OVERVIEW ON HEART SOUND REDUCTION FROM MIXED HEART-LUNG SOUND

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Abstract:

This paper deals with performing of lung and heart sound separation based on an objective method, which consists of a mathematical independent component analysis algorithm applied to a preprocessed waveform and spectra of lung sounds recorded with a digital stethoscope. At that point, by executing the Inverse Short Time Fourier Transform (ISTFT), the isolated signs are reconstructed in the time area. The strategy was connected to data of two solid subjects. Examination of the outcomes and in addition subjective assessments show the proficiency of the proposed method regarding Heart Sound (HS) detachment from lung sounds (LS).

Keywords: Heart Sound (HS), Lung Sound (LS), Independent Component Analysis (ICA), Inverse Short Time Fourier Transform (ISTFT).

Introduction

It has been found that while analyzing Lung sound using stethoscope Heart sounds are intermixed with Lung sound. Heart sound interference with lung sound is one of major problem, as actually it affects the potential of lung sound which often effects the proper detection and diagnosis of disease. [1] Heart and lung sounds are physical signals, that can be simultaneously recorded from chest envelop using spectrum recorded using digital stethoscope. Therefore, in order to minimize correlated effect in computer analysis; it is necessary to separate heart sound and lung sound. Generally, sound is described by its intensity, duration, frequency and velocity, and also pitch (Which is different from the frequency) is major factor that could be considered also. On the off chance that the recorded sounds are non-stationary, these systems must be time changing to give germane data. Hence, we have to consider a larger increase in frequency to create an equal supposed change in pitch for frequencies more than 1 KHz in particular. In this investigation we have utilized two
sensors to gather signals from 2 distinct focuses (left and right mid-section) and afterward isolate in the middle of lung and heart signals by means of the detachment ICA Calculation. Before utilizing the ICA calculation, recorded information has been preprocessed with the goal that it was less demanding to partition both signals effectively. Indeed, this preprocessing permits underscoring perceptibility of bioacoustics (lung and heart signals), extricating particular segments in both flags, and extricating suitable data for grouping of lung illnesses. The diverse works managing heart and lung sound partition, consider the mixed recorded signal as boisterous signal what's more, contingent upon what they are managing, they can evacuate lung from heart signal on the off chance that they require heart signal investigation else they expel heart from lung sound signal in the event that they are managing lung signal investigation. In both cases we are searching for an effective denoising calculation that takes advantage with the lung and heart signal properties to effectively. Separate those without losing the measure of data encased in both signs. This assignment is not all that simple since both signs are for the most part meddling and they are non-stationary signs. Additionally, those double flags are emphatically contingent upon signs record conditions. The mix of every one of these certainties expands the multifaceted nature of the required calculation.

A. Heart sounds and lung sounds (ls)

In breath sound recordings, in any case, are debased by meddling quasi-periodic heart sounds (HS), which modify the temporal and spectral qualities of the recording [1]. Components of lung sounds might be sullied by heart sounds on the grounds that lung and heart sounds cover as far as time area and ghastly substance [2]. Heart sounds are obviously perceptible in lung sounds recorded on the front mid-section and might be heard to a lesser degree in lung sounds recorded over back lung projections.

B. Lung Sounds

Breath sounds start in the substantial aviation routes where air speed and turbulence impel vibrations in the aviation route dividers. These vibrations are then transmitted through the lung tissue and thoracic divider to the surface where they might be heard promptly with the guide of a stethoscope. Lung sounds are delivered by vertical and turbulent stream inside of lung aviation routes amid inhalation and exhalation of air. Lung sounds recorded on the mid-section divider speak to produced sound in lung aviation routes as well as the impacts of thoracic tissues and sound sensor attributes on sound transmitted from the lungs to an information securing framework. Lung sounds show a Power Spectral Density
that is broadband with force diminishing as recurrence increments. The logarithm of amplitude and the logarithm of frequency are roughly straightly related in solid subjects gave that the signals don't contain extrinsic sounds increments and a few numerical relations between lung sounds and wind stream have been proposed. Inspiratory and expiratory lung sounds contrast in abundancy and recurrence.

C. Heart sound

Heart sounds are delivered by the stream of blood into and out of the heart and by the development of structures included in the control of this flow [3]. The primary heart sound results when blood is pumped from the heart to whatever remains of the body, amid the last 50% of the cardiovascular cycle, and it is included sounds coming about because of the ascent and discharge weight inside of the left ventricle alongside the expansion in rising aortic weight. After blood leaves the ventricles, the concurrent shutting of the semi lunar valves, which interface the ventricles with the aorta and pneumonic courses, causes the second heart sound.

The electrocardiogram (ECG) speaks to the depolarization and repolarization of heart muscles amid each cardiovascular cycle. Depolarization of ventricular muscles amid ventricular constriction results in three signs known as the Q, R, and S-influxes of the ECG [6]. The main heart sound quickly takes after the QRS complex. In health, the last 30–40% of the interim between progressive R-wave crests contains a period that is drained of first and second heart sounds. Attributes of heart sound signs have been evaluated as far as both force and recurrence. In spite of the fact that crest frequencies of heart sounds have been appeared to be much lower than those of lung sounds, correlations between lung sound recordings gained over the foremost right upper flap containing and barring heart sounds demonstrate that PSD in both cases is maximal underneath 150 Hz

Independent Component Analysis (ICA) Technique

By and large the decision of the most adjusted procedure of signal partition will rely on upon (the examining recurrence, the number of simples, the time term, the recording method, Furthermore, noise conditions). In the accompanying segments we will give a brief prologue to the most fundamental ICA separating calculation, and after that we will list the partition strategy approach utilized as a part of this work.

Ultimately, a few cases recorded from exploratory gathered information are run utilizing the ICA mat lab tool kit and results are examined in area four.
Fundamental Definitions for ICA Procedure

The ICA calculation depends on the Cocktail-Party-Problem; on the off chance that we consider the two source signs, S1 and S2 as said with figure1, speaking to at the same time, heart and lung sounds. The recorded signs x1 and x2 recorded in the privilege and left sensors are connected with the streaming comparisons.

\[ X_1(t) = a_{11} S_1(t) + a_{12} S_2(t) \] (1)

\[ X_2(t) = a_{21} S_1(t) + a_{22} S_2(t) \] (2)

Where \( a_{ij} \) are relationship coefficients, the issue is to get the unique signs out of the recorded ones, yet independently. So we need to recognize unique sources S1 and S2 utilizing just the recorded blended signs x1 and x2. A more rearranged written work of mathematical statements (1) and (2) is:

\[ X = A.S \] (3)

Where A will be a blending network, X is the recorded signs framework furthermore, S, the first stable sources lattice. We have no less than two undertakings, as blending grid is likewise obscure, evaluate either the lattices and S utilizing just the noticeable framework X. For effortlessness, we are additionally expecting that the obscure blending lattice is square, yet this suspicion can be some of the time loose. At that point, subsequent to evaluating the lattice A, we can register it’s opposite, indicated W, and acquire the autonomous segment just by:

\[ S = W X \] (4)

ICA is firmly identified with the technique called blind source partition (BSS) or visually impaired sign division. ICA is an exceptionally utilized strategy for performing blind source partition.

![Figure 1 Mixed recorded original lung and heart signals using digital multichannel stethoscope.](image-url)
Data Acquisition

Two healthy volunteer subjects (one female) matured 25 furthermore, 30 years took an interest in this study. Two piezoelectric contact accelerometers (Siemens EMT25C) were utilized to record the respiratory sounds from the subjects in sitting position. For every recording, the accelerometers were secured with twofold sided sticky tape rings on the taking after areas over the subjects' mid-section: right midclavicular, second intercostals space (R) and left midclavicular region, fourth intercostals space (L). Subjects wore nose cut so as to record their breathing wind stream with a mouthpiece appended to an aligned pneumotachograph (Fleisch no.3) associated with a differential weight transducer (Validyne, CA). The subjects were requested that keep up their objective breathing at 7.5 ml/s/kg (low) stream rate, by checking their breathing on oscilloscope show. This was then rehashed at a medium stream rate of 15 ml/s/kg. The subjects were told to inhale such that full breath happened each a few seconds at each stream rate and had no less than five breaths at every objective stream. The breath sound signs were increased and band pass separated from 50-2500 Hz and digitized at 10240 Hz utilizing 16 bits per test. Wind stream sign was likewise digitized at the same time with lung sounds.

![Figure 2 Signal acquisitions & processing.](image_url)

Implementation of ICA-Based Method

The spectrograms of the signs at every stream rate, $X^*(ω, ts)$, was ascertained by applying the discrete STFT to each 100 ms fragment (1024 specimens) of information utilizing a Hanning window. Following a little cover might prompt a Wrong arrangement [4], the cover between adjoining sections was picked as 85% of the fragment length. Considering the actuality that the recording was on sound subjects, with no extrinsic sounds, for example, crackles and wheezes, the number of sources are thought to be equivalent to two (n=2). At that point ICA-based method was connected to the spectrograms also, the isolated signs were acquired.
Conclusion

In summary, the spectrogram ICA-based strategy could altogether decrease the HS yet not totally scratch off it from the assessed lung sound recordings. The estimated lung sounds also look slightly different from the HS-free observed ones. This is normal since the ICA strategy gauges the recorded source signals; (i.e. for our situation the lung sound before going through the medium of fat tissues also, skin) and these signals are somewhat not quite the same as the recorded ones. In spite of the fact that in this study, the trial was done on information from sound subjects for isolating just two source signals, lung sounds and HS, the proposed strategy has the ability of isolating different unusual sounds, for example, crackles and wheezes from the recorded respiratory sounds from patients. Such data might give novel clinical data for doctors.

References


