Abstract

The electroencephalogram (EEG) signal is a time series depictive signal which contains the useful knowledge about the state of the brain. The pre-processing, feature extraction, selection and classification play an imperative role in computer aided analysis for the detection and localization of brain disorder. Epilepsy is a chronic neurological disorder, which affects about 70 million (1%) people worldwide. In this dissertation, we have presented the algorithms and techniques for artifacts identification, detection and denoising, as well as the detection of epilepsy with localization.

The most frequent non-cerebral signals, ocular artifacts (OA), often generated by the eye blinks and/or eye movements of the subject are detected along the scalp while recording EEG. These artifacts make EEG analysis difficult and hence an automatic method is essentially devised to eliminate OA from EEG without losing cerebral activities. The overall process of removing ocular artifacts includes identification, precise detection with extent of OA, and their denoising.

This thesis work begins with the ocular artifact identification by ANN and multiple ocular artifactual zones detection using novel, computationally fast Time-Amplitude Algorithm. The process of OA removal from detected artifactual zones is implemented by decomposition of each EEG channel through DWT and SWT with different basis functions and thresholding by the modified OTSU. The results of OA removal are analyzed by the performance metrics.

Further, this research work provides the multiple features - statistical, spectral, and spatial, extracted from multichannel epileptic and non-epileptic EEG. The four features, viz., Fuzzy Entropy, Wavelet Energy, Wavelet Variance and Phase Space Reconstruction-Euclidean distance, have been observed to be the most effective and robust features using feature selection strategy. The selected features analysis of each channel that leads to lobe wise detection of epileptic EEG with localization has been performed for each subject.

The classification has been done using SVM classifier. The performances of SVM classifier with four different kernels have been compared. The best SVM-kernel pair is figured out by their ROC analysis. On comparing ROC performance curve for classification through four different kernels, the SVM-polynomial kernel has the highest sensitivity, specificity, and classification accuracy, which have been observed as 99.37%, 98.57%, and 98.97% respectively.

The channel wise feature evaluation led to affected lobe detection for each of the 850 channels of 50 subjects. Eventually, epilepsy detection and localization by most affected channel and the region identification through the proposed methodology is cross-validated by expert Neuro-physician. The proposed non-invasive techniques will be helpful for implementing in real time hardware EEG recording system for ocular artifact detection and removal. The automatic detection of seizure/epilepsy and pre-surgical evaluations through localization can also be implemented effectively.

Keywords: Electroencephalogram, Ocular artifacts, Epilepsy, ANN, MSE, MAE, MSC, Correlation Coefficient, Robust Features, Student T-Test, SVM, Multi-kernels, ROC.