# DETECTION OF HEART MURMURS USING PHONOCARDIOGRAPHIC SIGNALS

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## Abstract

*The realization of cardio vascular diseases is low due to which most of the rural people were expired. The early recognisation of heart diseases is done by using phonocardiogram. This paper presents a non invasive technique to estimate the beat-to-beat information, phases and its durations, detection of heart diseases. Phonocardiogram is a representation of heart sounds done by means of ultrasonic transducer probe, LM386L which is the low voltage audio power amplifier and 8 ohms speaker. The real time and cost effective system for the heart auscultation monitoring and detection. During the cardiac cycle the heart normally produces repeatable heart sounds. However, under pathological conditions, such as with heart valves stenosis, ventricular septal defect, blood flow, turbulence may leads to the production of additional sounds called murmurs. These are random in nature, while the underlying heart sounds are being deterministic. The heart sound signal has much more information that can be assessed by the human ear are by visual inspection of the signal tracing as currently practiced. The system designed comprises of a phonocardiographic low voltage audio power amplifier circuit with LM386L and it is consist of an ultrasonic transducer probe which is used to pickup electrical signals into sound signals which is used as input for the circuit. The systolic and diastolic heart sounds are heard in the speaker. The designed circuit board is interfaced with arduino to record the analog values. These analog values are programmed in MATLAB and graphical is shown.*

***Keywords:-****Phonocardiogram, Auscultations, stenosis, Ventricular septal defect, murmurs, Arduino, Matlab*

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## 1. INTRODUCTION

Phonocardiogram is a recording of heart sound made by the hearts which are low frequency sound. These include its valvular events, muscular events, vascular events and acceleration deceleration blood vessels. For the daily leaving activities monitoring of heart rate is the basic parameter. [1] There are conventional methods for cardiovascular measurement through electrocardiogram recording, cardiac output measurement, stroke volume and pulse oximeter. These processes provide accurate result for cardiac rate monitoring however these hardware processes might not easy to access. [2]

Phonocardiogram (PCG) is the common technique is used to monitoring the status of heart valve. This can be recorded by using electronic stethoscope, microphones and probe[9]. Phonocardiogram is electronics equipment which can easily monitor mechanical heart signals with or without direct contact. Phonocardiogram is non stationary signals which are difficult to analyze and process. There are components in phonocardiogram the first and second heart sounds (S1, S2) are called “lub” and “dub” [2]. These are high frequency sounds which are related to closing and opening of AV valves produce S1, closing and opening of semi lunar valve produce S2 sounds. These are commonly heard by stethoscope .Third and fourth sounds (S3, S4) are heart murmurs and noise. The third sound S3 in pathological condition for reduce ventricular compliance is also called as “protodiastolic sound” [3]. The fourth heart sound S4 is caused by blood flow that hits the ventricular wall during the atrial systole causing it to vibrate is also called as “presistolic sound”[10].

## 2. DESCRIPTION

The main objective of this project is to develop a technique for easy initial diagnosis of cardiovascular disorders which can be easily referred, if required. The proposed design consists of chest piece which acts as the ultrasonic transducer .The chest piece pickups the electrical signals into sound signals which acquires heart sounds. The captured signal then is processed to low voltage audio power amplifier by LM386L. The systolic and diastolic heart sounds can be heard by using 8ohms speaker. These audio signals are interfaced with arduino which are programmed to analog values. The arduino is programmed to record the analog values from the speaker. The analog values are plotted in the MATLAB software. The block diagram is as shown in below figure 1.

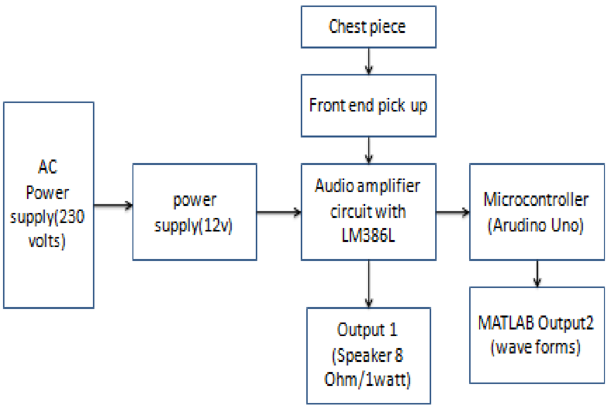


**Fig 1:** Block Diagram [2]

The proposed system provides ease to analyze the cardiovascular measurement in graphical form in different frequencies and amplitudes. The output of chest piece is fed to audio amplifier circuit to provide sufficient gain (46 dB) and hum rejection. Data obtained are converted in to analog form and programmed for graphical display by using software like MATLAB. The audio amplifier circuit is interfaced with arduino i.e. micro controller to obtain analog values. These analog values are plotted in MATLAB. Hence the graphical representations of heart sounds are obtained. [2]

## 3. METHODOLOGY

To determine the phonocardiographic signals the model requires the AC mains which fed to transformer, which steps down to 230volts to 12volts desired voltage. The bridge rectifier helps the transformer thus converting AC voltage into a DC output and through a filtering capacitor feeds directly into input of the voltage regulator. The common pin of the voltage regulator is grounded. The output of the voltage regulator is first filtered by a capacitor and the output is taken [4] [5].

Make the circuit on a general purpose PCB and use a plug to connect the transformer input to AC mains via insulated copper wires. The LED is used with a current limiting resistor in series as indication of power supply working.


**Fig 2:** Power supply board

### 3.1 Chest Piece

An ultrasonic transducer is used as an input for the circuit to pick up the cardiological signals with a frequency response ranging from 15Hz to 15 KHz. The sensitivity of this transducer is -40+2dB to -40-2dB at 1KHz.The clarity and distortion free features are highlighted. The selection of the transducer is based on the heart sounds frequency range and its amplitude and connected to the designed circuit. [3]

### 3.2 Circuit Model

The LM386L is a power amplifier designed for low voltage consumer applications, here the circuit is designed for low voltage audio power amplifier. The internal gain is set to 20 for the external part count low, but the addition of an external resistors and capacitors.LM386L pins 1 and 8 will increase the gain by bypass the 1.35 kΩ resistor, the gain will be up to 200 (46 dB). The inputs are ground referenced while the output automatically biases to one-half the supply voltage. When using the LM386L with higher gains (bypass the 1.35 kΩ resistor between pins 1 and 8) it is necessary to bypass the unused input pins, preventing degradation of gain and possible instabilities. This are done by a 0.1 μF capacitor, a short to ground depending on the dc source resistance on the driven input. [1]

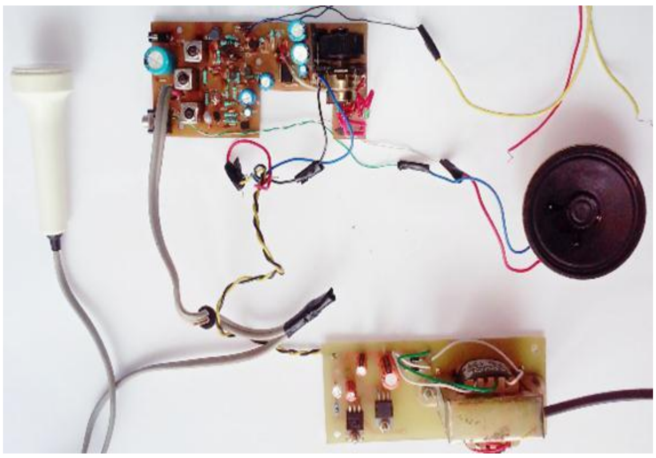

**Fig 3:** Interfacing LM386 L circuit and power supply circuit

**Frequency Tunings:** These tunings help in controlling the circuits broadcasts its signal by sending a particular voltage. These are sensitive to touch. Frequency response is flat in the audible region up to 20 KHz.

**Speaker Regulator:** The circuit uses an 8ohms speaker with a regulator to regulate the volume of the speaker. Output Power0.7000 watts.

**Potentiometer:** A potentiometer is an instrument for measuring the potential (voltage) in a circuit. The 10k potentiometer will give the amplifier from zero to 20**.**

The circuit diagram of the low voltage power amplifier circuit is shown in the figure 1.2.

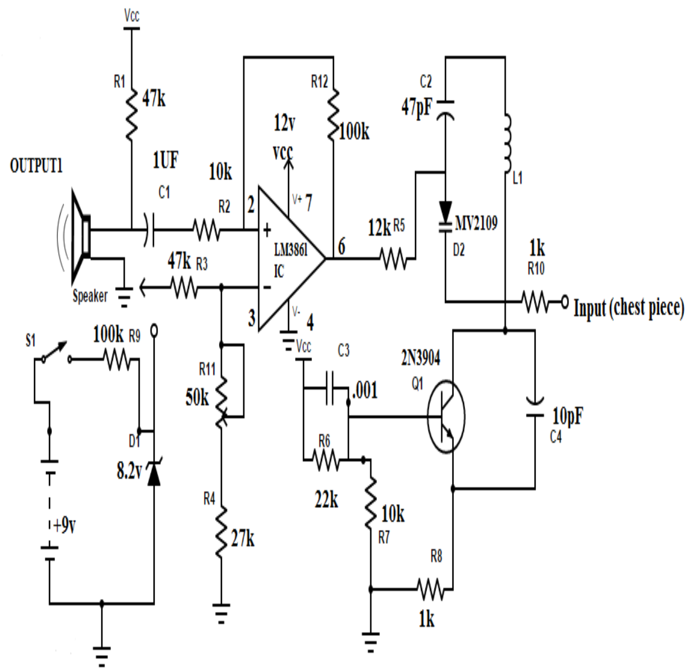


**Fig 4:** Low voltage audio power amplifier

### 3.3 Speaker

A speaker is also called as electro acoustic transducer which converts electrical audio signals into desired sounds. The circuit uses an 8ohms speaker. The speaker consumes a 0.5W power with an impedance of 8ohms.

### 3.4 Arduino Uno

The model used in this paper is arduino Uno which is user friendly and easy to program. The arduino Uno is micro controller based ATMEGA328.It has 14 digital input/output pins of which 6 can be used as PWM output,6 analog pins, USB connection, power jack and a reset button.

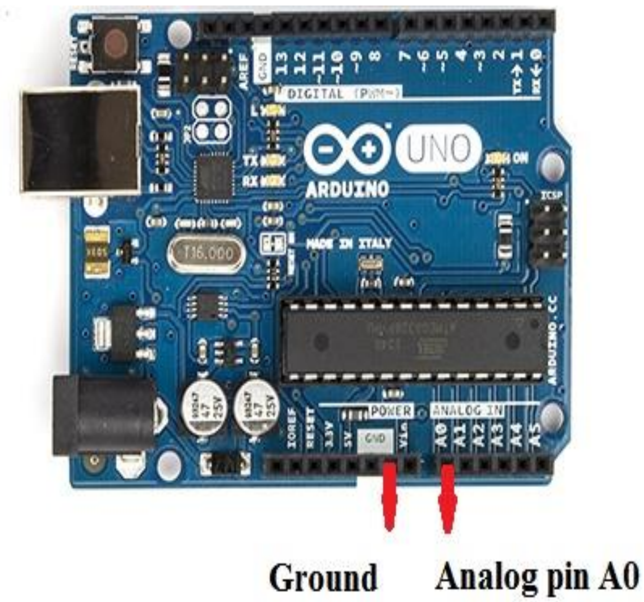


**Fig 5:** Arduino board

From the speaker the connections are connected to ground and analog pin (A0).The program is uploaded in the arduino. The analog values are displayed in the serial monitor. The connection of headphones is given to the socket for the easy evaluation of heart beats.

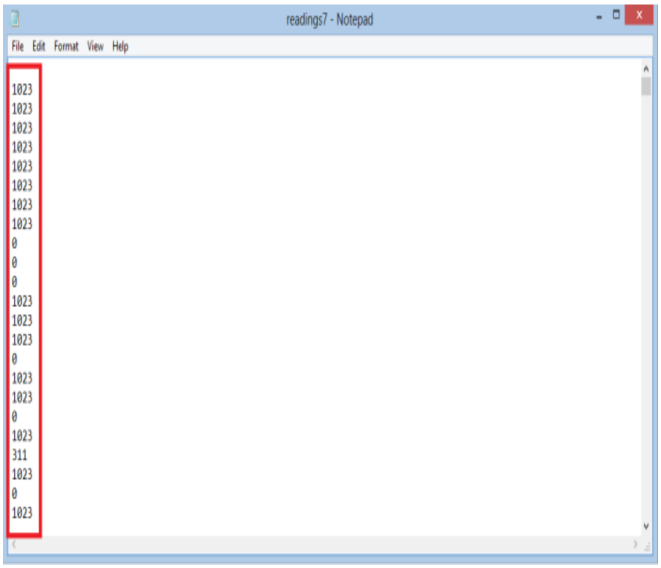


**Fig 6:** Analog values

### 3.5 Heart Rate Normalisation

When we consider ‘fs’ sampling frequency at a normal heart rate (80 beats per minute) then the period is 0.75 second.

If the sampling frequency ‘fs’ is 8000 Hz, one period of 80 beats per minute heart rate then PCG signal must contain 6000 samples (N). [6] [7]Since heart rate of the PCG signal may not be at that rate, one period of the obtained signal (M) may be longer or shorter than 6000 samples.α is the point to define the ratio of the standard length N and the obtained length M are one period of PCG signal, at 80 beats per minute respectively. [6] [9].

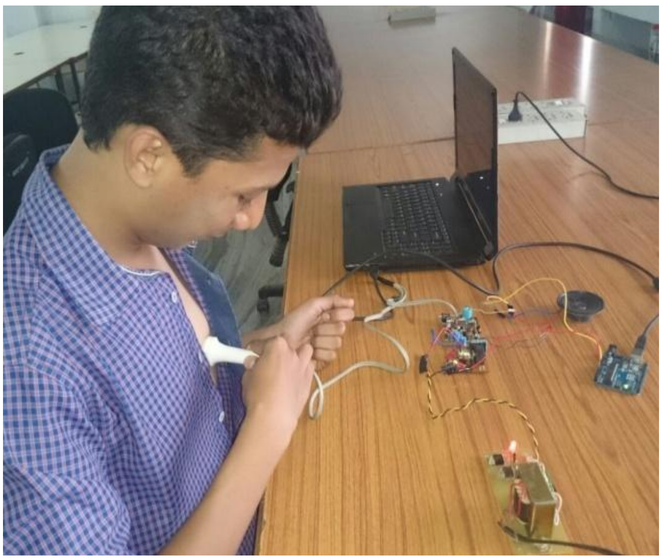

**Fig 7:** Using Designed Circuit Detection Of Heart Sounds

## 4. RESULT

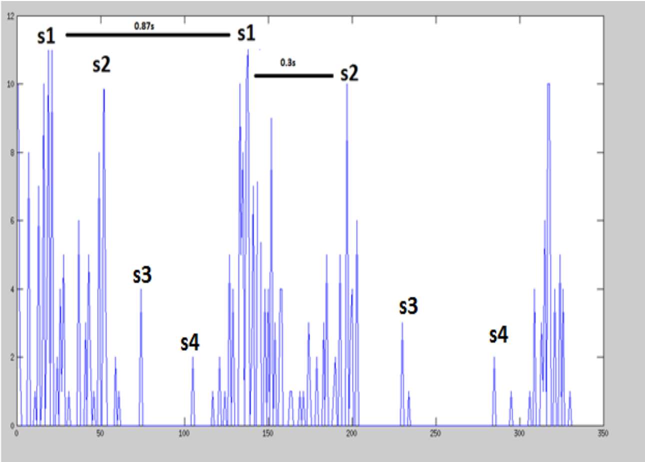


**Fig 8:** Graphical representation of heart sounds.

The setup is used to detect the condition of heart for detecting the systolic and diastolic pressures. The amplitude of the s1 heart sound is approximately 11uV [8], s2 heart sound is approximately 9.8uV, s3 heart sound varies between 3.5uV to 4uV, where as the amplitude of the s4 sounds are lower than s1, s2 and s3 heart sounds. The amplitude of s4 is approximately 1.80uV to 2uV. The time interval is the beginning of the average is about 0•07 seconds for the s1 hear sound that is ‘lub’s2 of the 2nd heart sound that is ‘dub’ the opening snap varies from 0•03 to o•14 seconds. [7] [1] Hence the PCG signal is used to detect the diastolic, systolic heart rates, bradicardia, tachycardia etc. [7] [1]

## 5. CONCLUSION AND FUTURE SCOPE

This design is a unique technique for phonocardiogram setup. These sounds have two segments S1 & S2 these belongs to first and second sounds respectively s1,s2 sounds are recorded using ultrasound transducer probe. Heart samples are collected through ten volunteers as data (i.e. heart sounds) per individual and the wave forms are displayed and screened to assist doctors in diagnosing heart malfunctions accurately this helps in preventing mistakes in diagnoses. The amplitude of theoretical PCG signal is equal to 11µV. [1]When compared to obtained values with the theoretical values of PCG they are approximate (i.e., 11 µV). The frequency obtained from the PCG signals are 30Hz.In future this technique can be used for easy identification of fetal heart sound auscultations further techniques can be used for the development of the fetal heart sounds detection of cattle. The country which depends on the production of cattle can easily detect the healthy fetal heart rate to reduce the death rate of cattle.

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