Quantitative EEG and machine learning methods for the detection of epileptic seizures and cerebral asymmetry

Chapter 8

Valorization

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Goal of this thesis is to develop and improve automated epileptic seizure detection algorithms. This goal is a part of a bigger goal, namely to enable reliable EEG neuro-monitoring on the intensive care unit. Our research is most relevant for patient admitted to an ICU unit which can be treated more adequately. There is a general consensus that it is important to be able to detect (non-convulsive) epileptic seizures in comatose ICU patients. In the most optimistic situation timely detection and subsequent intervention with anti-epileptica will lead to the ultimate goal of improved quality of life by preventing further brain damage. Furthermore adequate EEG monitoring could also lead to reduced time spend on the ICU and earlier release from the hospital. Via several ways EEG monitoring can lead to cost reductions. Manual EEG inspection by an EEG expert is very time consuming and therefore costly. ICU stay is expensive, therefore reducing the time spend on the ICU is another way of saving money and resources. Finally an improved quality of life after release from hospital will also result in less spending on for example revalidation and home help.
Although the general consensus is that detecting and treating non-convulsive seizures in comatose patients is important no consensus exists about whether the use of anti-epileptica in comatose patients result in a better outcome or that it is just etiology that both causes epileptic seizures and determines outcome. Therefore our seizure detection algorithm is also a useful tool for researchers in the field of neuro-monitoring .

Whether used for actual ICU monitoring or as a tool for monitoring studies, our algorithm has to be implemented either as a module in an EEG analysis software package, or as a separate plug-in. Before this final implementation phase can be started first some further research is required. Chapter 3 already indicated that classifier performance depends on the dataset used for training. Furthermore in the different datasets used in this thesis there are some EEG registrations in which the seizures cannot be detected using our current state of the art

classifier. Upon examination of these EEG registrations it turns out that either the seizures themselves or the specific combination of seizure and non-seizure EEG patterns are not present in the training dataset. In principle a seizure can only be recognized as such by a classifier when similar seizures were 1) present in the training dataset and 2) successfully learned during training. The first point is quite straightforward while the second point can occur when a certain seizure pattern is under represented. It is therefore important to investigate how an optimal training dataset should be constructed. To be able to this a large high quality EEG database is needed. Considering the fact that data availability is often limited and the task of providing annotations is very time consuming, having a high quality training dataset would have great (economical) value. Our automated seizure detection algorithm could also be used to facilitate the construction of such a dataset. As a high quality training dataset is available and the existing methods are optimized final implementation of the seizure detection method should take place. In our opinion the best way to approach this is to cooperate with an existing manufacturer of EEG recording hardware and associated analysis software. In this way there is limited risk compared to starting a company and try to develop and sell it as a software package. Incorporating our seizure detection method into an existing EEG analysis package does not require much effort other than translating the Matlab code into the preferred programming language. Another option is to package our code into a Matlab toolbox which can communicate with an existing package such as BrainRT. This EEG analysis software package already allows for communication with custom Matlab programs. For research purposes the Matlab toolbox can also be published as an open-source toolbox for example as part of the EEGlab toolbox.

The first option would be better when seizure detection is to be used for ICU monitoring while the second option be better when our methods are to be shared in the research community.