Epileptic Seizure Detection and Prediction using Machine Learning and Deep Learning

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Abstract

Epileptic seizures are abrupt neurological events that severely impair patients' health and quality of life, necessitating the development of accurate, automated monitoring systems. Electroencephalography (EEG) provides a dynamic representation of neural activity, capturing the intricate patterns associated with seizures, making it the primary data source for this research. This paper investigates the efficacy of Machine Learning (ML) and Deep Learning (DL) techniques for both real-time seizure detection and timely prediction. Traditional ML methods, such as Support Vector Machines (SVM), Random Forest (RF), and XGBoost, rely on handcrafted features extracted from the EEG signal in the time and frequency domains, often utilizing techniques like Discrete Wavelet Transform (DWT). Deep Learning models, particularly One-Dimensional Convolutional Neural Networks (1D CNNs) and Long Short-Term Memory (LSTM) networks, have shown superior performance by automatically learning hierarchical, discriminative features directly from raw or minimally pre-processed EEG data. Our study aims to compare the performance and computational complexity of these approaches on benchmark datasets like CHB-MIT to advance flexible, high-performance automated systems for clinical application, focusing on critical metrics such as sensitivity, specificity, and false detection rate per hour (FDR/h).

Keywords

Epilepsy, Seizure Detection, Seizure Prediction, Machine Learning, Deep Learning, Electroencephalography (EEG), Convolutional Neural Networks (CNN), Long Short-Term Memory (LSTM).