

Abstract

The general process of computerized lung sound analysis either employs inspiration expiration phases or the complete lung sound cycle for respiratory disease detection. The full breath cycle is found more suitable as it encompasses variation in acoustic properties of inspiration-expiration phases. The existing approaches for segregating cycles involve external medical devices or human intervention. Medical tools require controlled environment with expertise that inculcates additional cost, complexity, sometimes difficulty in breathing. Manual labelling is tedious and can lead to perceptual error in cycle demarcation especially for longer duration. Hence, we propose automatic breath sound cycle extraction techniques from lung sound recordings of normal and diseased subjects in single and multichannel scenario.

Our first approach of automatic cycle extraction uses lung sound envelope's spectral information to obtain such frequencies that helps in envelope's lowpass filtering. An intuitive and majority voting approach are utilized to obtain proper smoothed envelope representing the respiratory flow that helps to identify start-end points of the cycles.

Our next approach estimates respiratory frequency using tempo-spectral dominant frequency identification. We propose a feature that employs sub-band based time-averaging of the scalogram representation. Based on its morphological as well as statistical descriptors, the algorithm is devised to identify the specified frequency. Smoothing filters need this frequency to precisely extract lung sound cycles. This can further help to estimate respiratory rate from acoustical breath signal, the most vital sign of patient health status.

To assess suitability of the proposed automatically extracted lung sound cycles in disease identification, we employ a classification framework to distinguish asthma and normal subjects using an artificial neural network based classifier. Sub-band based moments are utilized as features from the power spectral density of each cycle. We compare the performance with manually extracted lung sound cycles. The outcomes of the proposed cycle extraction method and disease classification are found to be comparable in both single and multi-channel scenarios. The multichannel lung sound signal processing helps to improve data interpretation by studying concurrent breathing characteristics and physiological phenomena which is also supported from the obtained results.

Keywords: Lung sound signal, lung sound cycle extraction, envelope extraction, respiratory frequency, time-frequency representation, multichannel lung sound signal.