Cardiac Sounds Monitoring by Resonant Frequency of the Heart Sound

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This paper describes cardiac sounds monitoring techniques using advanced signal analysing algorithms. Cardiac sounds contain very important information about activities in the heart. In general, doctors analyse cardiac signals by listening to patient's heart sounds using acoustic stethoscopes. However, this technique is one of the oldest and primary ways of observing audio cardiac signals. The resonant frequency of the heart is highly correlated with the structure of the heart. Therefore, this paper investigates the probability of using resonant frequency of the heart for diagnosis of diseases. The cavity of the heart can be modelled using all poles acoustic filter as shown below in formula (1).

$$H(z) = \frac{1}{1-\sum_{k=1}^{p} a_k z^{-k}} \qquad (1)$$

Cavity Filter coefficients were predicted by using linear predictive coding (LPC) method. With the use of conjugate pole pairs in cavity filter it is possible to generate formants frequency components in a heart signal. Formants are the resonant frequencies of the heart signal which is produced due to propagation through the human chest cavity.

There are four different types of cardiac signals that are used for analyses. These are normal cardiac signals and the three different heart murmur sounds. Patent ductus arteriosus (PDA), pulmonic stenosis (PS) and mitral regurgiration (MR) are the murmur sounds which are been used for this research. Three sample signals from each case were analysed.

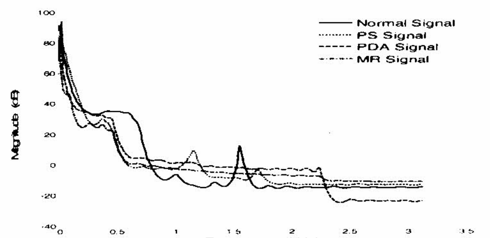

Figure 1.

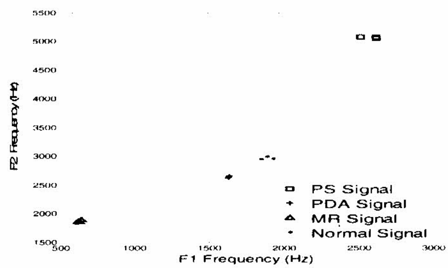

Figure 2.

According to the frequency spectrum graphs, it was revealed that analysed cardiac signal characteristics are different from each other. When spectrum results of each cardiac signal are closely observed, some sudden peaks were noticed. These peaks occurred at the resonating frequencies of the cardiac signals. To further differentiate normal cardiac signals from murmur signals, each signal's first two resonating frequencies were plotted in F1-F2 plane as shown in figure. 2. By plotting multiple realisations of healthy cardiac signal outputs in the F1-F2 domain, it is possible to define a 'general subspace' for healthy cardiac signals. Proper identification of this subspace enables the diagnostician to distinguish between normal and murmur conditions without much ambiguity.