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Respiratory sound analysis for diagnostic information

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Abstract: *The most important concern in the medical domain is to consider the interpretation of data and perform accurate diagnosis.The bronchitis, pneumonia and many other pulmonary diseases causes respiratory disorders which affects respiratory systems. Diagnosis of these diseases is facilitated by pulmonary auscultation by using stethoscope. This method depends on individuals hearing capability, experience and ability to differentiate the sounds. The quantitative measurement and permanent record of the related parameters is difficult. The recording and analysis of the respiratory sounds may quantify the changes in abnormal respiratory sounds in respiratory disorder. The signal processing techniques may be used for diagnostic information.*

Keywords: *bronchitis, pneumonia, pulmonary auscultation, respiratory sound, respiratory disorder etc*

I. INTRODUCTION

Pulmonary disease is a major cause of ill-health; chronic obstructive pulmonary disease (COPD) and asthma have been estimated to affect the adult population. Pulmonary infections such as acute bronchitis, pneumonia, and interstitial lung disease are increasing. The diagnosis of these common chest diseases is facilitated by pulmonary auscultation using a stethoscope. 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. 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 digital signal processing technique may lead deep insight to get related diagnostic information.

II. Respiratory Sound Signal

(a) 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].

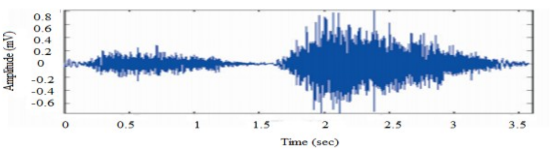


Figure 2.1 Bronchi Sound [5]

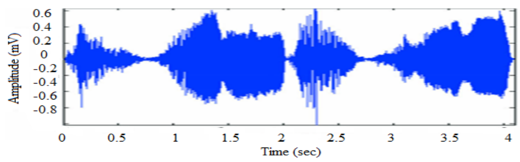


Figure 2.2 Wheeze sounds [5]

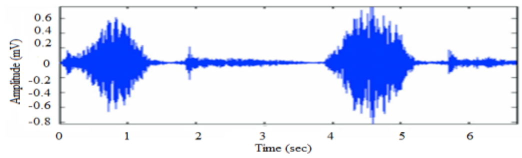


Figure 2.3 Stridor Sounds [5]

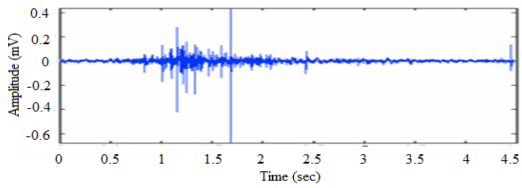


Figure 2.4 Fine Crackles [5]

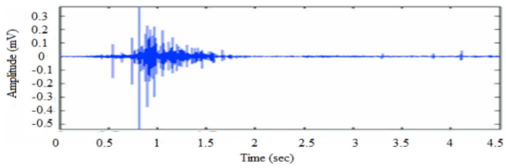


Figure 2.5 Course Crackles [5]

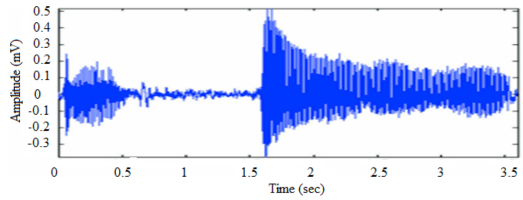


Figure 2.6 Rhonchi Sounds [5]

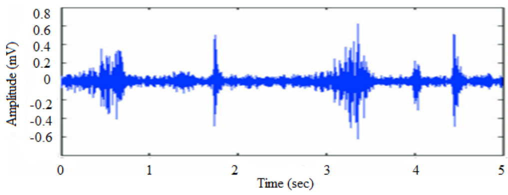


Figure 2.7 Pleural Sounds [5]

(1) Bronchial sound

This sound is similar to the normal breathing heard over large airways; however, if heard over the chest it is considered as an abnormal sound.

(b) Abnormal Breath Sounds

These sounds are generated in certain pathological conditions of the airways or lungs. Abnormal sounds may resemble a musical wind instrument. Identification of abnormal breath sound can assist for diagnosis of respiratory disorder. 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 Hz to 1600 Hz is shows in Fig 2.2. These are produced by fluttering of the airways. The sound begins at a critical airflow called as a flutter velocity Wheezes are produced in patients with obstructive airways diseases such as asthma. [5].

(2) Stridor

Stridor is loud wheezes up to 1 kHz which occur due to partial obstruction in the upper respiratory airways (pharynx, larynx) and upper part 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. The recorded stridor sound is as shown in Fig 2.3. The frequency range of the stridor components up to 1000 Hz [5]

(3) 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 and coarse crackles are as shown in Fig 2.4 & Fig.2.5 respectively. 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. An increased elastic recoil pressure, stiffening of small airways causes abnormal closure of small airway. In chronic airway obstruction crackles are fine, repetitive and occur at end of inspiration. Crackles are from 100 to 2000 Hz or even higher. Characteristics of crackles, their timing in respiratory cycle and their waveform are significantly different in respiratory disorder [5].

(4) Rhonchi Sounds

Rhonchi sounds are continuous and musical sounds similar to wheezes. They usually imply obstruction of airway by secretions. Fig 2.6shows the typical example of rhonchi sound [5]

(5) Pleural Rub

Inpleural surface inflammation the two pleura, lining the lung cavity, rubs against each other and produces sound called as pleural rub sound. A recorded rub sound is as shown in Fig.2.7 [5].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.

III. Method

Respiratory disorder is subjective. The limitation of it can be overcome by using digital signal processing techniques. [3] [4].The quantification and analysis of the noise free respiratory sound signal may be possible for better diagnosis. Localization of abnormal sound may be possible by processing the recorded signal from chest. Many attempts have been done for artifact suppression in respiratory sound signal. In proposed work we have used piezoelectric transducer for signal recording. By putting this transducer on thorax cavity the respiratory signal get recorded.

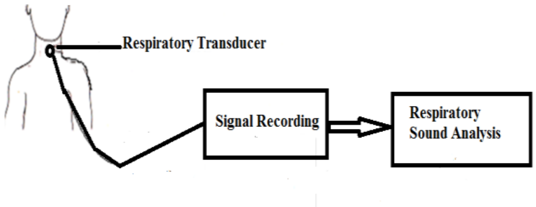
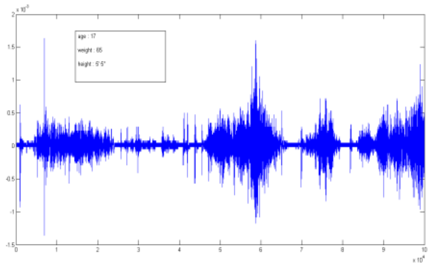


Figure 3.1 Proposed Instrumentation Block Diagram

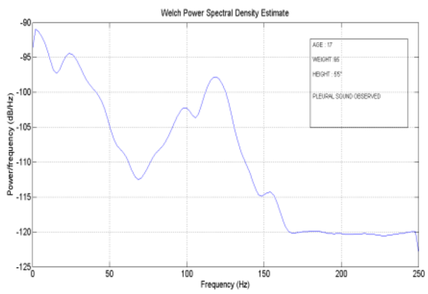
The recording from different age groups, gender, and different medical history subjects the respiration sound signals will be analyzed. At the end in the result we will get the analysis of respiratory sound for different subjects for different medical history and for different physiology analysis and power density spectrum to characterize the respiratory sound signal for diagnosis of respiratory disorder.

IV. Figure And Table

Subject 1

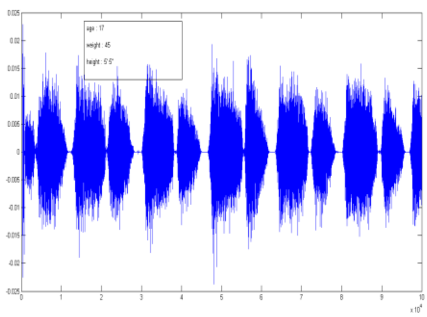


Respiratory sound for subject1

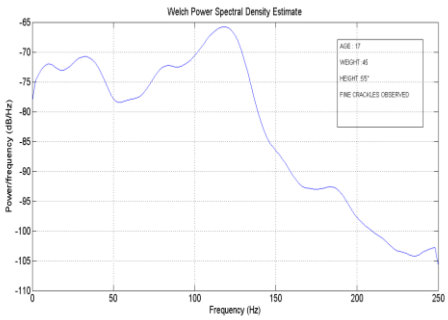


Power spectral density for subject 1

Subject 2

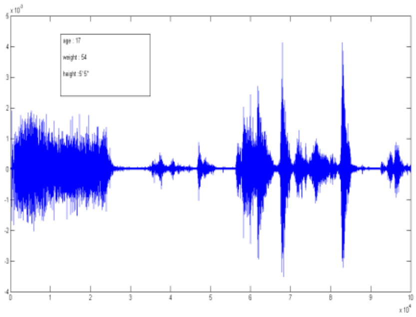


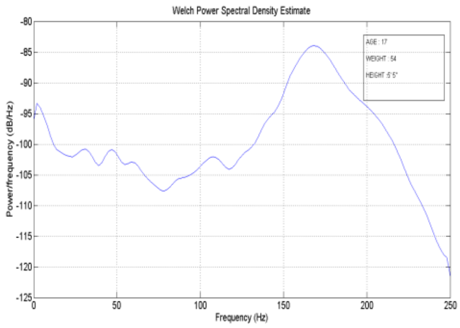
Respiratory sound for subject 2



Power spectral density for subject 2

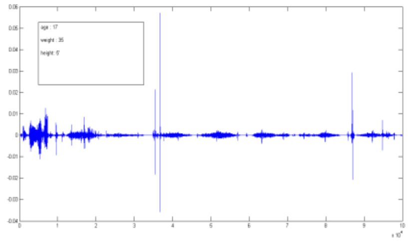
Subject 3

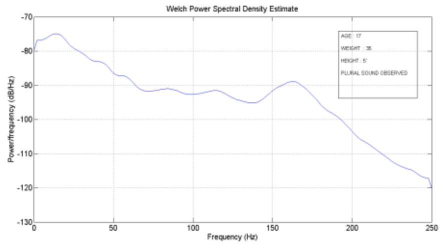




Respiratory sound for subject 3 Power spectral density for subject 3

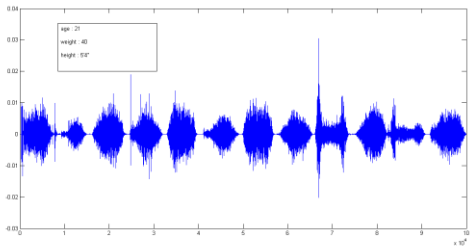
Subject 4

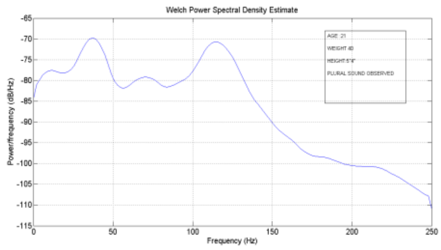




Respiratory sound for subject 4 Power spectral density for subject 4

Subject 5





Respiratory sound for subject 5 Power spectral density for subject 5

Figure 4.1 Respiratory sounds and their power spectrums

Table 4.1 Respiratory sound analysis

Subject no.	AGE	WEIGHT	Medical History	FREQUENCYPEAK
1	17	65	Cough	5 Hz
2	40	63	Pneumonia	120Hz
3	17	54	None	160Hz
4	21	40	Cough	5Hz
5	35	50	Cough	10Hz

Above graphs and table give us the information about each subject respiratory sounds and their power spectral density gives the information about the sounds present.

V. CONCLUSION

The respiration sound changes according to subject weight, medical history for particular subject. As well as this method give us the data for mixture of different respiratory sounds. For normal subject the frequency over power spectral is above 138 Hz. For fine crackle frequency is in the range of 60-138 Hz. For pleural sound the frequency is below 60 Hz of power spectrum. For subject 2 of age 40 weight 63 shows fine crackle sound in their power spectral density. The subject 3 of age 17 weight 54 is normal the frequency range over the power spectrum found above 138 Hz. The remaining subjects shows their frequency over the power spectrum below 60 Hz having pleural sound some them having frequently cough problem.

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