DFA- and DWT- Based Features of HRV Signal for Automatic Sleep Staging

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The electroencephalogram (EEG) is one of the most important signals for automatic sleep staging. However, recording and analysis of this signal presents a number of technical challenges, especially at home. Instead, electrocardiographic (ECG) signals are much easier to record and may offer an attractive alternative for home monitoring of sleep. The heart rate variability (HRV) signal spectral components produce quantitative markers of sympathetic and parasympathetic nerve activities, which differ significantly during wake and different sleep stages. As such using HRV signals to extract information for automatic sleep staging is a promising exploration. In this study Detrended Fluctuation Analysis (DFA) and Discrete Wavelet Transform (DWT) were used to extract discriminative features from HRV signals. The Analysis of Variance (ANOVA) followed by a post-hoc Bonferroni test was used to check the significance of the extracted features. The results showed that good outcomes could be achieved in automatic sleep staging by combining DFA- and DWT-based features calculated from 30-second segments of HRV signals. We observed that DFA feature α1 seems suitable for separating REM sleep from wake stage and NREM sleep, while α2 and energy in different frequency bands seem beneficial for separating the wake stage from other sleep stages, and entropy can separate wake stage from deep sleep.