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Characterizing Functional Connectivity Network Based on Multi-Domain Analysis for Epilepsy Classification

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Abstract**:** ***Epileptic is a neural disease exemplified through untypical concurrent signal discharge from the neurons present in the brain region. This abnormal brain functionality could be captured through electroencephalography (EEG) system. Generally the observed EEG signals are examined by the experienced neurologist, which may be time consuming when observing hours of EEG signal. Therefore, this proposed work provides a fully automatic epileptic seizure detection system by means of the multi-domain features along with various machine learning algorithms. Initially, the obtained EEG signals are processed to clear noise and artefacts. Subsequently, the pre-processed signals are segregated as 5 seconds epochs and for each epoch various features are extracted from frequency domain, time domain. Additionally entropy, correlation and graph theory approaches has been used for analysis the connectivity of the brain network. Subsequently, distinguishable features are chosen carefully in this regard from the immense feature set by virtue of multi-objective evolutionary method and convincingly, classification has been performed using support vector machine(SVM).A Bayesian optimization (BaO) algorithm was utilized to optimize the SVM's hyper-plane parameters. In addition, Quadratic Discriminant Analysis (QDA), Linear Discriminant Analysis (LDA),Random Forest Ensemble (RFE) and k-Nearest Neighbor Ensemble (k- NNE) was also used for comparing the proposed results. These obtained results validates by considering the performance of this work is competing along with state-of the-arts approaches. The proposed work is implemented on a CHB-MIT database.The obtained performance measure of the classifiers are 99.09%, 81.49%,80.90%,76.85% and 84.14 % in SVM , LDA, QDA, k- NNE and RFE respectively. Finally SVM with Bayesian Optimization (BaO) algorithm outperforms than other classifiers with accuracy, AUC, sensitivity and specificity, as 99.09%, 99.67%, 98.06% and 98.12%, respectively.***

Keywords: About four key words or phrases in alphabetical order, separated by commas.

I. INTRODUCTION

Epilepsy is a nervous disease and it's often caused within functionality variation occur in the brain neuronal activities. It may trouble all age group peoples [1]. It is amongst the most known brain disorder that ends in around 1% among the whole populace worldwide and around 0.2% of affected peoples are expire due to this epileptic seizure. Clinically, many diagnostic tools namely, computed tomography scan, magnetic resonance imaging and ultrasound are used for epilepsy diagnosis but these are considered to be expensive and cannot be utilized for evaluation for long time. Rather, EEG is a non-surgical and inexpensive tool perhaps employed for long-lasting evaluation [2]. Thus, it is considered as the greatest practical mechanism for the epilepsy diagnosis.EEG signals are acquired from the scalp of the head. Neurologist observes EEG patterns and decisions are made based up on his observation.

In recent days, many researcher's extracted features from standard deviation, wavelet features [4], entropy , line length , absolute mean value, average power and proportion of absolute mean values[3] and fractal dimension [5] from epileptic signals. Then, the obtained features can be fed into various classifiers such a SVM [7], fuzzy logic model [8], artificial neural network [6] and Markov modelling to classify the seizure occurrences. The most familiar uni-variant features obtained from EEG signal is spectral power estimation. Wavelet [9] and Fourier Transforms [10] are utilized for transforming the EEG signal from time domain into frequency domain. Over the beyond, establishing the overall power of EEG signal of each channel, the energy of the signals is also obtained from the frequency bands: delta (< 3 Hertz), theta (4-7 Hertz), alpha (8-13 Hertz), beta (14-30 Hertz) and gamma (>30 Hertz).

The negative and positive zero level crossing of the signals are also considered for prediction of seizures [11].The known bi-variant feature for estimating the dependence among a pair of EEG channel is obtained from cross-correlation. Secondary cross-correlation features could be extracted as spatiotemporal Eigen values estimated between channels covariance and correlation matrices [12]. In previous work, Connectivity measures for analyzing the synchronization among the signal phase have been calculated from phase coherence, phase locking value and weighted phase locking value [13]. Similarly, the graph theoretic feature has been originated towards observing the functional and analytical connectivity of the brain network [14]. Preceding the constructed graphs, secondary features such as degree, global efficiency, diameter, and eccentricity, characteristic path length and centrality [15] can be obtained.

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