Non-convulsive status epilepticus detection

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Abstract

Non-convulsive status epilepticus (NCSE) is an epileptic process, where electrographic seizure activity persists over 10 minutes without noticeable motor symptoms [1]. Long-term NCSE with high degree of unresponsiveness may result in structural brain damage for the ICU patients. During the patients' hospital stay, it is practically difficult to constantly make precise diagnosis of NCSE by clinicians via a routine procedure. Given the subtle and variable clinical symptoms, clinicians widely use electroencephalography (EEG) to diagnose NCSE. The ictal discharges during NCSE are visually analyzed by the clinicians based on some common morphological EEG patterns. However, the visual inspection by humans is time-consuming and subjective. Moreover, the safety of the chronic patients with NCSE is not guaranteed without proper monitoring. Daily monitoring of these patients unduly burdens their caregivers. Therefore, a 24/7 automatic NCSE detection system via continuous EEG signals is desirable at both hospital and home. We aim to develop a 'brainwave' chip, which can constantly monitor the EEG signals from NCSE patients. An automatic NCSE detection algorithm applied on this chip is investigated.

This is a retrospective observational study with existing EEG and one-lead ECG recordings from two groups: 16 participants with a clinical diagnosis of NCSE and a control group of 12 participants where a clinically suspected NCSE was not confirmed. The NCSE detection system was built and validated on the training and testing dataset in the NCSE group, respectively. Around 15 features were mainly extracted from the time and frequency domains of EEG signals [2]. We trained a 3-class RUSBoost classifier to score each epoch (2.56 seconds) in three categories: ictal, abnormal activities, and normal activities. The abnormal activities mainly indicate the electrographic activity during the transition between ictal and normal activities. The decision of the ictal or normal-activity event was based on the evolution of three-category scores in 20-second window. As a preliminary result, a 5-fold cross validation method was executed to achieve the classification performance within one subject. About 85% of ictal events could be detected using our system, and its precision achieves 78%. The performance of each participant will be presented in future work.

[1] P. W. Kaplan, “EEG criteria for nonconvulsive status epilepticus,” in *Epilepsia*, 2007.

[2] L. Wang, J. B. A. M. Arends, X. Long, P. J. M. Cluitmans, and J. P. van Dijk, “Seizure pattern-specific epileptic epoch detection in patients with intellectual disability,” *Biomed. Signal Process. Control*, 2017.