Effect of Window Lengths on the Analysis of Cardiorespiratory Synchronization

Lin-Sen Pon*, Chih-Hsiang Tsou, Jong-Chih Chien, Jun-Jih Liang and Tsair Kao

Taipei, Taiwan, Taiwan

The cardiac and respiratory rhythms interact weakly with each other and may exhibit a synchronous behavior in the human body. The mutually coupled relationship is investigated by analyzing the biological electrocardiogram (ECG) and respiration signals. In general, the relationship between these two types of signals is non-stationary, irregular and somewhat chaotic. Consequently, it is hard to use the widely applied Fourier transform or any other stationary processes to analyze the data. Respiration and cardiac rhythm alike are periodical in themselves. Signals of these two physiological systems exhibit similar patterns and the change in individual rhythm may affect on one another. Instead of processing the whole set of data, only certain well-defined events are selected for processing. Comparing the phase variations of the selected signatures between the two signals periods of cardiorespiratory synchronization can be identified. The contiguous R peaks of heartbeat are picked out and the phase difference of two adjacent peaks is set to 2p. The starting points of respiratory signal are used as the zero-phase points and the phases within two continuous signals are linearly interpolated in the range of 2p. This derived phase information is related to the instantaneous radian frequency for each one. By inspecting the existence of R peaks and different respiratory cycles, the cardiorespiratory synchrogram is presented. Gamma evaluation method (? n,m) is used to quantify the strength of cardiorespiratory synchronization. This method processes a selected window length of data and calculates the degree of interaction. The analysis of the synchronization between cardiac and respiratory rhythms is presented and the effects of using different window lengths on ? n,m are discussed. Experimental results and the corresponding cardiorespiratory synchrogram are presented to demonstrate the cardiorespiratory synchronization.