International Journal of Electronics, Electrical and Computational System
IJEECS
ISSN 2348-117X
Volume 6, Issue 8
August 2017

EEG Feature Extraction and Classification of Alzheimer's Disease using Support Vector Machine Classifier

Deepa R
Bannari Amman Institute of Technology, Sathyamangalam
Dr. A.Shanmugam
SNS College of Technology, Coimbatore
Tamilselvan E
Bannari Amman Institute of Technology, Sathyamangalam

ABSTRACT

Support Vector Machine (SVM) is the most commonly used classification algorithm in healthcare industry. It is widely used to predict the abnormalities in brain such as Alzheimer's, Epilepsy and Parkinson disease. It is essential to reduce the number of input features to Support Vector Machine in order to get competent results. To reduce the feature set, select only the main features from the entire set of features. There are many methods available for feature extraction. In this paper, the feature extraction methods like Fast Fourier Transform (FFT), Discrete Wavelet Transform (DWT), Revised Principal Component Analysis (RPCA) and Auto regression are discussed for disease classification using Support Vector Machine. This paper gives the accuracy and efficiency achieved by these feature extracting techniques for classifying various diseases.

Keywords : Fast Fourier Transform, Discrete Wavelet Transform, Revised Principal Component Analysis, Auto regression, Support Vector Machine

INTRODUCTION

Support vector machine is the most commonly used algorithm for disease classification. It is widely used to classify the diseases like Alzheimer's, Epilepsy and Parkinson. It is a supervised learning model with associated learning algorithm analyzes the data used for classification and regression analysis.

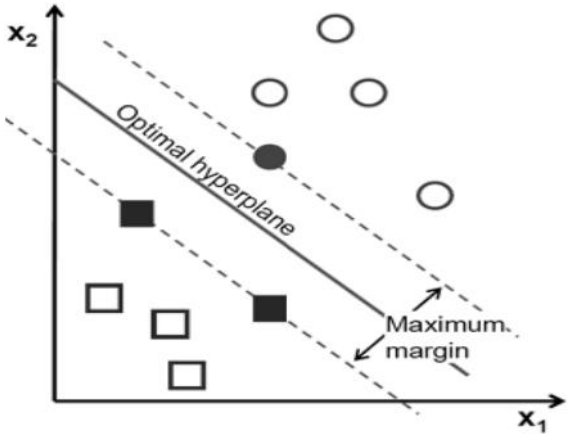

Fig 1: SVM Hyperplane

SVMs were first introduced by Vapnik in 1960s for the classification of data. In SVM, the classification is performed by drawing hyperplane [1]. A good separation is achieved by the hyper plane, which has the largest distance to the nearest training data point of any class (so called functional margin) and it is shown in fig 1. Since in general, larger the margin, lower the generalization error of the classifier. The equation to define the optimum separation hyperplane and the maximum margin are wt $x + b = 0$ and $wt\ x + b = \pm 1$ respectively, where w is defined as weight vector and b is defined as bias.

For better results of SVM, the features that are given as an input to SVM are needed to be reduced. The reduced feature helps to improve the efficiency of the results produced by the algorithm.

Feature Extraction technique by means of some functional mapping by keeping as much information in the data as possible. Feature extraction for classification is to seek a transformation, which extracts a subset of new features from the original feature set and it maximize the separability of different classes. Many time domain and frequency domain features can be utilized for this task.

Electroencephalogram (EEG) technique uses electrodes, which are located on the participant scalp. Those electrodes amplify the electrical waves coming from the brain. Before analyzing the EEG, it is necessary to remove the artifacts i.e. the pre-processing of EEG to be done. EEG has been demonstrated as a reliable tool in dementia research and diagnosis.

Alzheimer's disease (AD) is a dynamic neurological disorder of the neural system prompting to the irreversible loss of neurons and the loss of cognitive capacities including memory and thinking, which is sufficient to block the normal functioning of brain [2]. Alzheimer's is the most well-known type of dementia in human population. Although influencing primarily, the ages around 65, indicates showing up somewhat prior and are frequently disregarded as age-related changes or stress issue. Out of 1000 people in India, there exists a disorder of 33 subjects which holds a 3.3%. The true predominance of this disease in our nation has been hard to estimate, however a few reviews recommend that, there are around 37 lakh Indians influenced by Alzheimer's at present. It is assessed that the quantity of individuals experiencing Alzheimer's will twofold by 2030. For the treatment and recovery of the Alzheimer's disease, a coordinated exertion to be taken by the government and private medical services.

To overcome the mentioned limitations, the analysis was done with the help of SVM classifier. Most of the literature survey concerns recognizing visual attention are listed below.

Navneet kour.et.al (2015) proposed a paper titled Feature Detection and Analysis of Alzheimer’s disease using Gabor Filter. This paper highlights an improved and a simple, very easy to use, visualization program which is specially designed in software called MATLAB for the detection of mental and psychological disorder called Alzheimer’s disease as earliest as possible [3]. The filtered images of the healthy brain and the diseased brain are compared and analyzed then the differences between the two are also brought out in terms of parameters like histogram calculation, Euclidean distance calculation.

Kulkarni N.et.al (2017) proposed a paper titled Extracting Salient Features for EEG-based Diagnosis of Alzheimer's Disease Using Support Vector Machine Classifier. This paper depicts Alzheimer's disease (AD) is one of the most common and fastest growing neurodegenerative diseases in the western countries. The research is carried out on an experimental database [4]. Three different features such as spectral-, wavelet-, and complexity-based features are computed and compared on the basis of classification accuracy obtained. The support vector machine classifier giving 96% accuracy on complexity based features and it increases the performance in terms of sensitivity and specificity.. The results show the improved performance in the diagnosis of AD. It is observed that the severity of AD is depicted in EEG complexity. These features used in research work can be considered as the benchmark for AD diagnosis.

Raymundo Cassani.et.al (2014) proposed a paper titled Towards Automated EEG -Based Alzheimer's Disease Diagnosis Using Relevance Vector Machines. In this paper, we overcome these limitations by proposing the use of an automated artefact removal (AAR) algorithm to remove artefacts from the EEG signal without the need for human intervention [5]. We investigate the effects of the so-called wavelet enhanced independent component analysis (wICA) AAR on three classes of EEG features, namely spectral power, coherence, and amplitude modulation, and ultimately, on diagnostic accuracy, specificity and sensitivity.

METHODS

Data Acquisition and Preprocessing

In this analysis the EEG were recorded from 8-bit resolution with a sampling frequency of 2000 Hz. Notch filter is implemented using the impulse response filter of 100Hz is shown in the fig 2. In order to ensure the optimum operation of the circuit, that the source impedance should be less than about 100 ohms [6]. Additionally, the load impedance should be greater than about 2M ohms.

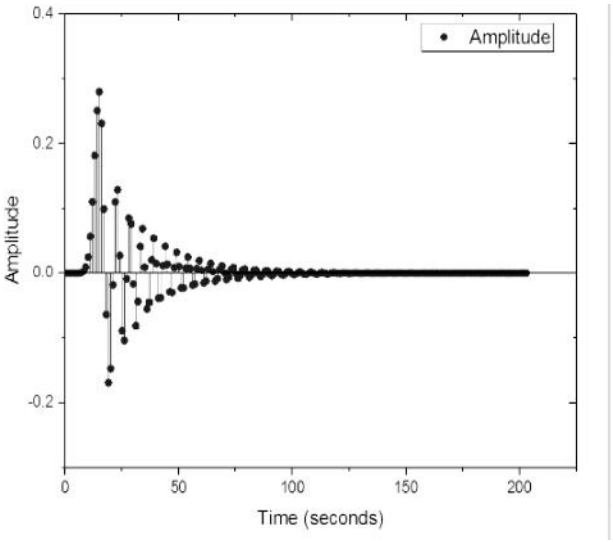

Fig 2: Impulse Response of Notch Filter

Transforms and Feature Extraction of Signals

In this, Wavelet transforms and Fast Fourier transform are used for feature extraction. An FFT rapidly computes such transformations by factorizing the Discrete Fourier Transform (DFT) matrix into a product of sparse (mostly zero) factors. The DWT of a signal is calculated by passing it through a series of filters. First the samples are passed through a low pass filter with the impulse response resulting in a convolution of two signals [7].

With the help of transforms, 12 features have been computed per EEG epoch. Building classifiers with such high dimensionality uses limited data results in over fitting. As such, feature extraction is required. From the available EEG data, we have set aside 25% of the data (randomly selected) to perform feature extraction and have left the remaining 75% for classifier training and testing. Motivated by recent findings which have advocated for the use of support vector machines for feature extraction and classification.EEG signals were segmented into non overlapping epochs that were assessed for the processing the signals [8].

International Journal of Electronics, Electrical and Computational System
IJEECS
ISSN 2348-117X
Volume 6, Issue 8
August 2017

Dimensionality Reduction

A few standard techniques have been proposed to locate a reasonable change. Revised Principal Component Analysis (RPCA) is a direct change strategy, in which the coveted portrayal has the maximum variance and prevents the minimum variance [3]. The utilization of RPCA for highlight extraction is initiated by results in neurosciences that propose that the comparable rule of repetition diminishment clarifies a few parts of the early preparing of tangible information by the mind.

RPCA has additional applications in investigating an indistinguishable path from the firmly related strategy for projection interest. The utilization of highlight extraction is roused by the hypothesis of excess diminishment.

A few calculations are established in the minimization of common data; others flourish in the augmentation of non gaussianity. Common data can be viewed as the lessening of instability in regards to variable X after the perception of Y. The calculation shares limited data, which follow down segments that are maximal free.

RPCA is a supervised procedure and in that capacity does exclude name data of the information. In the event, the information is ordinarily circulated and made the guideline segments are free. The primary explanation behind the utilization of RPCA concerns about the maximum variance. The RPCA is a straightforward nonparametric technique used to extricate the most significant data from an arrangement of repetitive information [7].

SVM Classifier

It constructs a hyper plane or set of hyper planes in a high- or infinite-dimensional space, which can be used for classification, regression, or other tasks [8]. Based on the input date, SVM devise the hyper plane, that has the largest distance to the nearest training-data point of any class (so-called functional margin), since larger the margin results in the lower generalization error of the classifier. SVM is a supervised learning process, analyses the EEG signal and evaluates the training data and classifies the disease. In this classification, they predict the subject is normal or affected by Alzheimer's disease. The accuracy and sensitivity are the parameters are calculated using SVM Algorithm and it is shown in Table.1

Table 1. Table captions should be placed above the table

Conditions	Accuracy %	Sensitivity
Normal	96.3	0.25
Alzheimer Disease	96	0.25

RESULTS & DISCUSSIONS

The training inputs are taken from the PHYSIONET database and it is processed using the feature extraction. From this analysis, the algorithm detects the normal subject and the diseased subjects.

Sixty subjects of dataset with each dataset comprising of Sixty-five types of signals. Training set includes thirty signals with diseased subjects. Testing is being carried out after consecutive training of datasets. The Alzheimer's disease which affects the delta wave of an EEG signal.

CONCLUSIONS

Support vector machine classifies the Alzheimer's disease based on various testing data sets provided. In this, the data sets are tested with the help of support vector machine classifier and the results of accuracy and sensitivity are found to be 96%, and 0.25 respectively. Hence by the use of support vector machine classifier and data sets patients who are bound to affect by Alzheimer's disease can be found.

REFERENCES

[1] Ingo Steinwart and Andreas Christmann, "Support Vector Machines", John Wiley and Sons, Ltd, 2006.

[2] Anthoula Tsolaki, Dimitrios Kazis, Ioannis Kompatsiaris,Vasiliki Kosmidou and Magda Tsolaki,"Electroencephalogram and Alzheimer's disease: Clinical and Research Approaches", International Journal of Alzheimer's Disease, vol. 2014, pp. 1-10, April 2014.

[3] Navneet Kour and Rajesh Mehra, "Fault Detection and Analysis of Alzheimer's disease using Gabor Filter", International Journal of Computer Trends and Technology, vol. 29, No. 2, pp. 74 -79, November 2015.

[4] N.N.Kulkarni and V.K.Bairagi, " Extracting Salient Features for EEG p based Diagnosis of Alzheimer's Disease Using Support Vector Machine Classifier", IETE Journal of Research, vol.63, issue 1,2017

[5] Raymundo Cassani, Tiago H Falk, Francisco J. Fraga, Paulo A.Kand, Renato Anginah, " Towards Automated EEG- Based Alzheimer's Disease Diagnosis Using Relevance Vector Machines", 5th ISSNIP-IEEE Biosignals and Biorobotics Conference (2014), pp. 1-6.

[6] Deepa R, Shanmugam A and Sivasenapathi B, "Reasoning of EEG Waveform using Revised Principal Component Analysis (RPCA)" accepted in Biomedical Research, Volume 28, issue.9, May 2017.

[7] N.Elavarasan and K.Mani, "A Survey on Feature Extraction Techniques", International Journal of International Research in Computer and Communication Engineering, vol.3, issue.1, pp. 52-55, January 2015.

[8] H.U.Amin et.al.," Feature Extraction and Classification for EEG Signals using wavelet transform and machine learing techniques", Australian Physical and Engineering Sciences in Medicine, vol. 38, issue 1, pp. 139 -149, March 2015.

[9] Zhao, W.Zhou , K.Liu and D. Cai, " Application of SVM and Wavelet Analysis in EEG Classification", Sheng Wu Yi Xue Gong Cheng Xue Za Zhi,vol.28, issue.2,pp. 277-279, April 2011.