

# A Non Invasive Method for Monitoring Cardiac Activities

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**Abstract** - Over the past few decades, heart diseases has been increased due to the physical inactivity, diet and stress. Latest survey on cardiac disease in India reveals that there are roughly 30 million heart patients and 2 lakh surgeries are being performed every year. In order to reduce this problem continuous monitoring of cardiac parameters is necessary. Therefore, in this project Electrocardiogram, Seismocardiogram and Heart sound are measured which offers the monitoring of heart failure patients and general population. ECG is acquired through single lead ECG sensor, with the help of accelerometer the micro vibrations are measured and microphone is used to pick up the heart sounds. The Embedded system design methodology enables the monitoring of three parameters and is transmitted through zigbee for continuous monitoring.

**Keywords** - Seismocardiogram, Embedded technology, Zigbee transmission.

## INTRODUCTION

Seismocardiography is based on the accelerometer method which measures the micro vibrations of the heart [1]. Seismocardiogram was first discovered by Bozhenko in 1960s which represents the vibrations of the chest wall due to the pumping of the heart and movement of the heart within the chest [2]. Some already established methods for measuring electrical phenomena of heart are cardiovascular magnetic resonance imaging, echo cardiography are comparatively expensive than SCG. In this project, vibrations of the heart are measured using tri axial (Microelectromechanical system) accelerometer, in which x, y and z axis indicates the lateral, longitudinal and sagittal element respectively. The accelerometer sensor is placed on the sternum of the patient [6].

Electrocardiogram measures the electrical activity of the heart by placing the clip electrodes on right hand (RH), left hand (LH) and left leg (LL). When the cardiac fibres contracts and relaxes, ECG signal is produced. It is used as the most important choice for diagnosing the cardiovascular diseases. ECG waveform comprises of PQRST waves, P represents the atrial contraction, QRS complex represents the ventricular contraction and T represents the ventricular relaxation. The variation in the normal ECG waveform denotes the presence of heart diseases [4]. Heart sounds are noises generated during the pumping action of the heart which is created by the shutting of heart valves. Together with ECG it helps in the proper diagnosis of several heart diseases. In this project heart sounds are extracted with a help of stethoscope.

A study revealed that the combination of SCG and ECG signals enhances the diagnosis in detecting the coronary artery

disease (CAD) compared to ECG alone [3]. SCG records the low frequency vibrations produced by the heart. In order to assess the mechanical activity of the heart the accelerometer based method detects the aortic opening and closure events. This information helps us to know the current status of atria and ventricle to acquire an accurate estimation of cardiac cycle [5].

## II. METHODOLOGY

### A. Overview

The system showed in Fig.1 involves the analysis of three main parameters, among them accelerometer sensor is used to measure the micro vibrations of heart, by placing the electrode over the sternum of the patient. With the help of ECG leads cardiac activity is sensed. The heart sounds are measured through stethoscope which is connected to the microphone. Then the measured parameters are interfaced with PIC microcontroller and are transmitted through zigbee to PC for analysis.

### B. Block Diagram

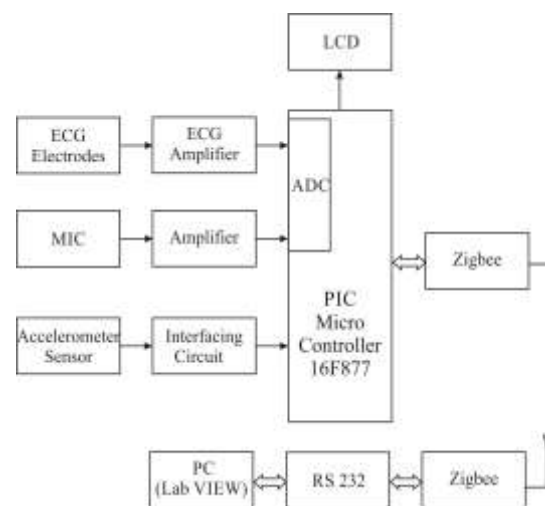


Fig.1 Block Diagram of Cardiac Analysis

### C. Components Description

The MMA7260Q is a low cost capacitive (MEMS) accelerometer which is used to obtain micro vibrations of the heart. The working of MEMS accelerometer is based on the principle of Newton's second law. The capacitive accelerometer senses the output voltage which depends upon the distance between the plates of the capacitor. This method of sensing gives high accuracy and stability.

It is less affected by noise and temperature variations. The supply voltage ranges from -0.3 to 3.6v and its maximum acceleration is  $\pm 2000g$ . This tri-axial accelerometer provides the sleep mode which reduces the current consumption. It has inbuilt single pole switched capacitor filters so that it eliminates the need for external passive components. The ECG is acquired using limb clamp electrodes and the heart sound is obtained through microphone.

The 16F877 PIC microcontroller is a 40 pin reduced instruction set computing (RISC) based microcontroller. It uses small and highly efficient set of instructions compared to other microcontrollers. It comprises of input / output ports (port A-E), master reset, clock pulse and supply pins. It has inbuilt 10bit multi-channel analog to digital converter. It can retrieve its memory even when the power is off due to the FLASH technology. There are three memory blocks program FLASH, data memory, data EPROM with the storage capacity of 8K, 358 bytes and 256 bytes respectively.

Zigbee is used for the transmission of three parameters from the measuring system to personal computer for monitoring. It is a full function device wireless personal area network (WPAN). The rate of transmission is 250 Kbps and it can transmit the data up to 30 meters.

#### D. Software

Laboratory Virtual Instrument Engineering Workbench is a programming language, represented in graphical form. Lab View is incorporated with hardware RS232 for communication purpose. The execution speed of the program is fast and it has less complexity. Embedded C programming language is easy to understand and it reduces the difficulties of the program. It can be moved from one controller to another.

### III. ANALYSIS OF SIGNALS

The three axis of Seismocardiogram will help to analyse the heart activities and the process involved in the system of blood flow. The combined analysis of ECG and SCG acts as an important tool for diagnosing heart disease.

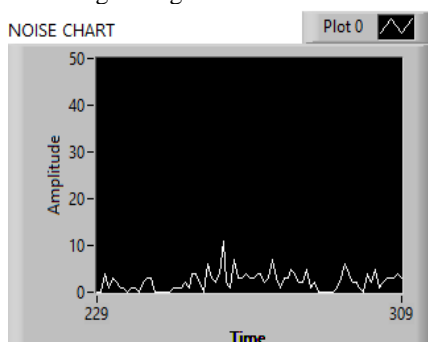


Fig.2 Waveform of Heart sounds

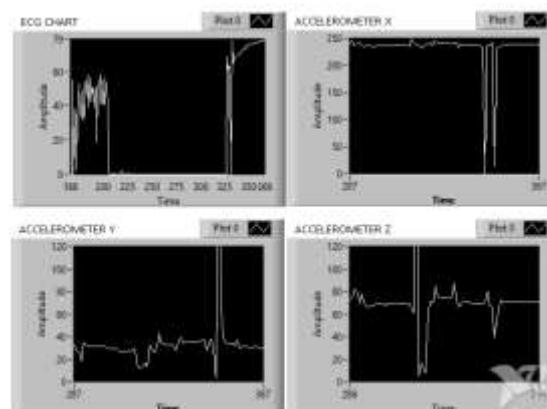


Fig. 3 Waveform of ECG and SCG

The sounds produced by the heart provide information about the motion of valves and pumping of blood. Depending on the number of beats produce per minute, the presence of stenosis or other cardiac diseases can be predicted.

The fig.2 shows the output waveforms of heart sound, fig.3 shows the ECG and SCG of cardiac activity. The x, y and z axis waveforms of accelerometer give cardiac vibrations. The above two figures helps in the analysis of cardiac diseases like Ischemia, Stenosis, etc in heart. It can be analysed by comparing ECG and SCG waveforms.

### IV. LIMITATIONS

The transmission of multiple cardiac parameters through zigbee transmission reduces the accuracy of output. The limitation of the system is the placement of accelerometer sensor in sternum that reduces the comfort for subject. The sensors can be placed on clavicle.

### V. CONCLUSION AND FUTURESCOPE

A low cost non-invasive method for the measurement of SCG, ECG and heart sound is presented. It is a simple way of diagnosing the cardiac diseases. This system enables the continuous monitoring of cardiac parameters through zigbee transmission.

In future, this system can be improved by transmitting the analysed data through Wi-Fi to mobile phones. To make the patient feel comfortable the monitoring system size can be reduced.

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