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Deep Learning Approaches for Accurate Detection of Epileptic Seizures from Electroencephalogram Data

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Abstract : Epilepsy is a chronic neurological disorder characterized by recurrent, unprovoked seizures resulting from abnormal electrical activity in the brain. Timely and accurate detection of these seizures is essential for improving patient care. In this study, we leverage the UK Bonn University open-source EEG dataset and employ advanced deep-learning techniques to automate the detection of epileptic seizures. By extracting key features from both time and frequency domains, as well as Spectrogram features, we enhance the performance of various deep learning models. Our investigation includes architectures such as Long Short-Term Memory (LSTM), Bidirectional LSTM (Bi-LSTM), 1D Convolutional Neural Networks (1D-CNN), and hybrid CNN-LSTM and CNN-BiLSTM models. The models achieved impressive accuracies: LSTM (98.52%), Bi-LSTM (98.61%), CNN-LSTM (98.91%), CNN-BiLSTM (98.83%), and CNN (98.73%). Additionally, we utilized a data augmentation technique called SMOTE, which yielded the following results: CNN (97.36%), LSTM (97.01%), Bi-LSTM (97.23%), CNN-LSTM (97.45%), and CNN-BiLSTM (97.34%). These findings demonstrate the effectiveness of deep learning in capturing complex patterns in EEG signals, providing a reliable and scalable solution for real-time seizure detection in clinical environments.

Keywords : electroencephalogram, epileptic seizure, deep learning, LSTM, CNN, BI-LSTM, seizure detection
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