Detection of Epileptic Seizures with Multi-modal Signal Processing - DTU Orbit
(29/12/2018)

Detection of Epileptic Seizures with Multi-modal Signal Processing
The main focus of this dissertation lies within the area of epileptic seizure detection. Medically refractory epileptic patients suffer from the unawareness of when the next seizure sets in, and what the consequences will be. A wearable device based on uni- or multi-modalities able to detect and alarm whenever a seizure starts is of great importance to these patients and their relatives, in the sense, that the alert of the seizure will make them feel more safe. Thus the objective of the project is to investigate the movements of convulsive epileptic seizures and design seizure detection algorithms for these based on uni- or multimodalities. Regarding seizure detection, the highest potential clinical relevance is for the generalized tonic-clonic (GTC) seizures, as these are associated with an increased risk for sudden unexpected death in epilepsy (SUDEP) in unsupervised patients.

Several methods have been applied in different studies in order to achieve the goal of reliable seizure detection. In the first study we present a method where the support vector machine classifier is applied on features based on wavelet bands. This was used on multi-modal data from control subjects, with the result that the inclusion of more modalities provided a better performance. We succeeded in performing a multi-modal recording of a GTC seizure from an epileptic patient, and a visual analysis of the data showed that it was similar to the data from our control subjects, only more pronounced. Based on this we expected the algorithm to perform better on the patient data as well if more modalities were used. The presented algorithm proved to be able to detect epileptic tonic and GTC seizures based on one modality, surface electromyography (sEMG), but it did not prove to be sufficient for the other convulsive seizures tested.

Another study was performed, involving quantitative parameters in the time and frequency domain. The study showed, that there are several differences between tonic seizures and the tonic phase of GTC seizures and furthermore revealed differences of the epileptic (tonic and tonic phase of GTC) and simulated seizures. This was valuable information concerning a seizure detection algorithm, and the findings from this research provided evidence for a change in the definition of these seizures by the International League Against Epilepsy (ILAE).

Our final study presents a novel seizure detection algorithm for GTC seizures based on sEMG from a single channel. The algorithm is simple, based on a high-pass filter and a count of zero-crossings, in order to ease the implementation into a small wireless sEMG device. The algorithm proved to be reliable, and was after minor changes implemented in a wireless sEMG device. A double-blind test on patients in the clinic, showed 100 % reliability for three of four patients, whereas it failed for the last patient, who had atypical GTC seizures.

General information
State: Published
Organisations: Department of Electrical Engineering, Biomedical Engineering, Danish Epilepsy Center
Contributors: Conradsen, I., Sørensen, H. B. D., Beniczky, S., Sams, T., Wolf, P.
Number of pages: 200
Publication date: 2013

Publication information
Place of publication: Kgs. Lyngby
Publisher: DTU Elektro
Original language: English
Electronic versions: Dissertation_IC_final..PDF
Research output: Research › Ph.D. thesis – Annual report year: 2013