Non-Invasive Sensors Based Human State in Nightlong Sleep Analysis for Home-Care

Magdalena Smolen*, Klaudia Czopek and Piotr Augustyniak

Faculty of Physics and Applied Computer Science, AGH University of Science and Technology, 30 Mickiewicza Ave., 30-059 Krakow, Poland, Krakow, Poland

In this paper we present a non-invasive, easy-to-use and low-cost monitoring system for nightlong human sleep quantification. Our system uses simultaneous measurement of three different signals describing the activity of the human body: infrared video-recorded subject motion, audio-recorded acoustic effects and the three double-leads electrocardiogram. This study is aimed to show how sleep disorders influence a good night sleep. Acoustic characteristics of snoring sounds, which are approximately periodic waves with noise, were analyzed in this paper by using a multidimensional voice program MDVP. The ECG recordings were used to acquire electrocardiogram-derived respiratory (EDR) and the pattern of heart rate variability (HRV). The typical tachogram and its main parameters were calculated: RMSSD, SDANN. The square root of the mean squared differences of successive NN intervals (RMSSD) and the standard deviation of the average NN interval calculated over five minutes periods (SDANN) represented short-time and long-time variability respectively. Quantitative evaluation of the movements activity during nightlong sleep were carried out by means of processing the difference images from the consecutive video frames in respect to the background signal. During these studies several recordings of nightlong sleep were investigated. Characteristic pattern of each of the acquired signals and video frames were analyzed and final conclusions about the state and activity of every investigated patient were presented by setting-up the parameters corresponding to each of the signals. Our study shows the coincidence of respiratory sounds (snoring and breathing) with the subject motion and cardiovascular response. Both the value and frequency of the movements parameter revealed inter-subject motion variability as well as motion variability in time of the same patient. Increasing SDANN and RMSSD parameters are correlated with observed increased snoring sound intensity, which is above 65dB at any snoring event.