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Visibility Graph methods in nonconvulsive seizure detection

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ABSTRACT

A nonconvulsive seizure is an epileptic process without prominent motor symptoms. A nonconvulsive seizure detection can be considered as a classification task between the ictal class and the non-ictal class. Many seizure detection methods have been reported, aiming at distinguishing ictal and non-ictal patterns by analysis of features from electroencephalogram (EEG). These features are extracted in different domain such as time and frequency domain. However, with the development of the visibility graph, a single-channel EEG signal can be characterized in the graph domain as well. Time series analysis based on visibility graph (VG) has been proposed over the recent decades [1]. The VG algorithm converts time series into complex networks. The structure of the time series retains in the graph topology. That is to say, a one-dimensional signal can be characterized by mapping it into a two-dimensional network in a graph.

Different kinds of pseudo signals were first used as experimental data to evaluate the performance of the algorithms, including basic VG (BVG), horizontal VG (HVG), difference VG (DVG) and a novel VG named Telescoping VG (TVG). The concept of TVG is to artificially change the time series before extracting the features in the graph domain. After this, the EEG signals can be converted into VGs by these four aforementioned methods. In this work, an EEG signal from one epileptic patient was analysed in the graph domain with the existing VG algorithms and our novel TVG method (enlarging 10% random points to local maximum value), aiming at nonconvulsive seizure detection. Specifically, the features extracted from the associated VGs were compared to demonstrate the effectiveness in classifying ictals and non-ictals. The absolute standardized mean difference (ASMD) was used to evaluate feature separability. The degree entropy [2] calculated from TVG has a higher ASMD (1.48) compared with that from BVG (1.18). These preliminary results indicate that our proposed TVG method would potentially help improve the separability of features in classifying ictal and non-ictal patterns. Other features will be investigated in the future on a larger data set with more patients for nonconvulsive seizure detection.

Bibliography

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