Automatic artifact detection in long-term EEG recordings

A. Malafeev[1], A. Wierzbicka[2], A. Wichniak[2], Ximena Omlin[3], P. Achermann[1]

1 University of Zurich, Institute of Pharmacology and Toxicology, Chronobiology and Sleep Research

2 Institute of Psychiatry and Neurology in Warsaw, Department of Clinical Neurophysiology, Sleep Disorders Center

3 ETH Zurich, Department of Health Sciences and Technology, Institute of Robotics and Intelligent Systems, Sensory-Motor Systems Lab

WearMeSoC RTD 2013

Introduction

We are aiming to develop and implement algorithms for automatic detection of artifacts in long-term EEG recordings for further automatic analysis of the data. We are looking at EEG data recorded from narcoleptic patients during a Multiple Sleep Latency Test (MSLT) and at the recordings of healthy subjects during sleep. We aim to separate sleep and wakefulness phases, but first we need to detect artifacts in the recordings.

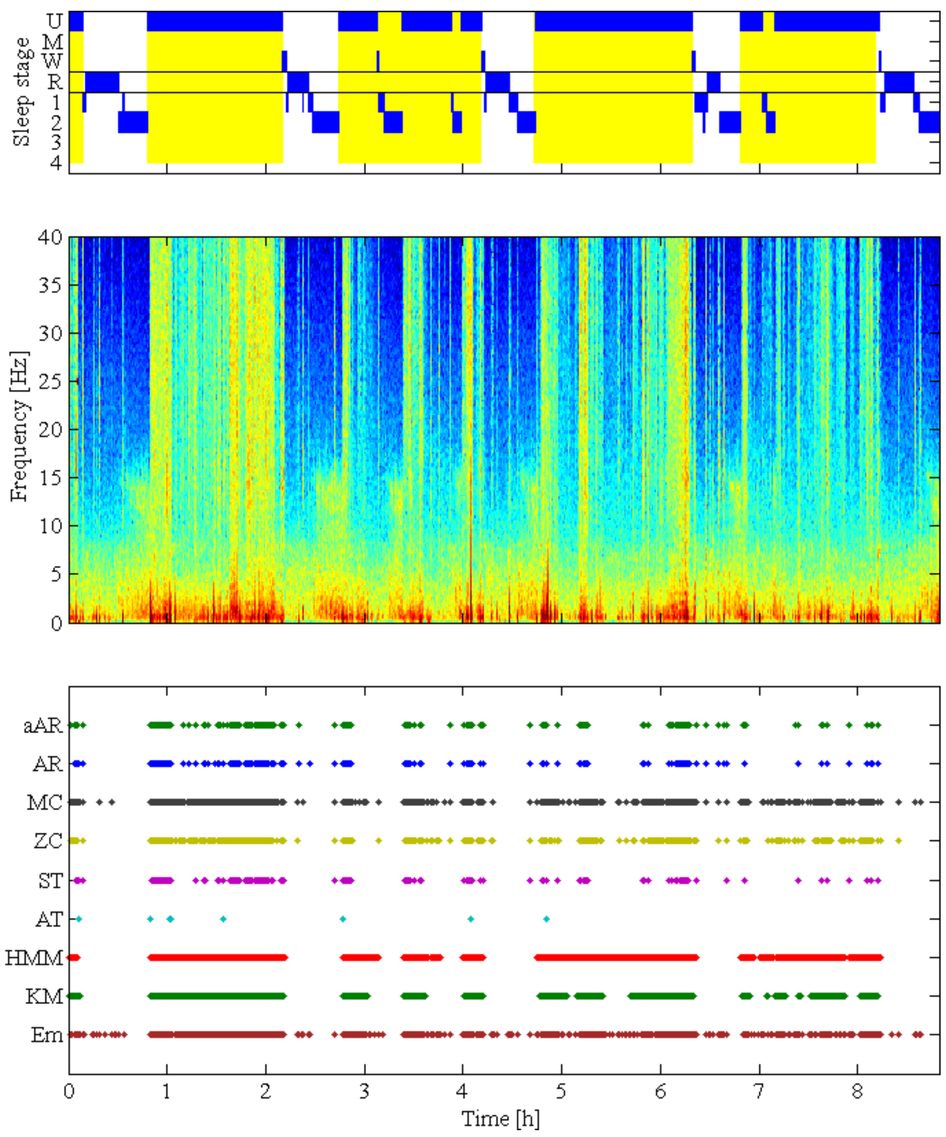
Methods

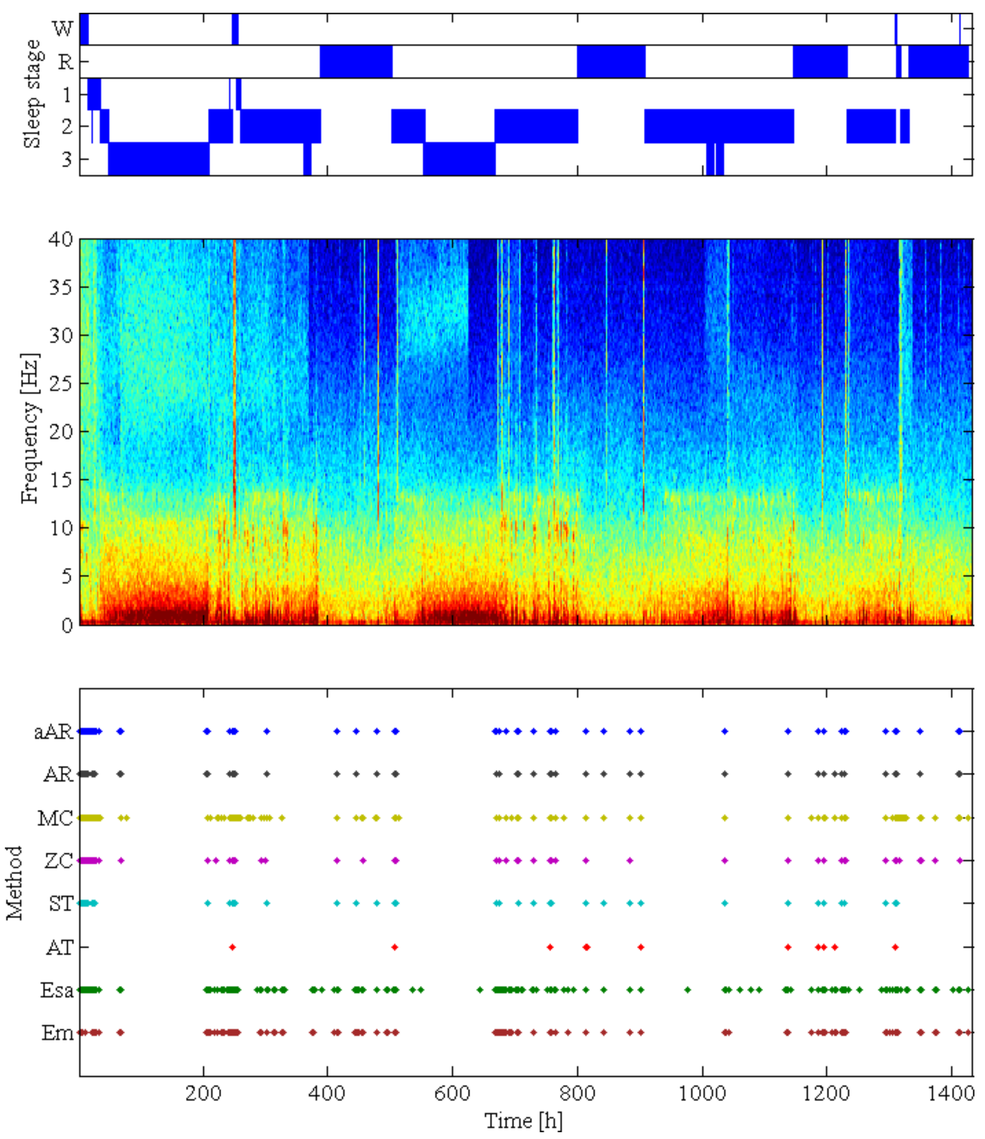
1) Continuous, 9 hours long polysomnography recording with 5 nap opportunities, 5 patients: 6 EEG, 2 EMG, 2 EOG and 1 ECG channel
2) Normal sleep, 18 subjects, 3 nights per subject, 12 EEG, 2 EMG, 2 EOG, 1 ECG, respiration and body temperature, 8 h of recording

Unsupervised artifact detection: ***K-means (KM)*** and ***Hidden Markov Model (HMM)***, applied to power in 1-s moving windows, and ***Autoregressive Model (AR)*** applied to entire data set, ***Adaptive Autoregressive Model (aAR)***, ***Amplitude Thresholding (AT), Slope Thresholding (ST), Zero Crossings (ZC) and Mean Crossings (MC).***

Results

With all methods we could reliably identify long intervals of the EEG contaminated with artifacts. HMM and K-Means could not recognize short intervals of artifacts. In contrast, the AR algorithm and thresholding methods catched transient artifacts. Simple methods are also quite accurate both in sleep and wakefulness. HMM and K-Means are not suitable for sleep data. A combination of methods seems most appropriate.





Conclusions

Using HMM and K-Means we can identify severe artifacts (movement, electrode artifact, etc.) in wakefulness recordings. Other methods allow us to identify also minor artifacts. We would like to develop better algorithms in order to have higher precision.

AR and aAR methods perform better than HMM and K-Means, and adaptive AR model is also suitable for online analysis. Simple thresholding algorithms are also suitable for our tasks, Mean Crossings, Zero Crossings and Slope Thresholding algorithms perform almost as good as AR model. Amplitude Thresholding performance depends on the data set.