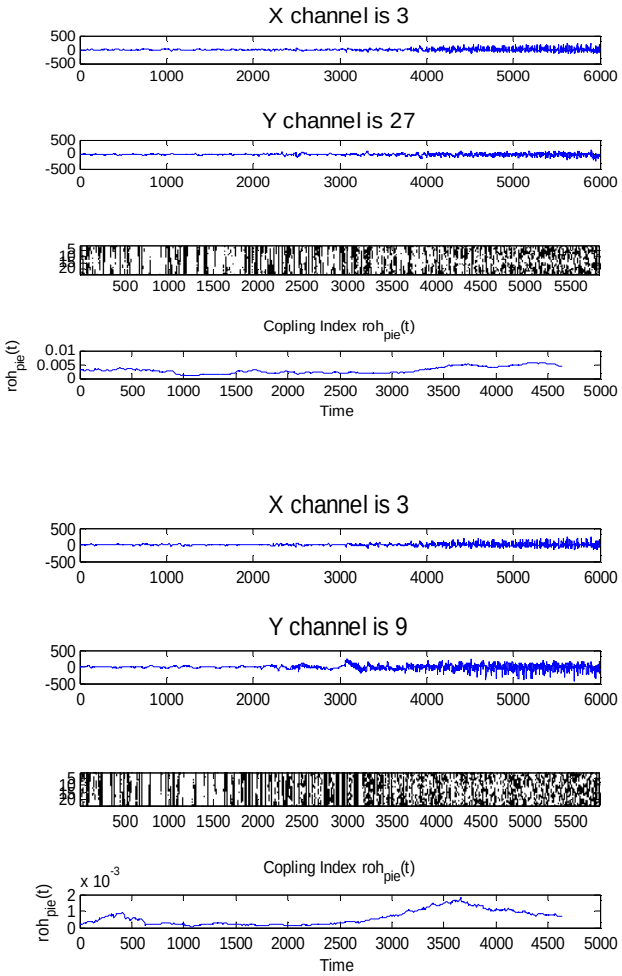
5. Then finally a parameter called "synchronization index" is found and plotted

The formula for synchronization index is given as follows:

$$\rho_x = 1 - \frac{-\sum_{\tau=\tau_{min}}^{\tau_{max}} rr(\tau) \ln rr(\tau)}{\ln(\tau_{max} - \tau_{min})}$$

III. RESULTS

By using the above algorithm a program is written in MATLAB which shows the synchronization index between different channels of EEG machine. Some results are displayed below:



IV. CONCLUSION

The synchronization index is plotted between the EEG signals taken from two different channels of an EEG machine. If the plot of synchronization index shows growing trends between different channels then it indicates the occurrence of epileptic fits in a patient. Though this method is not a very efficient method right now and is mainly used to roughly detect the epileptic seizure ,but this method do pave the way to designing better algorithms in near future, for the diagnosis of neurological disorders in near future as the neuronal activity during epileptic seizure has some striking similarities with that of Alzheimer disease and other such neurological disorders.

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