Mitra, Joyeeta, “A System for Automated Detection of Seizures in Neonatal EEG”

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Seizures in neonatal EEG are characterized by rhythmic waveforms of varied morphology. Though rhythmicity is a salient feature of most seizures, algorithms designed on rhythmicity characteristics alone suffer from false alarms due to the fact that non-seizure EEG also has rhythmic episodes due to artifacts (e.g., patting, respiration) or just as a characteristic of the subject’s brain activity (e.g., abnormal EEG, bifrontal delta).

In this project, a 3-stage automated system was developed to detect seizures with high sensitivity and low false alarm rate suitable for clinical application. Stage I algorithms detect seizure in small segments (5 s) in each channel of EEG data, and are based on the rhythmicity characteristic of seizures. Rhythmicity in pseudo-sinusoidal seizure activity is detected using spectral analysis, and the rhythmicity of repetitive spike-like seizure activity is detected by autocorrelation analysis of wavelet coefficients. To lower the false alarm rate due to non-seizure rhythmic activity, both algorithms use neural network-based classifiers cascaded with rule-based classifiers. The rule-based classifiers use “loose” thresholds to produce supersets of the true seizure segments. The neural networks are trained to eliminate the non-seizure segments from these sets. Events from Stage I are then spatio-temporally clustered to produce multi-channel candidate seizures in Stage II.

In Stage III, the candidate seizures are processed further using measures of quality and context-based rules to eliminate false candidates. In addition, false candidates due to commonly occurring background patterns such as bifrontal delta and suppression-burst and from sources external to EEG such as EMG, EKG, and respiration are also rejected. Seizures at least 10 s in duration are considered for reporting results. The training set includes 21 seizure subjects and 20 non-seizure subjects, and the testing set includes 28 seizure subjects and 48 non-seizure subjects. Performance of the system has been evaluated in terms of individual subjects, as well as the overall detection sensitivity of seizures. The system is able to detect seizures with a subject sensitivity of 96% and average false detection rate of 0.78 per hr in the testing data.