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RESEARCH ARTICLE

Detection of Cardiac Murmur

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Abstract: The project is focused around designing a system that detects the cardiac murmur. So much work has already done in this field and all are efficient but when it comes to cost all of them seems to be costly for a normal people. Thus a system is to be designed that detects the cardiac murmur easily and that is simple to construct and operate. The whole concentration is on accuracy satisfaction and cost of work so that it is easily accessed by anyone anywhere. The designed system takes the cardiac signal and provides it to the sound card and classifies them either normal or cardiac murmur and all the signals are taken in real time.

Background

In this field many studies are done to design system that can detect the cardiac murmur. Murmurs are simple heart sounds that are produced as a result of blood flow. The sounds because of blood flow is generally normal but sometime due to some reasons like narrowing of valves or leaking of valves or abnormal passage certain problems are caused. A computer aided diagnosis algorithm has been designed and implemented on an ultra cyclone II FPGA to detect cardiac murmurs from recorded heart signals, but system is difficult to implement because of use of FPGA board and also it is difficult to interface with computer system. Thus this tends to design a system that can overcome this problem.

Thus the system is designed to achieve the goal of designing a system which can detect cardiac murmur with better accuracy level and ease.

Introduction

Objective

This design project aims to assist physicians in detecting heart murmurs by analyzing cardiac signals in real time during auscultation and reporting any detected abnormalities. Detailed diagnoses of pathologic murmurs often require echocardiogram procedures. Although the procedure is effective, if requires special equipment and trained technicians to captures the necessary images. On the other hand heart murmur can sometimes be detected by a physician using a standard stethoscope during auscultation. This procedure is commonly performed during routine checkups. However, depending on the grade of the murmur, the quality of stethoscope and the training and skill of the physician, it can be difficult for a physician to distinguish a murmur from a normal heartbeat.

The performance of the algorithm is dependent on training and evaluation data sets. Medical diagnostics often suffer lack of data due to patient's confidentiality and limited no of available datasets. Trained physicians and technicians are often needed to generate accurate ground truth annotations. In addition to small data sets, there are several hardware and software constraints related to the implementation of the detection algorithm. The designed algorithm and user interface must be memory-efficient. The computational efficiency is also an important factor. Many features require several matrix operations to be computed on the input data so must be computed relative quickly to reduce the analysis time of the system. Cardiac murmurs can mostly be detected with the help of an ordinary stethoscope but the results are doubtful and the process requires special equipments and specialized trained physician. So there is a requirement of system that can effectively detect cardiac murmurs and can be implemented easily. The system need to be cost effective and work efficient. The murmurs are the pathologic heart sounds that are produced because of turbulent blood flow that is enough to cause audible noise. The pathologic heart sounds that are produced by the disorderly blood flow which is adequate to produce clear noise are known as the cardiac Murmurs. Most of the murmurs are audible with the help of an ordinary stethoscope. Murmurs may be caused by many problems like narrowing of valves, leaking of valves, or existence of abnormal passages all the mode all the way through which blood flow inside or close to the heart. Pathologic murmur should be evaluated by an expert [E.Etchell et al 1997]. Cardiac murmur may also be caused by an overworked or a damaged heart valve. The abnormalities present in the heart valves may be caused by aging process, rheumatic fever, heart attack, or may be present at birth.

The ECG is considered to be the main detection technology used for the analysis of cardiac signal. The technology is very efficient an gives result that are trust worthy and can be implemented. The signals acquired with this technology can be used for different purpose such as for detection of various diseases related to human heart. Besides having so many applications and efficient results the technology is quite costly and can't not be implemented everywhere.

Normal heart sound comprises of S_1 and S_2 (two distinct heart sounds namely the first heart sound and the second heart sound. The first and second heart sounds are the normal lup and dup sound signals respectively. There can be many other signal activities else to and in between the first heart sound and second heart sound in case of an abnormal heart. Any other signal activity between the first cardiac sound and second heart sound (such asS_3, S_4, snaps, clicks, murmurs) are helpful in detecting heart diseases are considered as abnormal.

Murmurs can be classified by seven different characteristics: timing, shape, location, radiation, intensity, pitch and quality. Timing refers to whether the murmur is a systolic or diastolic murmur. Shape refers to the intensity over time; murmurs can be crescendo-decrescendo or crescendo-decrescendo. Location refers to where the heart murmur is usually auscultated best. There are four places on the anterior chest wall to listen for heart murmurs; each of the locations roughly corresponds to a specific part of the heart and should be auscultated with the patient lying supine. The four locations are: Aortic region - the 2nd right intercostal space. Pulmonic region - the 2nd left intercostal spaces. Tricuspid region - the 5th left intercostal space. Mitral region - the 5th left mid-clavicular intercostal space. Additional maneuvers can be performed for additional auscultation:-Left lateral decubitis, With the patient sitting upright, With the patient leaning forward and exhaling. Radiation refers to where the sound of the murmur radiates. The general rule of thumb is that the sound radiates in the direction of the blood flow. Intensity refers to the loudness of the murmur[Atanasov and Taikang Ning Nikolay et al,2008]. A diagnostic system based on artificial neural networks has been implemented as a detector and classifier of heart murmurs. The system enables users to create a classifier that can be trained to detect virtually any desired target set of cardiac sounds. Results are described for a system designed to classify heart sound as normal, aortic stenosis, aortic regurgitation[T.S Leung et al,1991] In an another system the cardiac sound signals were low-pass filtered at 1000 Hz and converted to timescale (analogous to time-frequency) domain using the continuous wavelet transform method. The derived energy values, ex-pressed in decibels (dB), are relative. Data were analyzed using the one-tailed, two-sample unequal variance Student's t-test, with $p < 0.005$ considered significant[W.R. Thompson et al,1993]. Signal processing approach has also been used to isolate systolic heart murmurs based on wavelet transform and an energy index[B. Tovar-Corona et al,1999].This approach demonstrates the isolation of the systole interval and the detection of systolic murmur onset and duration[Nikolay Atanasov and Taikang Ning,2008].

A process has been described in which a signal processing algorithm that utilized wavelet transform and autoregressive modelling to identify heart sounds and to generate clinical features that characterize systolic and diastolic heart murmurs. A wavelet transform (WT) based on the Daubechies wavelet is adopted to facilitate the identification of the first and second heart sounds (S_1 and S_2) and to isolate systole and diastole periods without referring to the ECG waveform. Quantitative descriptors of heart murmur features such as the pitch frequency and configuration (crescendo, decrescendo, or plateau) are derived from either the systole or the diastole period where the murmur resides using a second order autoregressive (AR) whitening filters. A novel method for segmentation of heart sounds (HSs) into single cardiac cycle (S_1-Systole S_2-Diastole) using homo- morphic filtering and K-means clusteringhas been presented. Feature vectors are formed after segmentation by using Daubechies-2 wavelet detail coefficients at the second decomposition level. These feature vectors are then used as input to the neural networks. Grow and Learn (GAL) and Multilayer perceptron-Backpropagation (MLP-BP) neural networks are used for classification of three different HSs (Normal, Systolic murmur and Diastolic murmur). It is observed that the classification performance of GAL was similar to MLP-BP[Curt G. DeGroff et al ,2001]. However, the training and testing times of GAL are lower as compared to MLP- BP. The presents framework can be a potential solution for automatic analysis of HSs that may be implemented in real time for classification of HSs. All these systems are efficient but very difficult to implement and require special training, so we designed a computer aided system for detection of cardiac murmurs which can be easily implemented on a system. In this system a real time cardiac signal is acquired from mitral region of human body using digital stethoscope. The signal is then analysed using the proposed algorithm with a compatible monitor for data visualization and the cardiac signal is finally classified as normal or a cardiac murmur. The approach used in wavelet method demonstrates the isolation of the systole interval and the detection of systolic murmur onset and duration.

Methodology

The procedural steps followed include real time signal acquisition and filtering of the signal, display of the signal waveform, classification of the signal as normal heart signal or a cardiac murmur and the performance metrics calculation.

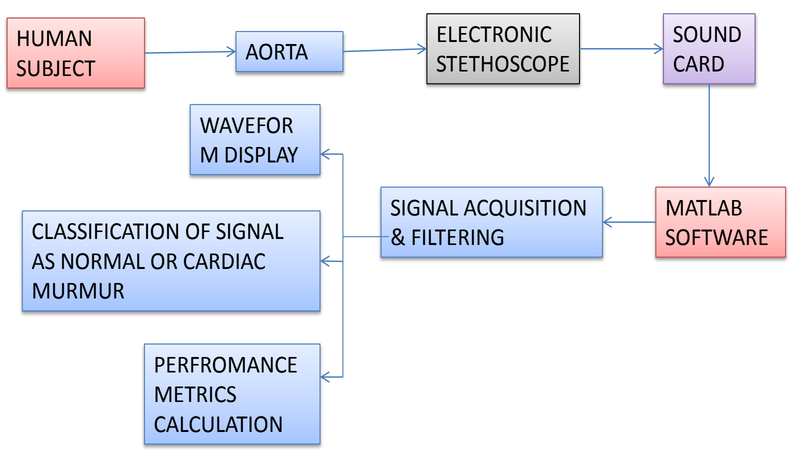
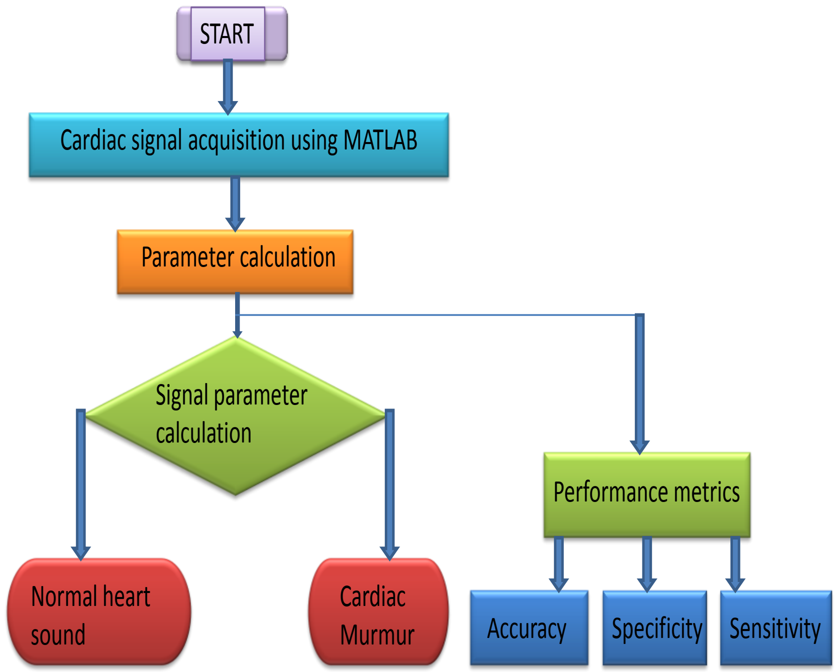


Fig: system design

The flow chart shown in the figure tells the flow of signal from subject to system. the first step is the acquisition of real time data using electronic stethoscope. Hardware is interfaced with the computer and no external interfacing hardware is required for the purpose. The real time cardiac signals are contaminated with external noise, so the signal will required to be filtered before analysis.



Conclusion

A system designed for detection of cardiac murmurs. The signal are acquired from the human body and then fed to sound port of the computer. As the signals are directly fed to the sound port so no external ADC or amplifier is required so the system is cost effective. The system is efficient to acquire real time data using stethoscope and classify the signal as normal or a cardiac murmur depending on signal parameters like RMS value and LER of the signal. The system can be used to assist physician to detect cardiac murmur in an efficient way as ordinary stethoscope can sometime fail to detect a murmur with low intensity. The work efficiency of the designed algorithm is calculated using the performance metrics. The performance metrics include accuracy, sensitivity, and specificity. The designed system is cost effective and efficient.

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