ABSTRACT

Epilepsy is the most common neurological disorder with 40-50 million people suffering with it worldwide. Epilepsy is not life threatening but it disables the person to a greater extent due to its uncertainty of occurrences. Epilepsy is detected by repeated occurrences of seizure. Seizure can be generated in brain due to abnormal activity of group of neurons caused by brain tumor, genetic problem, infection, hemorrhage etc. Seizure can be detected by observing the variation in Electroencephalogram (EEG) signal. Focal seizure is defined as seizure localized in one lobe of brain. In this chapter discrete wavelet transform and Hidden Markov Model based focal seizure detection method is proposed for epileptic focus localization. EEG signal was decomposed up to level 5 using dual tree complex wavelet transform and entropy features such as collision entropy, minimum and modified sample entropy were extracted. Hidden Markov model was used for classification purpose. Maximum 80% accuracy was achieved in detecting focal and non-focal EEG signal.

INTRODUCTION

Seizure is defined as sudden surge of synchronous electrical activity of group of neurons. Around 10% of entire population may experience seizure at some point in the life. But repeated seizures indicate epilepsy. Epilepsy may be experienced by person from different age groups. Seizures are not life threatening but
may cause injury and disable a person to a great extend. Seizure becomes a burden to a person and also to the care taker. Focal seizures are seizures generated in one lobe of brain and do not spread to other lobes. Generalized or non-focal seizures spread to entire lobes of brain. Frontal and Temporal lobes are mostly affected from seizure. Based on the symptoms seizure can be tonic, clonic, tonic-clonic, myoclonic, and atomic and absence seizures. Tonic seizure results in muscle stiffness, atomic seizure causes muscles to lose stiffness, absence seizure results in brief loss in consciousness, myoclonic and clonic seizures are indicated by jerky movements. Nearly 20-30% of seizure patient do not respond to available seizure prevention medicine. So surgery is used as an option to treat epilepsy for drug resistant patients by removing the lobe generating seizure. In operative seizure treatment it is important to locate the lobe generating seizure before surgery. An EEG based technique for focal epilepsy detection can be of great use for surgeons for deciding the exact lobe to operate. EEG has the advantage of low cost system and easy to use. Patients with artificial organ implant and small babies cannot go for imaging approach such as functional magnetic resonance imaging. Also there are many seizures which at initial stage cannot be detected by imaging approach. In this chapter a focal epilepsy detection method is proposed. Some of the state-of-art methods are discussed below.

Two most used methods for focal seizure detection are discrete wavelet transform based (DWT) or Empirical mode decomposition based approach. Rajeev Sharma et.al (Sharma et.al 2014) proposed EMD based classification of focal and non-focal EEG signals. Average sample entropy extracted from each intrinsic mode functions and average variance of instantaneous frequency were used as features along with least square support vector machine classifier (LSSVM) for detecting focal seizure. Only 50 EEG signals are used for classification purpose. EMD along with average Renyi entropy and average negentropy were used for detection of focal seizure by (Dwivedi et.al 2016). Artificial neural network are used for classification. Entropy features such as average Shannon entropy, average Renyi entropy, average approximate entropy; average sample entropy and average phase entropy were used for classifying focal and non-focal EEG seizure (Sharma et.al 2015). Least square support vector machine classifier was used for classification. Integrated index based focal seizure detection is proposed by Sharma et.al (Sharma et.al 2015). Various entropy features such as average wavelet, fuzzy, permutation and phase entropy were extracted and least square support vector machine classifier was used for classification purpose. Combined analysis of EMD-DWT based approach was proposed by das et.al (Das 2016). Features used were entropy features and classifier used was k nearest neighbor classifier. Duo Chen et al. (Chen et.al 2016) had proposed discrete wavelet transform based focal and non-focal seizure detection. The best accuracy of epileptic focus localization achieved was 83.07% using sym6 from levels 1 to 7. Piyush Swami et al. (Swami et al 2016) had used dual tree complex wavelet transform for seizure classification. All details and last approximation coefficients are used to calculate features such as energy, standard deviation, root-mean-square, Shannon entropy, mean values and maximum peaks. Classification result was high with computation time less than 0.023 sec. Discrete wavelet transforms and support vector machine classifier based focal seizure prediction method was proposed by K. A. Helini Kulasuriya et al. (Kulasuriya et.al 2015). Statistical features such as maximum, minimum, mean and standard deviation were extracted from approximate and detail coefficients.

Now a days, hidden Markov model (HMM) (Kolekar et. al 2004 Dec) is used for epileptic seizure detection (Dash et. al 2017). Three states HMM for seizure detection is proposed by (Stephen et.al, 2007). Stationary wavelet transforms and hidden markov model between ictal, interictal and seizure EEG signal was used for seizure detection with higher efficiency (Abdullah, 2012).