Bio Medical Application of Clustering Techniques for Epilepsy Detection

1Lokesh Kumar, 2Dr. Geetika Srivastava
1, 2Department of Electronics & Communication Engineering, Amity University, Lucknow Campus, Uttar Pradesh

E-mail: 1lokeshkmr870@gmail.com, 2gsrivastava2@lko.amity.edu

ABSTRACT

Signal processing has varied range of applications ranging from our daily life activities to advanced research in different domain. Signal processing is widely involved in communication, artificial intelligence, advance robotics to the advance bio medical applications like ECG, EEG processing etc. In this paper we have studied EEG signal as a part of signal processing for diagnostic understanding of epilepsy. Epilepsy is one of the most common neurological disorder with a widespread 0.6-0.8% of the India’s population [1-2]. Two-third of the patients achieves sufficient seizure control from medicine and some other 8-10% benefit from respective surgery. For the remaining 25% of patient no sufficient treatment is currently available [3-7]. A fixed cluster size approach for epilepsy feature extraction and propose explaining the concepts of the classification of EEG. The experiment result showed that fixed cluster epileptic data algorithm can produce a better classification rate than the previous reported method by Siluly et al [8]. Which used LS-SVM for the extracted features to classify EEG signals.

Keywords: EEG, Epilepsy, Signal Processing, Brain activity, BCI

I. INTRODUCTION

Electro Encephalography (EEG) is the recording of electrical activity along the scalp. The EEG measures voltage fluctuations from ionic current flowing within the neurons of the brain. In clinical terms, EEG refers to the recording of the brain’s spontaneous electrical activity over a short period of time, say 20-40 minutes recorded from multiple electrodes placed on the scalp. EEG is the most used technique to capture brain signals due to its excellent temporal resolution, noninvasiveness, usability, and low set-up costs. An EEG can show state of a person. (sleep, awake, anaesthetized, emotion, sadness, happiness as the characteristic patterns of the electrical potentials differ for different states [9].

II. EEG Waveforms Analysis

Most of the brain disorders are diagnosed by visual inspection of EEG signals. The improved analysis techniques of EEG signals has lead to improved results in EEG feature extraction and classification for epilepsy [13-14]. The recorded brain electrical activity is defined in terms of specific descriptors or features. EEG analysis focuses on the frequency or wavelength of signal and manner of occurrence of voltage fluctuation (random, serial, continuous), its dependency on reactivity (eye opening, mental task, sensory, bodily gesture, affective state) and symmetry of the signal [10-11].

III. Nature of rhythms of the EEG signals

For assessing abnormalities in clinical EEGs and for understanding functional behavior in cognitive research, the frequency is considered to be most important parameter. With billions of oscillating communities of neurons as its sources, the human EEG potentials are visible as aperiodic unpredictable oscillations with irregular burst of oscillations which are typically categorized in specific bands such as 0.5-4 Hz (delta), 8-13 Hz (alpha) 13-30 Hz (beta) and>30 Hz (gamma). [12]

IV. Classification of EEG signal

In pattern recognition feature extraction is widely used in the areas of face recognition, database indexing, image recovery, multimedia computation and other model-based coding ofimage sequences. The use of the classifier is to determine the particular class of a signal. The signal to be classified must be defined by features that could be extracted from the signal for the purpose of classification [13].

The classification techniques generally work in two stages, where features are extracted from raw EEG data in the first stage and then obtained features are used as the input for the classification process in the second stage. It is important to note that features are compressed parameters that characterize the behavior of the original data [14-15]. In the present study, the fixed clustering techniques (FCT) algorithm is used to extract feature parameters representing EEG signals from the original EEG data.

V. Previous Research

Till date several techniques have been proposed for the classification of EEG signals, and diverse classification techniques have been reported in the last decade [39-40].

EEG signal classification by support vector machine (SVM) can detect whether a subject’s planning to perform a task or not [17]. In EEG classification SVM various different Kernels were utilized to find the best kernel function but it’s the more time taking process and inefficient to classify the EEG signal. A wavelet-based neural network (WNN) classifier for recognizing EEG signals is proposed by Guler et al [17]. The Discrete Wavelet Transform (DWT) with the Multi Resolution Analysis (MRA) is applied to decompose the EEG

20
signal at resolution components of EEG signal[19][20]. For detection of Siluly et.al have processed SVM technique[14].

VI. Proposed Methodology

In this paper we propose a new algorithm of the Clustering. Fixed cluster size approach is used for classifying the EEG signals cluster.Earlier of clustering techniques (CT) method was based on variable cluster size the variable cluster size resulted in variation of results with number of samplesLeast Square Support Vector Machine (LS-SVM)[21-24].

This approach is conducted in three steps: acquisition EEG signal, determination different of clusters and feature parameters extraction from each cluster.

Nine feature parameters are used to classify the signals[25]. Each EEG channel data is considered as a population which is divided into N groups with a specific time duration, called Clusters. The Cluster size is chosen to be 20(t=0.2 sec with fs=1000Hz). - In this study, EEG signals were classified over ten set of two subjects each, one epileptic and one healthy. The recording time period is fixed of both subjects ( healthy and epileptic )

![Cluster Diagram](Fig.1)

Feature extraction plays an important role in pulling out special patterns from the original data for reliable classification. The feature extraction stage must reduce the original data to a lower dimension that contains most of the useful information being included in the original vector[26-28]. It is therefore, necessary to find out the key features that represent the whole dataset, depending on the characteristics of a dataset. The nine feature parameters are extracted from each cluster data as they are the most representative values to describe the original signals[31].

The nine feature parameters of each cluster of EEG channel data are used as the valuable parameters for the representation of the characteristics of the original EEG signals[29-30].

I Minimum-Minimum value of cluster
Min=min(Ki),where i=1………..20

II. Maximum-Maximum value of cluster
Max=max(Ki) where i=1………..20

III. Mean-Mean of the absolute values of each channel signal.

\[ F_i = \frac{1}{n} \sum_{j=1}^{N} |S_{ij}|^2 \]

IV. Median-Median value of cluster (k) is (k/2)

V. Mode-Mode value of cluster (k) that is common value of a single cluster.

VI. First quartile-First quartile of cluster (k) that is placing value of cluster (k/4).

VII. Third quartile-Third quartile is placing value of cluster (k/3).

VIII. Inter-quartile range-Inter-quartile placing value of cluster (k/2).

IX. Standard deviation-Standard deviation of each channel signal.

\[ F_i = \sqrt{\frac{1}{N-1} \sum_{j=1}^{N} S_{ij}^2} \]

(a). Average sample of each channel signal.

\[ F_i = \sum_{j=1}^{N} |S_{ij}|^2 \]

(b). Sampling frequency (Fs) =1000Hz

(c). Fixed cluster size of epileptic signal (k=20)

VII. EEG Data

Healthy subject and epileptic EEG subject are used separately to test the performance of the proposed method. In epileptic EEG database the data set IV for Brain Computer Interface (BCI) [32-38] contain EEG recording from two subjects during two kind of tasks which are the epilepsy and healthy human. The recording was made using Brain Amp amplifier and a 128 channel. Ag/Agcl electrode cap from ECI.

<table>
<thead>
<tr>
<th>EEG Hardware</th>
<th>Brain Amp Amplifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kind of electrode</td>
<td>Ag/Agcl</td>
</tr>
<tr>
<td>Hardware reference</td>
<td>Electrodes, Neurofeedback</td>
</tr>
<tr>
<td>Sampling Rate</td>
<td>1000 Hz</td>
</tr>
<tr>
<td>Hardware filter</td>
<td>Hum notch filter</td>
</tr>
</tbody>
</table>
VIII. Flow chart of classification of single channel EEG data

Start

EEG Signal Generation

Sampling of the signal (Fs=1000Hz) (10/20 system 118 channel EEG)

Data set of Sampling Signal (Generating .m)

Clustering of the Dataset (k=20)

Feature Parameters Extraction

Plot for Classification of EEG Signal

Compare & Classify EEG Signal

Result

Stop

118 EEG channel were measured. Analysis have been done for each data. Here we are taking some fixed channel data which are more important for classification of signal. Selection of channel are shown in figure (2).
Cluster Max value of different channel for healthy subject

For Cluster max value of different channel for Epileptic Subject

Fig.2 for channel C2

Fig.6 for channel C2

Fig.3 for channel C3

Fig.7 for channel C3

Fig.4 for channel FZ

Fig.8 for channel FZ

Fig.5 for channel OZ

Fig.9 for channel OZ
Result - Cluster min value of different channel for healthy subject

Result - Cluster min value of different channel for Epileptic Subject
Result – Cluster mean value of different channel for healthy subject

For Cluster mean value of different channel for Epileptic Subject

IX. Result and discussion

In this study, EEG signals were classified over ten set of two subjects each, one epileptic and one healthy. For the specific channel (Fz, C2, C3, C4, &Oz) the average value of cluster feature more in epileptic subjects. After classification from feature parameters the comparison is done between these two subjects average fluctuation is checked by classifying the data. In this result also indicate that average fluctuation in epileptic higher than the healthy subject. In epileptic signal repeated fluctuation occurred in a particular sample value. It is well
evident from these result that epileptic data set can be easily identified by method of feature extraction using fixed cluster size. In above given result we summarized that the difference between the healthy human and epileptic.

REFERENCES:


[18] Siuly, Y. Li and P. Wen, EEG signal classification based on simple random sampling technique with least square support vector machines, International journal of Biomedical Engineering and Technology (2010), forthcoming.


http://ida.first.fraunhofer.de/projects/bci/competition_iii/desc_V.html

AUTHOR PROFILES:

1. **Lokesh Kumar** received the degree in Electronics & Communication Engineering from Uttar Pradesh Technical University Lucknow, in 2012. He is currently pursuing M.Tech.(EC.E) as well as research from Amity University Uttar Pradesh,Lucknow campus.

2. **Dr.Geetika Srivastava M.tech,Ph.D(low power VLSI)** has more than 10 years teaching and research experience and published many reputed international journal papers.Qualified UGC NET in electronics Science & presently working as ASET Prof.in Amity School of Engineering &Technology,Amity University Lucknow Uttar Pradesh.