Journal of Ambient Intelligence and Humanized Computing
https://doi.org/10.1007/s12652-020-01774-w

ORIGINAL RESEARCH

A novel approach based on BSPCI for quantifying functional connectivity pattern of the brain's region for the classification of epileptic seizure

S. Anupallavi[1] · G. MohanBabu[1]

Received: 28 September 2019 / Accepted: 6 February 2020

Abstract
Epilepsy seizure is brain neurological abnormality which arises from the sudden deviation of the electrical interaction in the brain. Electroencephalography (EEGs) are obtained from 22 subjects with epileptic seizure and non-epileptic seizure states recorded using 23 channels with a sampling frequency of 256 Hz. The functional connectivity of the brain region can be exacted from the features obtained from EEG signals by measuring phase locking value (PLV). The neuronal connection in the brain can be expressed in terms of phase synchrony. Despite of the fact that brain states should be characterize independently based upon its extracted features. Therefore, a novel functional connectivity index (FCI) feature is proposed, namely Bi-Spectral Phase Concurrence Index (BSPCI). It is used to represent the spectral information with third cumulant order correlation functions of the EEG signal. In this paper, three FCI features were measured namely, the magnitude's mean of the bi-spectral, the normalized entropy of bi-spectrum (NE1) and the normalized entropy of squared bi-spectrum (NE2) from the BSPCI. Rank sum test based on the Wilcoxon approach is used to find the set of statistical difference between quantitative features extracted from EEG signals. The results provide evidence that the FCI will have an impact in separating the difference among seizure states of various epileptic seizure patients. On the part of reducing a large number of the feature vector, feature selection is performed by utilizing the sequential forward selection method. PLV is measured for quantifying the obtained phase synchrony of EEG signal. For the classification of epileptic seizure, Support Vector Machine is utilized which gain a large accuracy for the proposed bi-spectral analysis method when compared with Incremental Gradient Descent (IGD), Logistic Regression (LR) and Multilayer Perceptrons (MLP). The result is compared with IGD, LR, and MLP for obtaining better performance rate and the classification is 98.79% for the proposed work.

Keywords Electroencephalography (EEG) · Feature extraction · PLV (phase locking value) · Bi-spectral phase concurrence index (BSPCI) · Classification

1 Introduction

Epilepsy is one among the known brain diseases. The clinical indication of epilepsy is the occurrence of seizures, which are described as transient clinical symptoms and changes due to abnormal synchronous neuronal brain activity. Recently, the ILAE so-called International league against epilepsy proposed a new noteworthy definition for epilepsy (Fisher et al. 2014).Worldwide, 1.5% of the adults and 2% of the children of the world population are reported to have a seizure due to epilepsy. Since the seizure occurrence is unpredictable, the daily life of epileptic affected patients might be in difficult by this uncertainty. Thus, diagnosis and classification methods for epileptic seizure must be enhanced through the proper recordings which may lead to the planning of therapeutic medicines and training. In order to record the brain signal many neurophysiologies techniques like EEG (electroencephalogram), MEG (magnetic encephalogram), and fMRI (functional magnetic encephalogram) are introduced in past decades. The most predominant and reliable method to assess brain activities are based on

✉ S. Anupallavi
anupallavi1991@gmail.com

G. MohanBabu
shamyubabu@gmail.com

[1] Department of Electronics and Communication Engineering, SSM Institute of Engineering and Technology, Dindigul, India

Published online: 14 February 2020