Graduate School of Science and Technology Master's Thesis Abstract

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Thesis title	An Epileptic Seizure Detection Method Integrating Multi-Scale Learnable Gabor Filters with CNN-LSTM Spatio-Temporal Modeling		

Abstract

Epilepsy is a common neurological disease, which not only seriously affects the quality of life of patients, but also can lead to accidental injury and even sudden death.
Electroencephalogram(EEG) is the gold standard for the diagnosis of epilepsy. However, manual reading of massive data is not only time-consuming and laborious, but also prone to misdiction due to visual fatigue. Therefore, a reliable automatic detection system is very important.
Although deep learning has made significant progress in accuracy, the existing black box models often lack interpretability and are difficult to effectively generalize among different groups of people.

In order to solve the above challenges,this thesis proposes a novel method integrating Multi-Scale Learnable Gabor Filters with Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM) spatio-temporal modeling.
This method is deeply inspired by the cognitive process of clinical experts. It diagnoses attacks by identifying specific morphological waveforms and analyzing their time evolution, and aims to explicitly simulate this process.
We use the physiologically constrained multi-scale Gabor filter to replace the standard convolution layer, enabling it to dynamically learn and capture pathological biomarkers (such as spikes and slow waves) across different time scales.
Then, the CNN module extracts spatial features, and the bi-directional LSTM module analyzes the time context
We validated the framework on a pediatric dataset and a Neonatal EEG Epilepsy dataset using a rigorous 5-fold grouped cross-validation.
The experimental results show that this method not only achieves excellent detection performance but also has the ability to generalize across populations and strong interpretability.