

Distinguishing between Heart and Lung Sounds in Remote Auscultation of Patients

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Auscultation is an early diagnostic procedure for abnormal sounds such as heart murmurs, lung sounds and gallops. Recently, it has become possible to wirelessly collect such sounds from remote patients using electronic stethoscopes that wirelessly relay the data to remote servers. Due to the inexperience of patients taking their own recordings, not all the data coming from these devices is useful. Therefore the incoming signal needs to be analyzed to extract important heart and lung sounds from the rest of the background noise arising due to stethoscope movements, incorrect positioning or even ambient noise.

In this paper, we describe a method to automatically segment and label heart and lung sounds in such recordings. The algorithm models the incoming signal as a short-time stationary process consisting of various sounds occurring in successive time segments. An overlapping window analysis is performed and evidence of periodicity is checked within each overlapping segment by approximating the sound signal using sound envelopes. Peaks in the auto-correlation function are then used to select candidate segments. A three-way classifier based on multi-class support vector machines was developed in a prior learning stage using samples of known heart, lung and other background sounds as training data. Each candidate segment is then labeled into one of the three classes using this classifier. The labeled segments are then stored as valid recordings of interest in the patients record.

A ground truth database of 675 original sound recordings taken from patients through wireless stethoscopes, was manually segmented by trained professionals into heart, lung and background sound containing regions. Of these recordings, the algorithm correctly identified respective (heart or lung) sounds in 546 cases. The average overlap of time extent with manual identification was 72.8%. The missed cases corresponded to arrhythmia cases and noise deeply intermixed with heart and lung sound recordings.