Development of Unconstrained Respiratory- Arrest Detection System for Use during Sleep Based on Lung-thorax Movement Model

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ABSTRACT

To monitor the respiration state during sleep for early detection of sleep apnea syndrome at in the home environment, unconstrained respiration measurement systems have been proposed; and that detect the respiratory arrest by utilizing the amplitude of the respiration signal. However, due to the influence of the sleeping postures to on the amplitude of the signal, the accuracy of respiratory arrest detection could may be decreased. Hence, in this study, we propose a respiratory arrest detection method that is robust against sleeping postures. In the proposed method, we construct a physical model that represents the movement of the lung-thorax system. The model contains tThree parameters that are influenced from the by posture are modeled: athe mass of the whole lung-thorax system, and amplitude and frequency distribution due to movement of each respirationory-related muscle. Based on the model, we propose a signal processing technique to detect respiratory arrest that is robust against the changes in sleeping postures. To reduce the influences from the of postures, the respiration signal measured by using the pneumatic method is normalized. In addition, the wavelet transformation and non-negative matrix factorization are applied to identify the peculiar characteristic frequency band. Finally, we can obtain an index to detect respiratory arrest by applying a threshold manner. We implemented the performed an experiment to verify the proposed method with in five subjects. Each subject is being asked to take four sleeping postures, and perform 20 seconds of respiratory- arrest for three times over a 3-minute measurement period for four different sleeping postures during the measurement time of 3 minutes. As the results of the detection of the respiratory arrest by the proposed method,A sensitivity of 0.86 of sensitivity for detecting respiratory arrest using the proposed method was achieved respectively.

Keywords: frequency distribution; non-negative matrix factorization; respiratory arrest; sleep apnea syndrome; respiratory arrest, frequency distribution; non-negative matrix factorization; wavelet transform