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ORIGINAL RESEARCH

An optimized deep learning network model for EEG based seizure classification using synchronization and functional connectivity measures

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Abstract

Epilepsy is a brain disorder related to alteration in the nervous system which affects around 65 million people among the world's population. Few works are focused on prediction of seizure relied on deep learning approaches, but the capability of optimal design has no longer been absolutely exploited. This work is focused on the seizure prediction obtained from long-short time records using optimized deep learning network model (ODLN). In this paper, the synchronization patterns and its feasibility of distinguishing the pre-ictal from inter-ictal states are examined by utilizing the interaction graph model as a functional connectivity measure. An optimized deep learning network with short- long-term memory is computed for the prediction of epileptic seizures occurrences. For, the modelling of ODLN, pre-analysis is performed with three modules and memory layers. It is finalized from these results; a two-layer ODLN is optimum to perform the epileptic seizure prediction for four different window sizes from 15 to 120 min. The assessment is implemented on the CHB-MIT Scalp EEG data set, providing 100% sensitivity and low false prediction rate ranges from 0.10 to 0.02 for seizure prediction. The proposed ODLN methodology reveals a notable increase in the performance rate of seizure prediction when compared with existing machine learning and Convolutional neural networks methods.

Keywords Multicast security · Multiple logical key trees · Group key management · One-way key derivation · Rekeying process · False prediction rate · Convolutional neural networks

1 Introduction

Epileptic's seizure is a nervous disorder of the brain which may result in sudden death, fractures, and accidents. Epilepsy can be controlled by therapeutic treatment to some extent. However, intake of antiepileptic drugs (Deckers 2003) fails to reduce the impact of seizures for about 20–30% of affected people. In these conditions, a predominant problem is feasibility of detecting the initial origin of seizure (i.e. pre-ictal) so that to neutralize the invading seizure or confine the injuries during seizures contingency Cui. The classification can be marked out with extracted features from raw EEG signals (Ashokkumar et al. 2019). This method relies on threshold-based approaches. The most reliable predictive features comprise of measured trends from an increase or decrease in the synchronization pattern and phase locking values of EEG signals at the time of pre-ictal state and through complete seizure (Iasemidis et al. 2005).

The synchronization measures so-called, the phase lock value (PLV), the phase lag index (PLI) and the extended PLI as weighted PLI (WPLI) (Vinck et al. 2011) has been utilized. Furthermore, for capturing the real-time variation in the trends of the synchronization pattern, the modified classical indicator has been implemented namely moving average convergence or divergence (MACoD) (Appel 2005). Finally, these features are utilized for seizure prediction algorithm (Deivasigamani et al. 2020). Machine learning (ML) has transfigured the seizure prediction approach for handling the high complexity and volume of EEG data and

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