Evaluation of Breathing Dynamics using the Correlation of Acoustic and ECG Signals

Klaudia Czopek*

Institute of Automatics
AGH University of Science and Technology, Krakow, Poland

Sleep breathing disorders are estimated to be present in 2%-4% of middle-aged adults. Serious adverse consequences such as hypertension, myocardial infarction or cerebrovascular disease may result from breathing disorders. Heart diseases have influence on insomnia or sleep apnea. Moreover, the closure of airways can cause problems with breathing and consequently have impact to the circulatory system. Our research was aimed at finding a correlation between sleep disorders represented by acoustic signals and heart activity parameters. The measurement of breathing through simultaneously acquired acoustic and ECG signals is used to quantify the respiratory obstruction during sleep. It is believed that the dynamic characteristics of this non-invasive technique allows for an inexpensive and accurate analysis of these events. Acoustic analysis provides information about the mechanism, intensity and location of upper airway obstruction. The quality of recorded sound is dependent on many factors: the way of breathing during sleep, sleep stage or body position. Acoustic signal is highly susceptible to external noise interference, therefore determining breathing based on breath rate can be very problematic. We determined the average rate of an epoch (30s) by using autocorrelation method. ECG recordings from number of subjects were used to collect electrocardiogram-derived respiratory (EDR) and heart rate variability (HRV) information. The respiratory signal was calculated using two methods: acoustic analysis and EDR. Comparison of the results indicates that both methods are equivalent in the assessment of breathing during sleep. The information collected by simultaneous recording of acoustic effects and the ECG signal are partially overlapping, giving the opportunity to improve accuracy and partly complementary, allowing for extending of the sleep analysis aspects. Proposed data collection scheme is more convenient and can be performed in ambulatory conditions (at home).