Volume : 4 | Issue : 6 | June 2015 • ISSN No 2277 - 8179

Research Paper

Epileptic Seizure Classification Using Time-Frequency Analysis of Eeg Signals

Engineering

KEYWORDS : EEG, Epileptic Seizure, Time-frequency analysis, Cohen class kernel function, ANN.

Priyanka R. Khot

ABSTRACT

Seizure is a transient abnormal behavior of neurons within one or several neural networks, which limits the patients physical and mental activities. This review paper gives idea to transform the EEG data using twelve Cohen class kernel functions in order to facilitate the time-frequency analysis. The transformed data thus obtained is exploited to formulate a feature vector consists of modular energy and modular entropy that can better model the time-frequency behavior of the EEG data. The feature vector is fed to an Artificial Neural Network (ANN) classifier in order to classify epileptic seizure data originating from different parts.

INTRODUCTION:

An EEG is the most used technique to capture brain signals due to its excellent temporal resolution, usability, non invasiveness and low set-up costs. The Supreme commander of the human body is the brain. It is the central part of the nervouss system which governs the functions of a variety of organs in the body. The signals measured from the central nervous system will give the relationship between psychological change & emotions. An EEG can show what state a person is in, whether in sleep, anaesthetized, awake, because the characteristic patterns of the electrical potentials differ for each of these states. On the classification of EEG signals in the two most important areas, epilepsy and brain computer interface (BCI). Seizure is a transient abnormal behaviour of neurons within one or several neural networks, which limits the patient physical and mental activities. EEG plays an important role in nervous electro-physiology field , spike wave is used for diagnosing epilepsy, brain tumour early, sleep analysis and monitoring the depth of anesthesia etc.

Although theoretically there exist various signal analysis methods used in EEG analysis, owing to the limitation of signal processing technique, the research on EEG by existing EEG instrument is not through, also the extracting of feature information of EEG, satisfied for clinical diagnosis. Virtual EEG instrument is based on the virtual instrument technology. The emergence of virtual instrument technology based on PC, enabled us not only to make full use of the resource of computer software and hardware, but also renew the functions and performance of the instrument in time. Because EEG signal is a stochastic complex non-stationary signal, it is difficult to extract the feature rhythms in EEG signals effectively only by some simple analysis methods in time domain or frequency domain. Furthermore, there are various different features contained in EEG signals, such as spike wave, slow wave, sharp wave, sine wave, spindles and K-complex etc., which have relation with different pathological changes, so it is very difficult to extract all feature information only by a certain signal analysis methods. Based on above consideration, for different feature information in EEG signals the concrete realization of several time-frequency analysis methods have been discussed and integrated into the virtual EEG instrument to extract adaptively feature information in EEG signals.

Automatic analysis of EEG recordings in the diagnosis of epilepsy is challenging task. Today, computer-based analysis addresses two major problems: 1) interictal event detection (or spike detection) and 2) epileptic seizure analysis. Many algorithms for spike detection have been proposed, including mimetic and rule-based approaches, frequency- domain methods, wavelet transforms, ANNs, independent component analysis, support vector machines, data mining, template matching, and topographic classification. On the other hand, epileptic seizure analysis refers for: 1) epileptic seizure detection; 2) epileptic seizure prediction; and 3) automatic focus channel identification.

Conventional temporal and frequency analysis measures have been used for the detection of epileptic seizures in EEG recordings. Many works focus on the quantitative characterization of the underlying nonlinear systems based on some evidence of a deterministic value of the EEG dynamics. Complexity measures of the underlying EEG dynamics, such as correlation dimension. These measures can then be combined with a classifier to identify the occurrence of seizures. For seizure detection, t-f methods have been used.

METHODOLOGY:

The proposed algorithm will be developed in separate modules and later combined to implement epileptic seizure detection and classification of EEG data.

The methodology is as follow

- Development of algorithm to perform analysis of EEG signal by using discrete wavelet transform(DWT).
- Development of kernel function.
- Development of algorithm for feature extraction using combination of discrete wavelet transform(DWT) and fast fourier transform(FFT).
- Development of algorithm for classification of epileptic seizure using artificial neural network(ANN).
- Perform analysis using ANN in terms average selectivity, sensitivity, accuracy.

LITERATURE REVIEW :

They have suggested the bi-spectrum analysis of EEG for detection of epilepsy. Feature extracted from bi-spectrum of EEG are applied to neural network classifier to detect normal and epileptic EEGs (G. R. Kiranmayi et al, 2014).

They have implemented a reliable automatic algorithm to detect high and low amplitude interictal epileptiform discharges in EEG recordings and designed a clustering method to extract spatial patterns of their propagation. For detection of seizure in EEG, they have used a signal envelope modeling technique which identifies statistical parameters of signals containing spikes. They have designed spike clustering algorithm to identify subsets of spikes with spatial profiles and accordingly classified seizures (R.Janca et al ,2013).

In order to classify five class EEG data , they used ANN as classifier and compare the performance of proposed method with that of an existing method using same EEG dataset and classifier. The proposed method for epileptic seizure classification consist of steps such as pre-processing, time- frequency analysis, feature extraction and classification. In pre-processing, analytical representation of real EEG signal is obtained through Hilbert transformation (Partha Pratim Acharjee et al ,2012).

They have done classification of normal and epileptic EEG signal using time-frequency domain features through ANN dependent

on sliding window segmentation. In feature extraction stage, ten features are extracted and used for identification of seizures and they have used feedforward artificial neural network to classify seizures (Anusha K.S et al , 2011).

For classification of epileptic seizure, feature extraction is important step. They have used discrete wavelet transform(DWT) and fast fourier transform(FFT) as feature extraction methods. These features then set as input to the feedforward neural network with backpropagation training algorithm to get classification accuracy (Azian Azamimi Abdullah et al, 2011).

They have implemented autoregressive model(AR) model. They have developed a novel AR-model based algorithm and tested for epileptic seizure detection that is suitable for an implantable device. The AR model estimation have selected for extracting features from EEG signal (H. Kim et al ,2010).

They have demonstrated the suitability of time-frequency analysis to classify EEG segments for epileptic seizures and they compared several methods for t-f analysis of EEGs. They used short-time fourier transform and several t-f distributions to calculate power spectrum density (PSD) of each segment. They have done comparison of STFT and well-known TFDs to access the non stationary properties of EEG signal with respect to epileptic seizure detection and classified epileptic seizures in different categories (T. T Alexandros et al, 2009).

Method suggested for detection of epileptic seizure is support vector machine. They have used GRB-SVM using GRBF (Gaussian Radial Basis Functions). Neural network followed by a fuzzy system for classification of seizures is used (Naseer Sadati , 2006).

They have proposed a three stage procedure based on ANN for automatic detection of epileptiform events. They have used different types of artificial neural network for classification of seizures (Nurettin Actr et al, 2005).

REFERENCE

P. Vergallo, A. Lay-Ekuakille, D. Labate, F.e. Morabito, "Identification of visual Evoked potentials in EEG detection by Emprical Mode Decomposition", 978-1-4799-3866-7/14/$31.00 ©2014 IEEE. | R. Janca, P. Jezdik, R. Cmejla, P. Krsek J.G.R. Jefferys, P. Marusic P. Jiruska, "Automatic detection and spatial clustering of interictal discharges in invasive recordings", 2013 European Union. | Partha Pratim Acharjee and Celia Shahnaz," Multiclass Epileptic Seizure Classification Using Time-Frequency Analysis of EEG Signals", 2012 7thInternational Conference on Electrical and Computer Engineering, 20-22 December, 2012. | Anusha K S, Mathew T Mathews, Subha D.Puthankattil," Classification of normal and epileptic EEG signal using time & frequency domain features through artificial neural network",978-07695-4723-7/12 $26.00 , 2012 IEEE. | Azian Azamimi Abdullah, Saufiah Abdul Rahim,Adira Ibrahim," Development of EEG- based Epileptic Detection using Artificial Neural Network", 978-1-4577-1991- 2/12/$26.00 ©2011 IEEE. | H.Kim and J.Rosen,"Epileptic Seizure Detection-An AR Model Based Algorithm For Implantable Device", in Proc. 32nd Annual Int. Conf. of the IEEE EMBS,2010, pp.5544-5545. | T. T. Alexandros, G. T. Markos and I. F. Dimitrios,"Epileptic Seizure Detection in EEGs using Time-Frequency Analysis", IEEE Trans. on Info. Tech. in Biomed, vol. 13, no. 5, pp. 703-710, 2009. | Tsu-Wang Shen, Xavier Kuo, and Yue-Loong Hsin," Ant K-Means clustering method on epileptic spike detection", 978-0-7695-3736-8/09 $25.00 © 2009 IEEE. | Nasser Sadati, Member, IEEE, Hamid R. Mohseni, Arash Maghsoudi," Epileptic Seizure Detection Using Neural Fuzzy Networks", 2006 IEEE International Conference on Fuzzy Systems Sheraton Vancouver Wall Centre Hotel, Vancouver,BC, Canada July 16-21, 2006. | Nurettin Acir, Ibrahim Oztura, Mehmet Kuntalp, Baris¸ Baklan, and Cuneyt Guzelis,"Automatic detection of epileptiform events in EEG by a three-stage procedure based on artificial neural networks", 0018-9294/$20.00 ©2005 IEEE. | L. D. Iasemidis, D. S. Shiau, W. Chaovalitwongse, J. C. Sackellares, P.M. Pardalos, J. C. Principe, P. R. Carney, A. Prasad, B. Veeramani and K. Tsakalis, "Adaptive Epileptic Seizure Prediction System", IEEE Trans.on Biomed. Eng., | vol. 50, no. 5, pp. 616-627, 2003. |