Heart Sounds Segmentation Analysis Using Daubechies Wavelet (db),

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Abstract-This paper discusses the usage of digital signal processing techniques on phonocardiography (PCG) waveforms and presents all the cardiac signals and their dates on the PC. This makes it easy for medical professionals to interpret disorders and make a better diagnosis A segmentation which detects a single cardiac cycle (S1-Systole-S2-Diastole) of Phonocardiogram (PCG) signals using db wavelet family and heart sound is classify in three types Normal (N) Systolic murmur (S) and Diastolic murmur (D). Here we proposed an adaptive sub-level tracking algorithm based on wavelet transform is proposed to separates the S1 and S2 from other components such as murmurs and noises Criteria of time interval, energy and phonocardiogram (PCG) collecting position are used to identify S1 with respect to the beginning of each cardiac cycle.. In this proposed method we use db wavelet family for segmentation of PCG signal and find the best wavelet for this type of complex signals.

Keywords - PCG signal, Wavelet, energy, SNR, Segmentation, MSE. Etc...

1. INTRODUCTION

Heart sound signals carry the physiological and pathological characteristics of the heart. Each heart beat is very complex and short and the main frequency of heart sound signal is found between 10Hz and 250Hz. Phonocardiogram records the heart sounds and noise also and hence heart auscultation examination becomes essential. Usually, heart sounds are weak acoustic signals [1]. The PCG signals are heart sound signals produced by the vibration of the heart sound and thoraxes systems which contain information related to the heart condition. The PCG signals are used in diagnosing various pathological conditions of the heart valves. The signal of normal case includes two distinct activities, the first heart sound s1 and the second heart sound s2; whereas for an abnormal heart, many signal activities between the first and the second heart sound can be seen. These extraneous activities occurring between s1 and s2 are referred as two abnormal sound signals s3 and s4. There are numerous algorithms reported in existing literatures performing PCG segmentation. Some of them are studied and analysed for extracting the heart sound [2-4].

2. PHONOCARDIOGRAPHY – TECHNIQUE

The auscultation of the heart gives the clinician significant information about the functional integrity of the heart. Extended information can be collected if the temporal relationships between the heart sounds and the electrical and mechanical events of the cardiac cycle are compared [5-7]. This analysis of heart sounds using a study of the frequency spectra is known as phonocardiography [8]. The phonocardiogram is a device capable of obtaining heart sounds and displaying the obtained signals in the form of a graph drawn with the signal amplitude versus time. Different components of heart cycle are required to be separated [9]. This relationship is obscure but it can help the physicians to examine the PCG signal and further analysis.

3. CARDIAC SOUNDS

Heart sounds are basically short-lived bursts of vibration energy having transient characteristics which are primarily associated with valvular and ventricular vibrations. The site of origin and their original intensity determine the radiation of the heart sounds to the surface of the chest. There are four basic sounds during the sequence of one complete cardiac cycle [7]. Figure 1 shows the normal heart sound wave for



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4. METHODS

Here we load the normal heart sound signal and plot the waveform .Now load the heart sound and plot the graph Heart sounds is in the frequency range 10 KHz and 250 KHz. Here we apply wavelet transform for heart sound segmentation. The loaded sound decomposed using wavelet in five levels then

calculates the maximum thresholds value then finds the approximate coefficient and details coefficient of heart sound then calculates the parameters SNR, PSNR, NRMSE, value.



Fig-2 flow diagram of Methodologery

A. Lode the heart sound signal

The recorded heart sounds are stored in system for further processing .through USB connectivity the instrument can directly store the heart sound into PC in waveform audio file format [8]. Heart sounds in the format of MP3. MP3 audio format should be converted into recognizable format which can be read by MATLAB before analysis. The data is then denoised by wavelet de-noising method to eliminate the interference to the heart sounds, holding of stethoscope in some undesirable way or hardware itself of the recording system [7].Recorded PCG signal which store in work space. The recorded available data bases are converted into standard from manually.

B. Select the wavelet and level

The discrete WT assumes evaluation of wavelet coefficients for discrete parameters of dilation a = 2m and translation b = k2m, using only the initial (mother) wavelet function W (t) localized at a particular position. Wavelet signal decomposition and reconstruction can be used very efficiently for noise cancelling in many applications. In the case we use certain, possibly modified decomposition levels; it becomes possible to extract signal components only. Using the threshold method introduced in, it is further possible to reject the noise and to enlarge the signal to the noise ratio. Wavelet coefficients are modified using a chosen thresholding level S to determine new coefficients [10]

$$\hat{c}(J, k) = \begin{cases} \text{sign } c(|j, k) (|(j, k) - \delta) \text{ if } |c(j, k)| > \delta \\ 0 \quad \text{if } |c(j, k)| \le \delta \end{cases}$$
(1)

Discrete Wavelet Transform

The CWT is calculated by continuously shifting a continuously scalable function over a signal and calculating the correlation between them. We are clear that these scaled functions will be nowhere near an orthonormal basis and the obtained wavelet coefficients will therefore be highly redundant [2]. To remove this redundancy Discrete Wavelet Transform (DWT) is used. In DWT the scale and translation parameters are chosen such that the resulting wavelet set forms an orthogonal set, the inner product of the separate

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wavelets $s, \tau \psi$ are equal to zero. Discrete wavelets are not continuously scalable and translatable but can only be scaled and translated indiscrete steps. This is achieved by modifying the wavelet representation as[9].

$$\Psi_{j,k}(t) = \frac{1}{\sqrt{s_{0j}}} \Psi\left(\frac{t - k\tau_0 s_{0j}}{s_{0j}}\right)$$
(2)

Here j and k are integers and 0 s >1 is a fixed dilation step and 0 τ depends on the dilation step. The effect of discrediting the wavelet is that the time-scale space is now sampled at discrete intervals. We generally choose 0 s = 2 so that the sampling of the frequency axis corresponds to dyadic sampling. For the translation factor we generally choose 0 τ =1. In that case the Equation becomes

$$\Psi_{j,k}(t) = \frac{1}{\sqrt{2^j}} \Psi\left(\frac{t-k2^j}{2^j}\right) \tag{3}$$

One of the efficient ways to construct the DWT is to iterate a two-channel perfect reconstruction filter bank over the low pass scaling function branch. This approach is also called the Mallet algorithm [10]. DWT theory requires two sets of related functions called scaling function and wavelet function and are given by:

$$\Phi(t) = \sum_{n=0}^{n-1} h[n] \cdot \sqrt{2} \Phi(2t - n)$$
(4)

$$\Psi(t) = \sum_{n=0}^{n-1} g[n] \cdot \sqrt{2} \Phi(2t - n)$$
(5)

The function of φ (t) is called scaling function and ψ (t) is called wavelet function, h[n] is an impulse response of a low pass filter and g[n] is an impulse response of a high pass filter[14].

The spectrum of HSs was divided into sub-bands to extract the discriminating information from normal and abnormal heart sound .Wavelet coefficients were determined by using Daubechies-2 wavelet for the cycles of segmented PCG signals coefficients were obtained for a single cycle of PCG signal and wavelet detail coefficients at second decomposition level were seen to have the distinguishing features as reported in [9] for three cases of PCG signals. The signal formed by the wavelet detail coefficients at the second decomposition level.

Wavelet segmentation experiment

In heart sound signal segmentation on, different wavelet bases produce different effects [12]. Similarly the same wavelet, the effects vary depending on the comparisons in decomposition levels. In this paper, the experiments on commonly-used orthogonal signal. Wavelets in heart sound processing in this paper us using wavelet family and compare the performance of different Db wavelets.

C. Select the time domain or frequency domain

The WT has been used in many knowledge fields, ranging from Communications to Biology [4]. Due to its good performance in the analysis of signals that present non stationary characteristics, they have become a powerful alternative when compared to the traditional Fourier Transform (FT).The classical FT decomposes a signal, in time domain, using a base of orthogonal sinusoidal functions. The WT, by the other hand, presents a decomposition base whose constituents are obtained through expansions, contractions and shifts of a same basic function, called mother wavelet that can be selected according to the analysed signal [3]. For the dyadic case, the mother wavelet must satisfy (I), that correlates it with the so-called scaling function, that must satisfy (2)

$$\Psi(t) = \sqrt{2} \sum_{n=0}^{k} h_1(k) \Phi(2t - k)$$
(6)
$$\Phi(t) = \sqrt{2} \sum_{n=0}^{k} h_0(k) \Phi(2t - k)$$
(7)

Where j, k E z, ho and hl are coefficients associated with the impulsive response of a low-pass and high-pass FIR (Finite Impulse Response) filters, respectively. Thus, the WT can also be performed by a filter-bank tree approach, as illustrated.



aj,k,

Fig. 3: Block diagram of the filter-bank tree. The ho and h, are the impulsive response of the FIR filters and q,i and bj.i the approximation and detail coefficients, respectively.

By the application of the signal throughout a filter-bank, represented by **ho** and **h**,, are obtained the coefficients c+,k and bj,k, that represent the approximation and detail coefficients of the original signal at a level **j** [3]. The signals at the output of the high-pass filters will the called detail signals in the context of the present work

D. Analysis the heart sound signal

For the analysis of heart sound signal it is very important to extract only heart sound. To extract only heart sound we need

In signal-to-noise ratio, or SNR, is a measure of signal strength relative to background noise. The ratio is usually measured in decibels (dB). If the incoming signal strength in microvolt's is Vs, and the noise level, also in microvolt's, is Vn, then the signal-to-noise ratio, S/N, in decibels is given by the formula[15]

$S/N = 20 \log 10(Vs/Vn)$

The PSNR is most commonly used as a measure of quality of reconstruction of lossy compression codes signal in this case is the original data, echo signal noise is the error introduced by compression. When comparing compression codes it is used as an approximation to human perception of reconstruction quality[8].therefore in some cases one reconstruction may appear to be closer to the original than another, even though it has a lower PSNR. One has to be extremely careful with the range of validity of this metric; it is only conclusively valid when it is used to compare results from the same codec and same content [16].

The peak signal to noise ratio is other method of measuring the amount of noise present in a signal. PSNR is defined as the ratio between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation. Because many signals have a very wide dynamic range, PSNR is usually expressed in terms of the logarithmic decibel scale[2-6].

PSNR =10*log10 (N *(x2)) Ediff

to segment the sound like as S1, S2, S3 and S4. To remove the unwanted signal, the heart sound signals there are different segmentation method are available but it is difficult to find the which method is best for segmentation as we know that is PCG signal it is difficult to predict the actual sound is appear in the fixed time duration of signal. The wavelet is best because it use the different thresholding method to detect the desired signal we used soft thresholding method for segmentation it is method which decide the thresholding value according the signal.

6 PARAMETERS

For objectively comparing the de-noising effect of the three methods, signal to noise ratio (SNR), the greater the value the better the de-noising is induced. SNR is defined as: [6].

 $SNR = \frac{power of signal}{power of noise}$

5 RESULT

In order to illustrate performance of the new thresholding function for segmentation, a section of the standard signal are tested by Daubechies wavelet (db), wavelet with specific

Parameters which shown in table1&2. According to the result the value of SNR, &Energy, Compare the both row and column for every types of value and calculate maximum level value and bold the highest value. This well be is plotted in the graph.

level	Normal	Atrial	Aortic	Patent	Pulmon
	heart	septal	insufficie	ductus	a-ry
	sound	defect	ncy	atrocious	stenosis
Wav	(7) db	(7) db	(7) db	(7) db	(7) db
elet					
Db2	60.5788	75.1208	73.7682	66.0805	80.6319
Db3	60.568	74.2763	73.1571	67.3212	80.0527
Db4	60.3229	74.2118	72.9805	67.6048	79.9442
Db5	60.1021	74.1262	72.9614	67.4894	79.9611
Db6	60.2318	74.0449	72.877	67.5076	79.829
Db7	60.1895	74.0591	72.8932	67.4977	79.7709
Db8	60.1698	74.0924	72.9101	67.3945	79.5731
Db9	60.2521	74.029	72.8451	67.3919	79.5889
Db10	60.3073	74.0653	72.8	67.2626	79.686

Table 1- Signal to noise ratio for decomposition value in seven levels

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level Wavelet	Normal heart sound (7) %	Atrial septal defect (7) %	Aortic insufficie ncy (7) %	Patent ductus atrocious (7) %	Pulmon -ary stenosis (7) %
Db2	99.9064	99.9825	99.9795	99.9506	99.9907
Db3	99.9063	99.9806	99.978	99.9575	99.99
Db4	99.9036	99.9805	99.9776	99.9589	99.9899
Db5	99.901	99.9803	99.9775	99.9584	99.9899
Db6	99.9024	99.9801	99.9773	99.9588	99.9898
Db7	99.9019	99.9802	99.9773	99.9591	99.9897
Db8	99.9017	99.9802	99.9773	99.9589	99.9895
Db9	99.9026	99.9801	99.9771	99.9591	99.9895
Db10	99.9031	99.9801	99.977	99.9587	99.9896





Figure 5: Comparison of SNR of different wavelets

From the following figure we calculate the SNR and find the maximum value of SNR for pulmonary stenosis heart sound



From the following figure we calculate the energy and find the maximum value of energy for pulmonary stenosis heart sound.

7 CONCLUSION

The heart sound signal is a representative biological signal of the human body. It is weak, unstable; As a consequence, it is subject to interference from various types of noise. Obtaining accurate heart sound signals, that is, obtaining ideal de-noising effects becomes the basis for non-invasive diagnosis of coronary heart disease. Experiments show that wavelet with seven level decomposition effectively eliminates the various sources of noise in the process of heart sound signal detection. As a result, a comparison of the Daubechies wavelet (db), wavelet has been shown there solution differences among them. It is found that the Daubechies2 wavelet (db2), filter the order of level seven it gives the maximum signal to noise ratio and maximum energy, Daubechies2 wavelet (db2), wavelet gives maximum values of SNR. In the de-noising process of PCG signal we use this Daubechies wavelet (db), and for analyses of PCG signal. From this figure we find that pulmonary stenosis is segmented much more efficiently.

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