

# Methodological Review on Respiratory Sound Analysis

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**ABSTRACT:** The Respiration sound analysis is important identification method for respiratory diseases. The respiration sound analysis using stethoscope is not reliable method as it is depends on human perception. Thus, computer aided system is required for better analysis. In the papers reviewed here mainly frequency based analysis is performed. It provides the detail of frequency component of the respiration sound. And generally used methods for analysis is Fast Fourier Transform, Short Time Fourier Transform and Cepstrum analysis.

**KEYWORDS:** Respiration sound, Signal processing, spectrum analysis.

## I. INTRODUCTION

Respiratory sound is generated due to movement of air through the respiratory tract. Respiratory sound gives information about the respiratory diseases like asthma, pneumonia etc. So analysis of respiration sound gives us the information about the human health conditions. Every respiratory sound has different characteristics and each sound represents the different respiration condition. The Respiration sound is mainly classified into Normal and Abnormal Sound. Normal sounds are vesicular, bronchial and broncho vesicular etc and abnormal sounds are stridor, wheezing ronchi etc. The characteristics of respiration sounds are as mentioned below:

Name	Continues /Discontinuous	Inspiraory/ Expiratory	Duration (ms)/Frequency (Hz)	Associated conditions
Wheezes	Continuous	Inspiratory or Expiratory	Inspiratory or Expiratory	Asthma
Crackles	Discontinuous	Inspiratory	<20 ms 100 to 200 Hz	Pneumonia, congestive heart failure etc..
Stridor	Continuous	Inspiratory	Low frequency wheezes	Epiglottis etc.
Rronchi	Continuous	Expiratory	>100 ms <300Hz	Bronchitis

Table 1. Characteristics of Respiration Sound

Acquisition of sound using microphone and computerize analysis of acquired sound is called electronic auscultation. In recent years there are changing in perception of analog to digital signal processing graphical analysis of respiratory is more accurate and reliable.

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## II. STUDY OF EXISTING METHOD

Respiration sound analysis is mainly divided in to three parts:

### a) Acquisition of Respiratory sound

Respiration sound heard at the different parts of the respiratory tract. Respiration sound acquire from the different places of the respiratory tract such as from nose, trachea and also from the chest. Frequency range is varies from the different acquisition position. Frequency rage is shows that the nasal breathing sound frequency is lies between 50-3000Hz. Lungs sound frequency is lies between 100-1200 Hz. And trachea or upper respiratory tract frequency of sound is lies below 1500 Hz. [3]

Acquisition of respiration sound is performed using various sensors such as Electret condenser microphone, piezoelectric sensor and accelerometer [7]. Electret condenser microphone senses the vibrations and converts that in to the electrical signal for the further analysis. For respiration sound acquisition range of the sensor is lies between 50-2000Hz. This type of sensor acquire respiratory sensor.

Piezoelectric sensor also used for the acquisition of the respiration sound. Piezoelectric sensor converts the one energy form to another energy form. Here the piezoelectric sensor is senses the vibration of the sound from the body and convert it in to the electrical form. Here the vibration converts in to the electrical form for the acquisition of sound.

Accelerometer is rarely used for the acquisition of the signal. In some cases online database is also taken in consideration for the respiration sound analysis.

### b) Signal Pre-processing

For pre-processing of the signal filtration sampling etc. are performed on the signal. In Respiration sound signal pre-processing butter worth filter is mainly used over the frequency range 100 to 1500 Hz. [1] Due to the filtering of the signal noise such as heart sound interference and external sound is removed from the signal. After filtering the signal is sampled at the 6000-8000 samples per second for analysis of signal. Sampled signal is then converted to the frames for the further analysis. [1][2][3] Once the signal pre-processing is completed signal analysis method is implemented.

### c) Signal Analysis Methods

There are various methods for respiration sound analysis has proposed. Among those few methods are as mentioned below:

Signal analysis using Fast Fourier Transform:

Fourier spectra is computed on the signal for the analysis of the signal on the frequency range of 100-1300Hz. Spectrogram analysis gives the information about the frequency range of the various respiration sound. In Fast Fourier transform analysis it gives information about the various sound frequency. So using frequency of particular sound identification is possible.[1][2]

Signal analysis using Short Time Fourier Transform:

Short time Fourier transform performed on the signal on the respiration frequency range it gives the information about frequency as well as time duration of the signal. In this method short time is consider for the analysis and it gives the information of frequency with correlation of the short time period over the signal.

Signal Analysis using Cepstrum:

The cepstrum is technique for finding echo arrival times in a composite signal.[4]Cepstrum is similar methodology as Inverse Fourier Transform. In cepstrum analysis the number of sound sources and time interval of sound sources is accurately calculated. Cepstrum shows a peak when the lung sound contains other sound sources. Cepstrum analysis capture multi-source signal characteristics amount of dieses sources and sound source interval. Cepstrum gives time

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base spectral analysis of sound and sound sources for identification of respiratory sound various respiratory sounds is identified using Cepstrum analysis.[4]

## III. RESULTS AND DISCUSSION

Respiration sound signal acquisition is a challenging task. Signal accuracy is depending on the sensors efficiency of capturing sound. If the sensor efficiency not good no accurate sound is capture. Another problem in acquiring data is external sound interference and heart sound interferences and the method of acquisition.

In the signal pre-processing most challenging is the signal filtration range selection if proper range is not selected then some sound is band pass as it is respiratory sound. Sampling rate of the signal is between 7500-8000 gives better performance in the analysis of the respiration sound signal.

As the characteristics of the respiration sound are determined in both frequency and time domain, respiration sound can be analysed in both domains. Using FFT this method author gets 80% result in identification of respiration sound with online Library data base [1]. FFT based method gives the information only about the frequency range and no time base information get from the FFT analysis. In respiration sound frequency of sounds are overlap each other so in some cases FFT based analysis not accurate.

STFT or time frequency analysis gives both the information on time as well as frequency of the sound. Due to that accuracy of the sound analysis is increases and identification of the sound is easily analyzed. Disadvantage of STFT transform is as for low frequency sounds it gives bad clarity in time domain and good clarity in frequency domain. And for high frequency sound it gives bad clarity in frequency domain and good quality in time domain

Cepstrum analysis accurately captures multisource signal characteristics, amount of the diseases source and sound interval. And comprehensive lung sound is difficult to identify [4].

## IV. FUTURE SCOPE

In the reviewed papers various author has mainly on frequency as well as time based analysis. This provides us detail of every characteristics of the respiration sound. Thus, it leads towards the scope of work in terms of developing reliable sound acquisition system and develop an algorithm which provides time-frequency analysis and as well amplitude and duration of every sound which improves the accuracy and reliability.

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