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Diagnostic Information from Respiratory Sound

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Abstract — pulmonary diseases are major causes of ill-health throughout the world. Pulmonary infection such as acute bronchitis and pneumonia are common. The diagnosis of these diseases is facilitated by pulmonary auscultation using stethoscope which has many limitations such that it depends on individuals own hearing, experience and ability to differentiate between the different sounds [1].The quantitative measurement and permanent record of the diagnosed diseases is difficult. The computerized methods for recording and analysis of the respiratory sounds may overcome some of limitations of auscultation using stethoscope. An analysis of respiratory sounds may quantify the changes in different respiratory acoustic in various diseases. The use of modern digital signal processing technique may lead deep insight to get related diagnostic information [2] [3]. Most of the respiratory sound energy is concentrated in the frequencies below 200 Hz, which overlap with the main frequency components of the heart sounds in 20-100 Hz. An attempt was made to implement an adaptive filtering for suppressing the artefacts in the respiratory sound signals. The respiratory sound signals were recorded with and without breath holding at different time. Adaptive filtering method effectively suppresses the heart sound signal.

Index Terms— Adaptive Filtering, Heart sound signal, Respiratory sound signal, Norman & abnormal Respiratory sound.

1. INTRODUCTION

Stethoscope enabled physicians to listen to respiratory sounds of the patients and detect any symptomatic signs. Modern technology can help physicians even more these days. Breath sound analysis using digital signal processing techniques has recently drawn much attention because of its diagnostic capabilities [3] [4]. The computerized respiratory sound analysis can quantify changes in lung sounds, store records of the measurements made, de-noise the signals of interest from any artifacts and interference. It produces graphical representations of characteristic features of the respiratory sounds to help with the diagnosis and treatment of patients suffering from lung diseases. Since lung sounds have relatively low frequency and low intensity, it is crucial to remove the noise and other interfering sounds (i.e., heart sounds) from the lung sounds prior to any diagnostic analysis.

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2. RESPIRATORY SOUNDS

Respiratory sounds originate in the large airways where air velocity and turbulence induce vibrations in the airway walls. These vibrations are then transmitted through the lung tissue and thoracic wall to the surface where they may be heard readily with the aid of a stethoscope. Respiratory sounds can be classified into two categories, either normal or abnormal (adventitious).

2.1 Normal Breath Sounds: In normal breathing respiration sounds are generated during inspiration and expiration with louder inspiration phase. Respiratory sounds are normally heard over the trachea and larynx [5].

2.2 Abnormal Breath Sounds: These sounds are generated in certain pathological conditions of airways or lungs. Abnormal sounds may resemble a musical wind instrument. Identification of abnormal respiratory sound can be used for the diagnosis of respiratory disorders. Sometimes more than one abnormal sound is simultaneously present. Further diagnosis is needed for separation of these sounds [5].

(1) Wheezing: The sounds are more musical than normal breathing sounds. The typical wheezing sound with frequency components 80 to 1600 is shows Hz. These are produced by fluttering of the airways. Wheezes are produced in patients with obstructive airways diseases such as asthma. [5].***(2) Stridor:*** Stridor are loud wheezes up to 1 kHz which occur due to partial obstruction in the upper respiratory airways (pharynx, larynx) and upper part

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of the trachea due to inflammation of the upper respiratory tract. It usually occurs during inspiration as well as expiration. Due to small supraglotic area stridor is mostly occurs in infants and babies ***(e) Crackles:*** Crackles are discontinuous or explosive sound caused by opening of airway and secretion within airway. Crackles indicate a collapse of the distal airways which rapidly open when air enters the respiratory tract during inspiration. Crackles are also produced when air or fluid enters the lung. Crackles are sign of disease. Crackles are of two types such as fine crackles and coarse crackles.. The fine crackles are of higher frequency compared to coarse crackles. On the other hand the coarse crackles are of less amplitude and longer duration as compared to fine crackles. The crackles are also observed in cardio respiratory disorders. Characteristics of crackles, their timing in respiratory cycle and their waveform are significantly different in respiratory disorder [5]. ***(f) Rhonchi Sounds:*** Rhonchi sounds are continuous and musical sounds similar to wheezes. They usually imply obstruction of a larger airway by secretions ***(g) Pleural Rub:*** In pleural surface inflammation the two pleura, lining the lung cavity, rubs against each other and produces sound called as pleural rub sound. A pleural rub is often accompanied by pain. Pleural rub sound is absent in presence of fluid between the two pleura (pleural effusion). Rubbing of pleura against the pericardial lining is called pleuropericardial rub. [5]

3. METHOD

Adaptive Filtering

There are three main components of the adaptive filter, the input or primary signal, the noise signal (noise artifact) or reference signal and filtered output signal. The combination of respiratory sound signal and heart sound signal along with other physiological sound artifacts forms gross signal which is considered as primary input for adaptive noise cancellation technique. The adaptive filtering method diagrammatically represented in figure 1.

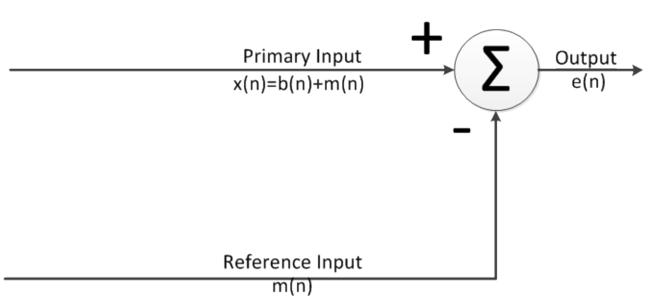

Fig 1 Adaptive filtering Technique [5], x (n) =gross signal, b(n) = breath sounds, m(n) = heart sounds, r(n) = reference heart sounds, e(n) = de noised breath sounds[5].

The heart sound signal acquired from sensor taken as reference input and contaminated respiratory signal being primary input. The output signal which is determined by subtracting reference signal from gross signal [5].

3 EXPERIMENTAL SET-UP

Recordings were taken from ten randomly selected subjects. Respiratory sound analysis instrument was used for recording the respiratory sound signal. A microphone based developed sensor used for recording, the sensor placed on the lower part of the throat for recording of signal with and without breath holding. Two signals was taken one signal with breathing (Respiratory signal) and other is signal without breathing (Noise signal)

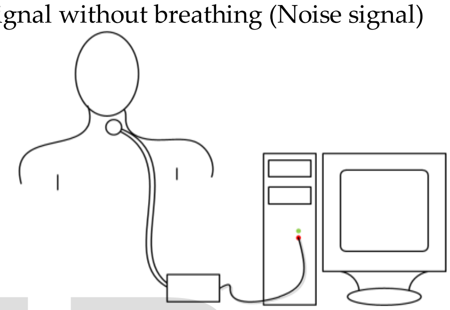

Fig 2 Experimental Setup

4 ALGORITHM IMPLEMENTATION

The respiratory sound signal carried the lung information. The processing and analysis of respiratory sound signal is difficult due the interference of heart sound. The processing of signals was done in MATLAB. Signals were recorded from ten subjects with and without breath holding consecutively. In adaptive filtering the signal recorded with breath holding was subtracted from the signal recorded without breath holding. The noise signal was subtracted from recorded signal without alignment of noise signal is called the processing without tuning and the aligned noise signal subtracted from recorded signal was called processing with tuning.

5 RESULTS AND ANALYSIS

Adaptive filtering

The recorded respiratory sound signal, noise signal and filtered respiratory sound signal shown in the figures 3.

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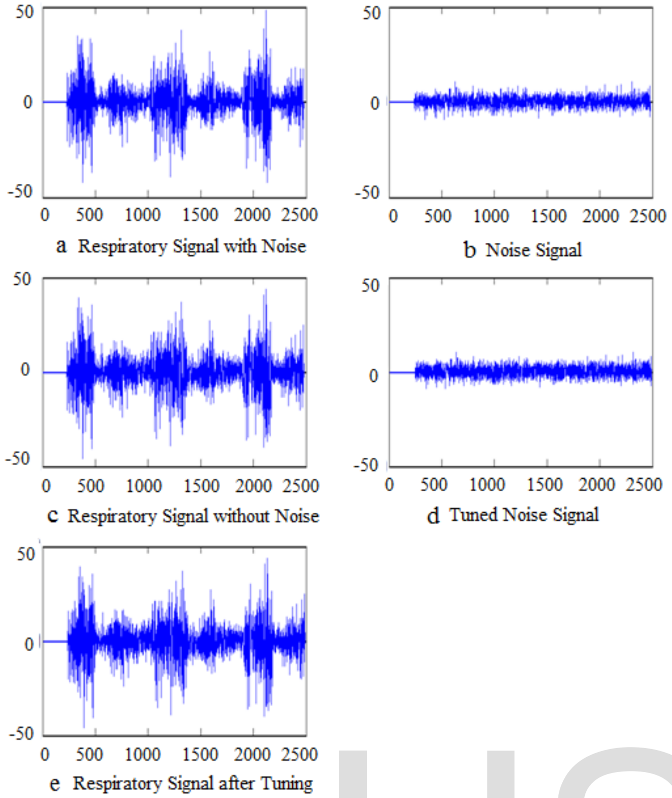
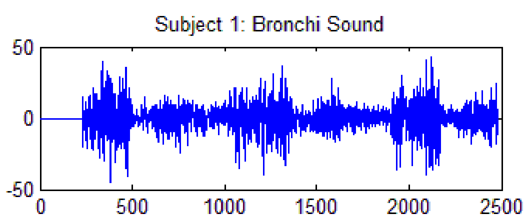
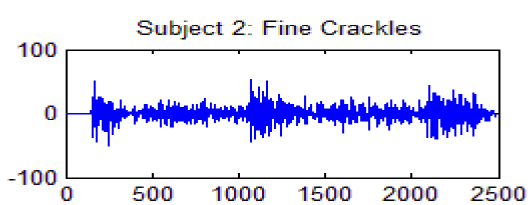
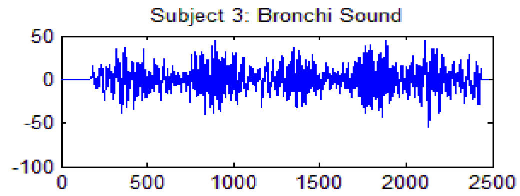


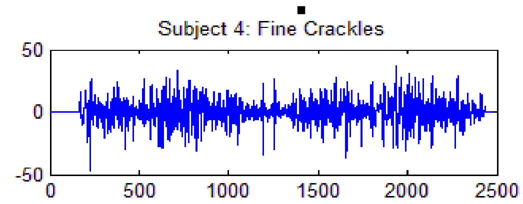
Fig 3 Respiratory sound signals a .Respiratory Signal with Noise b. Noise Signal c. Respiratory Signal without Noise d. Tuned Noise Signal e. Respiratory Signal after Tuning

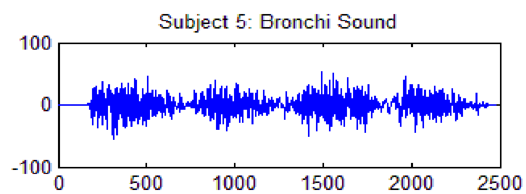
After Adaptive filtering easily identified the different respiratory sound present in the different diseases.

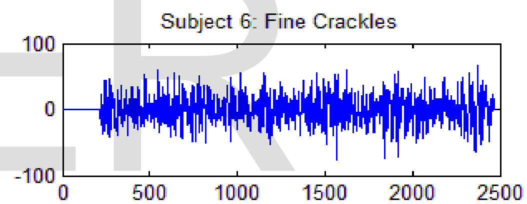


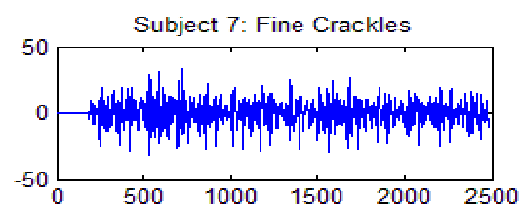


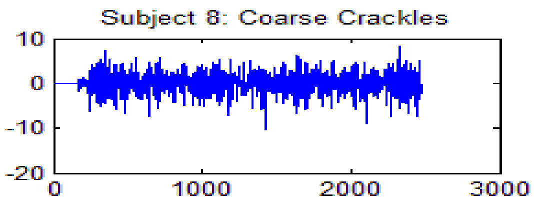


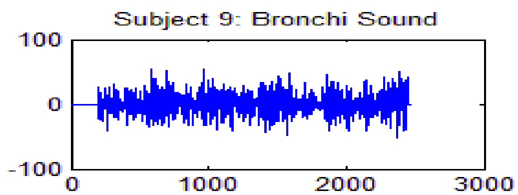


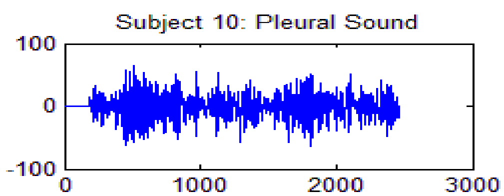












6 CONCLUSION

This paper is devoted to the problem and solution of heart sound cancellation from respiratory sound. The understanding of heart sound cancellation from respiratory sound was explained clearly to the readers, the methods and techniques applicable to be used discussed throughout the paper. It has been proposed a solution for the heart sound cancellation and other harmonics from respiratory sound. The results have been obtained which were required in purpose statement of the paper. Adaptive noise cancellation technique is used because noise i.e. heart sound ranging between 10-100 Hz and most of the respiratory sound signal ranging below 200 Hz. So if filters are used for noise removal from respiratory sound then it also loss the respiratory signal. The adaptive noise cancellation technique application of the algorithm can be implemented due to its simplicity.

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