Feature preprocessing improves Support Vector Machine accuracy for seizure detection in neonatal EEG

Guy Bogaarts*, Erik Gommer, Danny Hilkman, Vivianne van Kranen-Mastenbroek, Werner Mess, Jos Reulen
Academisch ziekenhuis Maastricht,
P. Debyelaan 25, 6229 HX Maastricht
The Netherlands
Email: guy.bogaarts@mumc.nl

Abstract

On Neonatal Intensive Care Units (NICU) many vital parameters are recorded but monitoring of brain function by Electroencephalography (EEG) is rare, mainly because signal interpretation requires expert visual inspection. In 1-6 % of newborns on the NICU (sub clinical) seizures occur and even more frequent in prematures and low-birth weight children [1]. Failure of detection and subsequent lack of treatment can result in brain damage. Automatic EEG analysis could enhance the application of NICU brain monitoring. Recently, a new seizure detection method was introduced using Support Vector Machines (SVM) [2]. Major aim of our project is to further optimize classification accuracy by introducing two pre-processing procedures. First, a Kalman filter (KF) was used to filter feature time series in order to reduce short false detections. Second, baseline feature correction was used to reduce inter patient differences. Data from 33 both term and pre-term newborns aged between 0 and 6 months consisted of 48 single channel routine EEG recordings (average duration of 26 minutes) in which convulsions were annotated by visual inspection. A total of 123 features for neonatal seizure detection [3-6] are computed for 10s EEG epochs. Each epoch is represented by a feature vector that can either be used to classify the epoch or for training. Feature correction is performed using either all non-seizure data for training or a 3 minute baseline for testing. KF is performed on both training and testing data as well as on the classifier output as introduced in [7].The SVM system without any of the proposed pre-processing steps achieves an area under the receiver operating characteristics curve (AUC) of 0.78 with a sensitivity and specificity of 70.6% at the equal error rate (ERR) point. Each of the proposed preprocessing steps resulted in a performance increase. The best classification performance is achieved on baseline corrected features with a Kalman smoother used for training data pre-processing and a KF used to filter the classifier output. This best classification model achieves an AUC of 0.90 with a sensitivity and specificity of 80.7% at the ERR point. As a secondary result the percentage of training data that becomes support vector was reduced from 59% to 29% which results in a decreased classification time and indicates that the seizure classification problem is simplified. This work shows the importance of feature preprocessing for the detection of neonatal seizures. Both baseline feature correction and KF improve seizure detection by removing information from the data set that is not only irrelevant but also hinders seizure detection.

1. Wirrell, E.C., et al., *Prolonged seizures exacerbate perinatal hypoxic-ischemic brain damage.* Pediatr Res., 2001. **50**(4): p. 445-54.
2. Temko, A., et al., *EEG-based neonatal seizure detection with Support Vector Machines.* Clinical Neurophysiology, 2011. **122**(3): p. 464-473.
3. Greene, B.R., et al., *A comparison of quantitative EEG features for neonatal seizure detection.* Clinical Neurophysiology, 2008. **119**(6): p. 1248-1261.
4. Temko, A., et al., *EEG Signal Description with Spectral-Envelope-Based Speech Recognition Features for Detection of Neonatal Seizures.* Information Technology in Biomedicine, IEEE Transactions on, 2011. **15**(6): p. 839-847.
5. Bajaj, V. and R. Pachori, *Classification of Seizure and Non-seizure EEG Signals using Empirical Mode Decomposition.* Information Technology in Biomedicine, IEEE Transactions on, 2011. **PP**(99): p. 1-1.
6. Pachori, R.B. and V. Bajaj, *Analysis of normal and epileptic seizure EEG signals using empirical mode decomposition.* Computer Methods and Programs in Biomedicine, 2011. **104**(3): p. 373-381.
7. Chisci, L., et al., *Real-Time Epileptic Seizure Prediction Using AR Models and Support Vector Machines.* Biomedical Engineering, IEEE Transactions on, 2010. **57**(5): p. 1124-1132.