Chapter 9
Epileptic Seizure Detection and Classification Using Machine Learning

Rekh Ram Janghel
National Institute of Technology Raipur, India

Yogesh Kumar Rathore
National Institute of Technology Raipur, India

Gautam Tatiparti
National Institute of Technology Raipur, India

ABSTRACT

Epilepsy is a brain ailment identified by unpredictable interruptions of normal brain activity. Around 1% of mankind experience epileptic seizures. Around 10% of the United States population experiences at least a single seizure in their life. Epilepsy is distinguished by the tendency of the brain to generate unexpected bursts of unusual electrical activity that disrupts the normal functioning of the brain. As seizures usually occur rarely and are unforeseeable, seizure recognition systems are recommended for seizure detection during long-term electroencephalography (EEG). In this chapter, ANN models, namely, BPA, RNN, CL, PNN, and LVQ, have been implemented. A prominent dataset was employed to assess the proposed method. The proposed method is capable of achieving an accuracy of 97.5%; the high accuracy obtained has confirmed the great success of the method.

INTRODUCTION

As per International League Against Epilepsy (ILAE) and the International Bureau for Epilepsy (IBE), Epilepsy is a neurological disorder distinguished by repeated unprovoked convulsions which are a consequence of irregular electrical activity in the brain (Guo et al., 2012). According to a study by WHO, Approximately 50 million people suffer from epilepsy universally (Cook, 2013). Approximately 2.4 million new cases of epilepsy are reported every year globally (Acharya et al., 2013). Epilepsy could be of two

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major types depending upon the area of the brain tissue that is involved, which are, generalized seizures and, partial seizures, generalized seizures roughly involves nearly the whole brain, partial convulsions develop in a particular section of the brain and is restricted to this area (Ling Guo et.al., 2010). Potential risk of mortality makes early diagnosis and treatment of epilepsy a critical task. Electroencephalography (EEG) is a famous electrophysiological technique used to comprehend the complicated activity of the brain (Gandhi et al., 2010). The EEG directly gauges and registers the electrical activity of the brain. Spontaneous EEG signals are classified into several rhythms based on their frequencies, which are δ band(0:3 - 4Hz); ɵ band (4 - 8Hz); α band (8 - 13Hz); β band (13 - 30Hz) (Zhou & Gotman, 2004). An EEG is especially useful at times when the brain is at risk by providing a sensitive indication of cerebral functioning. Such intervals are usually of long time spans, hence an extended EEG recording is needed Early studies have shown evidence of this abnormal activity to be a convenient aid in detection of epilepsy and cerebral tumors. Nowadays EEG signals are used to get information relevant to the diagnosis, prognosis, and treatment of these abnormal conditions. EEG is registered using electrodes placed on the scalp and have small amplitudes of the degree of 20 μV (Selvan & Srinivasan, 1999) The electrodes are placed as per the 10-20 international system which has been shown. Usually EEGs contain massive amounts of information and detection of traces of epilepsy requires a visual inspection of the total span of the EEG by a specialist which is a cumbersome task (Rivero et al., 2009). Hence, developing automated epileptic seizure detection system is noteworthy for assessing EEGs. Studies on automated seizure detection systems started in the 1970s and multiple techniques have been proposed for addressing the problem. Artificial Neural Networks (ANNs) are the most common classifiers that have been used for discriminating the EEGs as per the literature review. Artificial Neural Networks (ANNs) are information processing systems that were inspired by biological nervous system of humans. Artificial Neural Networks are highly parallel and interconnected and consist of simpler non-linear processing elements (Guo et al., 2010). Artificial Neural Networks were chosen as a classifier for the current work as it is capable of performing computations with high accuracy when executed on customized hardware. In this chapter, a unique epileptic seizure recognition system has been discussed.

The method is employs five different Artificial Neural Network (ANN) models, namely, Back Propagation Algorithm (BPA), Competitive Learning (CL), Linear Vector Quantization (LVQ), Probabilistic Neural Networks (PNN), and, Recurrent Neural Networks (RNN). A database consisting of 500 EEG segments is employed. High accuracies acquired designate the outstanding classification accomplishment of the suggested technique in contrast to other approaches.

METHODS AND MATERIALS

Steps involved in methodology and their flow of control is shown in figure 2.

Database Description

The dataset employed in the current work has been described by Andrzejak et al. (2001). The total dataset includes five subsets (designated as Z, O, N, F and S) each subset consisting of 100 single-channel EEG fragments, each fragment being of 23.6s, and were sampled at 173:6Hz. All fragments were chosen from continuous multi-channel EEG recordings after visual inspection for artifacts such as, muscle activity or eye movements. Sets Z, O contain fragments that have been obtained from surface EEG recordings