Sleep stage classification using spectral analyses and support vector machine algorithm on C3- and C4-EEG signals [Abstract]

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Technology/Technical

SLEEP STAGE CLASSIFICATION USING SPECTRAL ANALYSES AND SUPPORT VECTOR MACHINE ALGORITHM ON C3- AND C4-EEG SIGNALS

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Introduction: Sleep stage classification currently relies largely on visual classification methods. We tested a new pipeline for automated offline classification based upon power spectrum at six different frequency bands. The pipeline allowed sleep stage classification and provided whole-night visualization of sleep stages.

Materials and methods: 102 subjects (69 male; 53.74 ± 12.4 years) underwent full-night polysomnography. The recording system included C3- and C4-EEG channels. All signals were measured at sampling rate of 200 Hz. Four epochs (30 seconds each) of each sleep stage (N1, N2, N3, REM, awake) were marked in the visually scored recordings of each one of the 102 patients. Scoring of sleep stages was performed according to AASM 2007-criteria. In total 408 epochs for each sleep stage were included in the sleep stage classification analyses. Recordings of all these epochs were fed into the pipeline to estimate the power spectrum at six different frequency bands, namely from very low frequency (VLF, 0.1-1 Hz) to gamma frequency (30-50 Hz). The power spectrum was measured with a method called multitaper method. In this method the spectrum is estimated by multiplying the data with K windows (i.e tapers).The estimated parameters were given as input to the support vector machine (SVM) algorithm to classify the five different sleep stages based on the mean power amplitude estimated from six different frequency bands. The SVM algorithm was trained with 51 subjects and the testing was done with the other 51 subjects. In order to avoid bias of the training dataset, a 10-fold cross validation was additionally done to check the performance of the SVM algorithm

Results: The estimated testing accuracy of prediction of the sleep stages was 84.1% for stage N1 using the mean power amplitude from the delta frequency band. Accuracy was 67.8% for stage N2 from the delta frequency band and 74.9% for stage N3 from the VLF. Accuracy was 79.7% for REM stage from the delta frequency band and 84,8% for the wake stage from the theta frequency band.

Conclusions: We were able to successfully classify the sleep stages using the mean power amplitude at six different frequency bands separately and achieved up to 85% accuracy using the electrophysiological EEG signals. The delta and theta frequency bands gave the best accuracy of classification among all sleep stages.