# Multichannel Heart Sound Signal Acquisition And Segmentation

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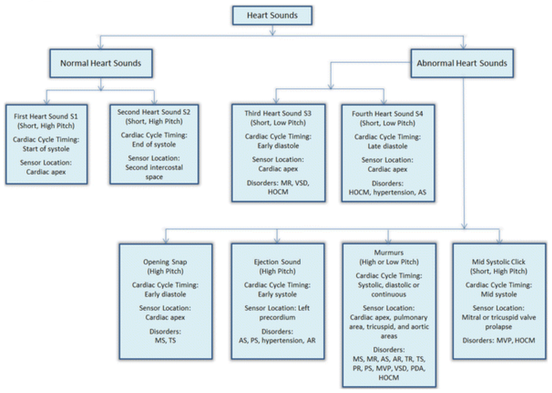
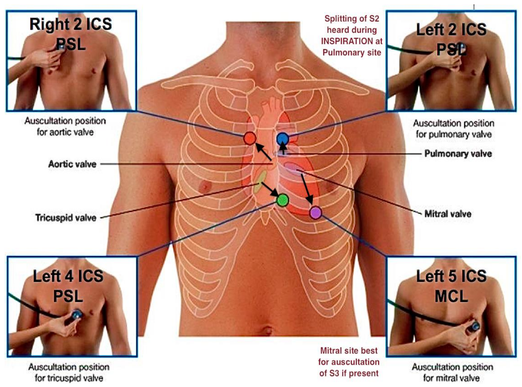
## Abstract

Aim of our project is to developing a multi-channel heart sound signal acquisition system which is beneficial to both researchers and medical professionals as it facilitates easy acquisition and segmentation of patient's heart sounds. This further enables application of state of the art machine learning techniques in real time to better characterize and study the different components of the heart sound obtained.

## Type of Heart Sounds




## Auscultation Areas



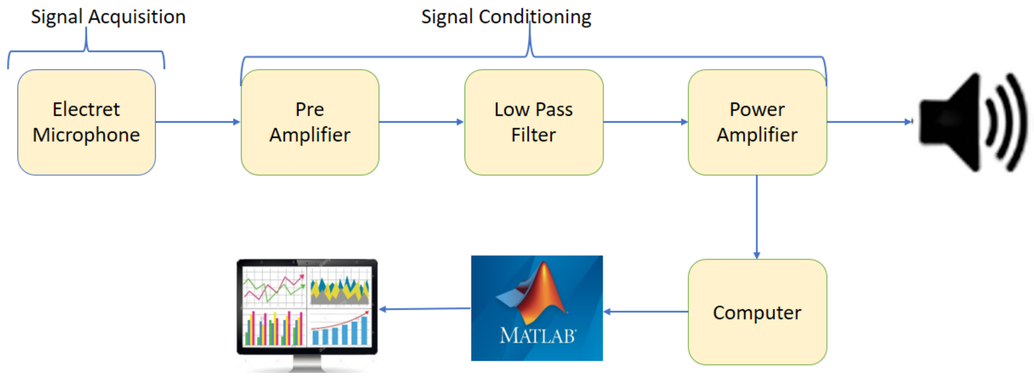

## Implementation

Our circuit consist two main parts. A)Signal Acquisition B)Signal Conditioning

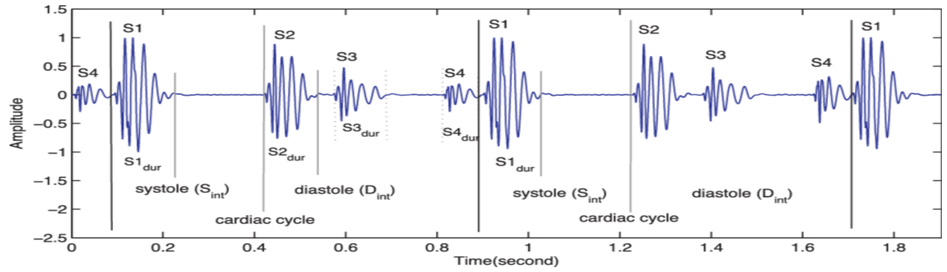
In signal acquisition, we acquire the heart signal from electret microphone, for this we cut the stethoscope, and fit the microphone into it.

Signal conditioning have four parts :- pre-amplifier, Low-pass filter, Voltage Buffer, Audio power amplifier.

- Signal coming from microphone is very weak, so preamplifier does the signal strong enough to be noise tolerant and strong enough for further processing.
- Heart sounds are mostly contained in frequencies less than 80Hz. So, A 4th order low pass filter of cut-off frequency of 90 Hz was used to remove noise frequency components. Two 2nd order Butterworth filters were concatenated to make a 4th order low pass filter.
- Aim of Buffer circuit is to avoid loading of the signal source.
- Audio Power amplifier is required to reproduce low-power heart sounds at a level that is strong enough for driving loudspeakers or headphones.




## Waveform of heart sounds




## Results

We have successfully implemented a two channel heart sound signal acquisition circuit. We clearly observed the S1 and S2 heart sound. After sensing the signal from electret microphone, the pre-amplifier is successfully able to convert the weak electrical signal obtained from transducer into an output signal strong enough to be noise tolerant and strong enough for further processing. Further, the designed 4th order low pass filter, obtained by cascading two 2nd order Butterworth filters, gave a cut-off frequency of roughly 90 Hz which was sufficiently close to the designed value and hence was shown to attenuate unnecessary out of band frequency components. The output from the audio amplifier was fed to a speaker and the heart sound (lub-dub) was heard clearly. Also the output was successfully transferred to a computer system for processing in MATLAB.

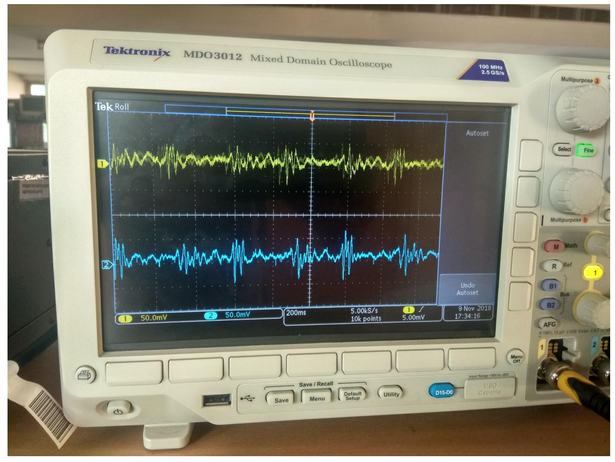
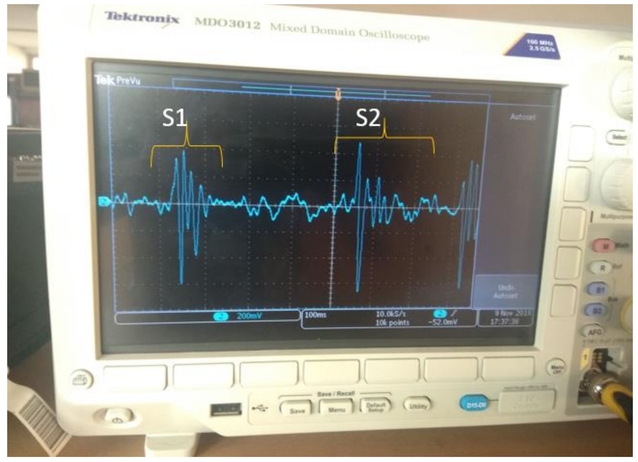



**Figure (a)-Yellow is the output of preamplifier and Blue is the output of 2nd order filter**




**Figure(b)- Output of audio amplifier (acquire the S1 and S2 heart sound)**

## Future Work

- We will implement four channel acquisition circuit which can acquire the signal from four different position of heart sound.
- Given our current work of real time analysis of the discretized heart sound signal obtained, we would next like to look at software level implementation of state-of-the-art machine learning based heart sound anomaly detection algorithms.
- Along the lines of our aim of building a robust product that can be easily used by researchers/ doctors, we would now look to transfer the circuit to a PCB board and use a raspberry pi 3 as the compute system for the software analysis.