A Review Based Design and Implementation of Electronic Stethoscope for Heart Sound Analysis

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Abstract - In this present work an attempt is made to design of an electronic stethoscope based on a literature survey done and implemented in two ways hardware and software. The objective is to develop a peripheral interface controller based electronic stethoscope to capture the heart sound. In the proposed work we designed device consist of following hardware component integration: microphone, preamplifier, Butterworth filter, compensating circuit, AVR Atmega-32, power amplifier, speaker, graphic liquid crystal display[128×64]. The captured different heart sound can be sent to personal computer for software simulation analysis using Proteus software. This would be fast and more effective since there is a visual and audio representation to diagnose such cardiologic sound.

***Index Terms*— electronic stethoscope , AVR, liquid crystal display, Proteous software**

I. INTRODUCTION

The stethoscope is an elementary, modest and useful instrument in the area of medicine in diagnosing health problem. It was developed in France in 1816 by Rene Laennic at the Necker – Enfantsmalodes Hospital in Paris. It involves of a wooden tube and was monaural. His device was similar to the common ear trumpet.The first springy, stethoscope of any kind could have been a binaural instrument with expressed links not very openly defined in 1829. In 1840 Golding Bird described a stethoscope, he had been using with a springy tube. Bird was the first to circulate a explanation of such a stethoscope. Bird's stethoscope had an only earpiece. In 1851 Irish physician Arthur Leared created a binaural stethoscope and in 1852 George Cammann perfected the design of the instrument for commercial production which has become the standard ever since. Cammann also wrote a major treatise on diagnosis by auscultation which the refined binaural stethoscope made possible. By 1873, there were explanations of a different stethoscope that could link to some extent different sites to create a small stereo effect, though this did not become a standard instrument in clinical practice. Rappaport and Sprague designed a new stethoscope in the 1940 which became the standard by which other stethoscope are measured, involving of two sides, one of which is used for the respiratory system and the other for the cardiovascular system, in 1999, Richard Deslauries patented the first external noise reducing stethoscope the DRG puretone. In 2004, Philips originated out with an Electronic stethoscope mode [3].

The name stethoscope drives from Greek words Stethos–chest and scope examination. It is an acoustic medical device for auscultation or listening to the internal sounds of a human or animal body. The stethoscope often is considered a symbol of the doctor's profession. It can also be used to check scientific vacuum chambers for leaks and for various other small-scale acoustic monitoring tasks. A stethoscope that increases auscultator sounds is called phonendoscope [1].

Stethoscopes as some other medical instrument have experienced a lot of distinctions and improvements. These improvements have primarily been approved out to assure that doctors and other medical general practitioner do not have any anxiety whatever listening to body sound while observing a patient. In the former level today the most frequently used stethoscope is the acousticones. They drive by the conduction of sound through a chestpiece via air-filled hollow tubes to the doctor or listener's ears. The chest piece of the acoustic stethoscope regularly involves of two sides a diaphragms (which is identical like a plastic disc) and bell (which is identical a hollow cap). The chest piece is located on the patient's chest for attending to the sound of the heart/lung. The bell conveys low frequency sounds whereas the diaphragm conveys greater frequency sounds. The shortcoming of the acoustic stethoscope are that its frequency reaction displays maxima and minima at exact frequency due to tubular resonance special effects its sound level is external low and can be a most important concerns in noisy atmospheres. Electronic stethoscopes are aimed to overcome the disadvantage of the acoustic stethoscopes[9].

II.RELATED WORK

The development of the stethoscope can be traced back to the creation of the nineteenth century when a French physician by the name of Rene Laennec first created the stethoscope in1816. Heart rate monitoring system with wireless transmission using zigbee is defined in [2]. The system contains a bandage size heart beat sensing unit, a wireless communication link, and a networkable computer and a data base. [3] and [4],provides idea about an electronic stethoscopebased on embedded processor and Bluetooth transmission which accomplish the shortages from auscultation. It consists of portable device to play heart sound after pre-processing and amplification. In addition, data can be transmitted to PC through Bluetooth. Design of electronic stethoscope for heart sound is clarified in [9]. The aim of it is to develop a Peripheral Interface Controller based electronic Stethoscope to capture the heart sound. The proposed designed device consists of following hardware stages: electronic stethoscope, Butterworth filter, Compensatory circuit, microcontroller (AVR Atmega-32). The captured data can be directed to hardware for software analysis using PROTEUS. In electronic stethoscope, main part is heart sound discovery which can be studied with the help of

[11]. It consists of heart sound detection system based on the new XH-6 sensor to collect the slight heart sound signals, to show in real-time. [18], presents a new concept of home diagnosis system, which is based on an electronic stethoscope and intelligent analysing software. The system consequently builds a database of patients including their normal S1 and S2; besides a series of heart disease murmurs are also kept as patterns. Data transmission over LAN is described in the paper [19] which proposes a design and implementation of a Web-Based remote digital stethoscope that integrates current software, hardware interface devices, PC, and Internet into the remotely operated virtual instrumentation. There are several commercially available electronic stethoscopes in the market. One of them is the Littmann Electronic Stethoscope Model 3000 manufactured by 3M [7]. Amplification is up to 18 times greater than the best non-electronic stethoscopes. There is one more electronic stethoscope which is commonly used CEI electronic stethoscope model CE-3D21 manufactured by C.E.I Technologies. Amplification is up to 18 times greater than standard acoustic scope and with built-in, 8 level volume controls.

III. HEART SOUND

Acoustic heart sounds are created when the heart muscles open valves to let blood flow from chamber to chamber. A normal heart will create two heart sounds, S1 and S2 as shown in figure 1. S1 symbolizes the start of systole. The sound is generated when the mitral and tricuspid valves close after blood has back from the body and lungs. S1 is primarily composed ofenergy in the 30Hz - 45 Hz range. S2 symbolizes the end of systole and the beginning of diastole. The sound is generated when the aortic and pulmonic valves close as blood exits the heart to the body and lungs which invention with maximum energy in the 50 Hz - 70 Hz range with higher pitch. Typically, heart sounds and murmurs are of relatively low intensity and are band limited to about 100–1000 Hz. Meanwhile, Speech signal is perceptible to the human hearing. Therefore, auscultation with an acoustic stethoscope is quite difficult [9-10].

IV.SYSTEM DESIGN

Hardware Architecture

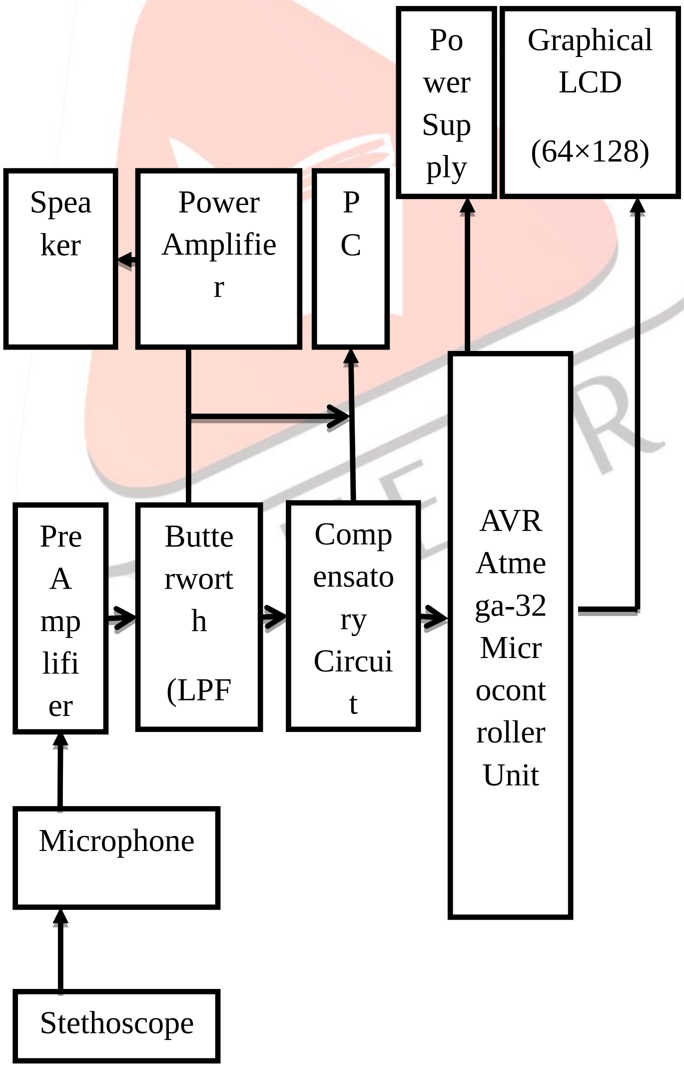


Fig.2. Main Block Diagram of Present Work

Electronic Stethoscope: The electronic stethoscope are designed to overcome the low sound level by electronically amplifying body sounds and the sound is converted into electronic signal and transmitted to the listener by wireless transmission.

Butterworth Filter: In this proposed work we use low pass Butterworth filter. To maintain the gain bandwidth and reduce the noise level.

Compensatory Circuit: With the help of compensatory circuit we shift the signal into positive peak.
Graphical Liquid Crystal Display (64×128):- It consist of 128 horizontal pixel and 64 vertical pixel resolution, parallel 8bit interface and also available in blue backlight with light blue pixels.
Microcontroller (AVR Atmega-32):- The microcontroller used for the purpose is AT89C52 having 8k in-built ROM and 128 bytes on chip RAM.
Microcontroller (AVR Atmega-32):- The microcontroller used for the purpose is ATMEGA having 32k in-built ROM, 1024 bytes on chip RAM and also 512 bytes EPROM. It has also consists of eight channels, 8/10 bit resolution ADC. There are the following features related to AVR Atmega-32 given below: -

- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
- Data retention: 20 years at 85°C/100 years at 25°C8-channel, 10-bit ADC
- 8 Single-ended Channels 7 Differential Channels in TQFP Package Only, 2 Differential Channels with Programmable Gain at 1x, 10x, or 200x
- Byte-oriented Two-wire Serial Interface

For single ended conversion, the result is

$$ADC = \frac{V_{in}.1024}{V_{REF}}$$

Where V_{IN} : is the voltage on the selected input pin
V_{REF}: the selected voltage

Voltage Reference Selections for ADC

REFS1	REFS0	Voltage Reference Selection
0	0	AREF, Internal Vref turned off
0	1	AVCC with external capacitor at AREF pin
1	0	Reserved
1	1	Internal 2.56V Voltage Reference with external capacitor at AREF pin

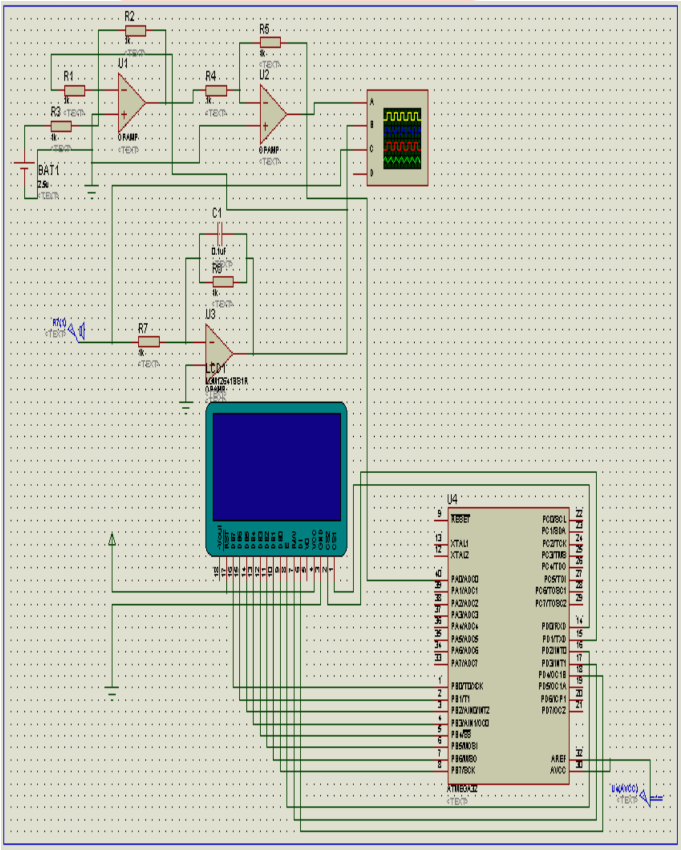


Fig.3. Proteus Simulation Diagram

Proteus Main Circuit Diagram

Firstly we have to identify the human heart sound signal by stethoscope which is a weak signal. Microphone receives this weak signal and microphone act as a transducer. These transducers convert the weak heart sound signal into the electrical signal. Therefore we increased the strength of this heart sound signal by using preamplifier circuit. Then with the help of butter worth low pas filter we maintain the gain, bandwidth and reduced the noise level. After these signal goes to the compensatory circuit, power amplifier circuit and also to portable computer for further analysis. In power amplifier circuit increase the level of signal and final signal goes to the speaker and we get output from the speaker. From the compensatory circuit we shift the signal into positive peaks. After these signals go to the microcontroller and distribute the signal into following different units such as electronic stethoscope and liquid crystal display (LCD).

V. SIMULATION OF DIFFERENT HEART SOUND SIGNAL

The present work is an attempt to make a hardware tool for analysis of heart sound for heart related problem. The four types of PCG signals obtain from net are: -

- Aortic insufficiency.
- Atrial septal defect.
- Coarctation of the aorta.
- Normal heart sound.

In the proposed work we have develop electronic stethoscope whose performance analysis is done in the proteus simulation and actual hardware design and implemented.

In figure shown below are the proteus simulation result observed in the proteus environment window of the personal computer and similarly same analysis is again observed in graphical liquid crystal display. The present work results are explain below into the following steps:-

Fig.4.Proposed Work Hardware Model

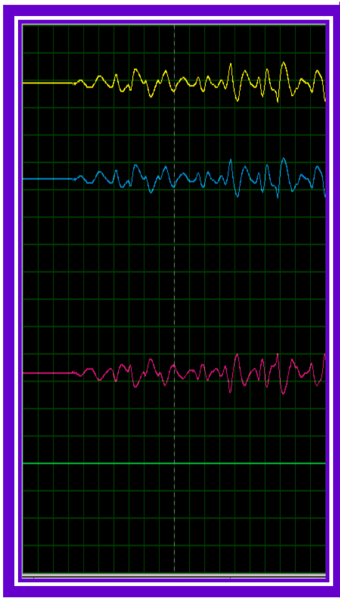


Fig. 5(a) DOS Displaying Aortic Insufficiency HSS

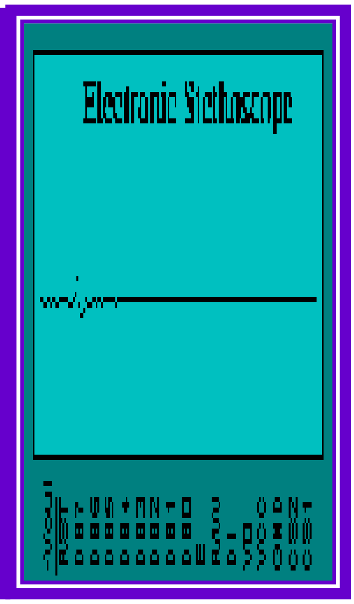


Fig. 5(b) GLCD Displaying Aortic Insufficiency HSS

Step-1 Aortic insufficiency heart sound signal as an input.
Step-2Atrial septal defect heart sound signal as an input.

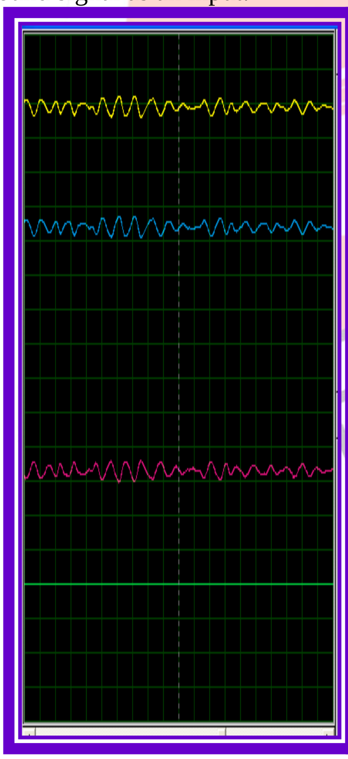
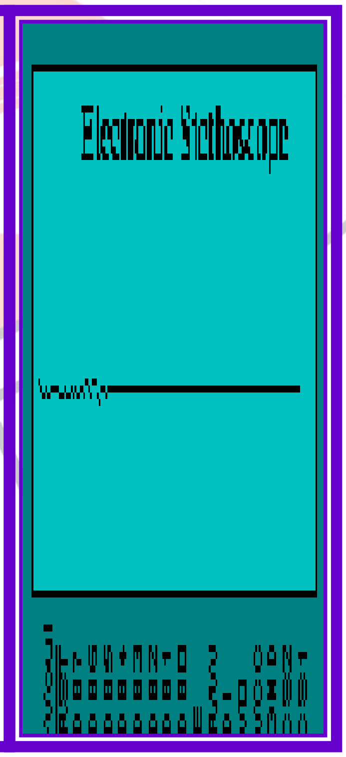


Fig.6 (a) DOS Displaying Atrial Septal Defect HSS



Fg.6(b) GLCD Displaying Atrial Septal Defect HSS

Step-3 Coarctation of the aorta heart sound signal as input.

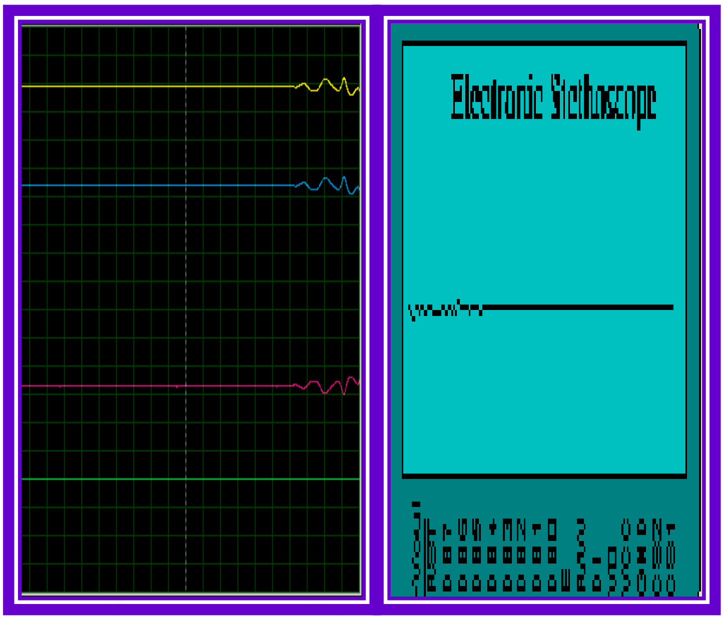


Fig. 7(a) DOS Displaying Coartation of the Aorta HSS

Fig. 7(b) GLCD Displaying Coartation of the Aorta HSS

Step-3Normal Heart sound signal as input.

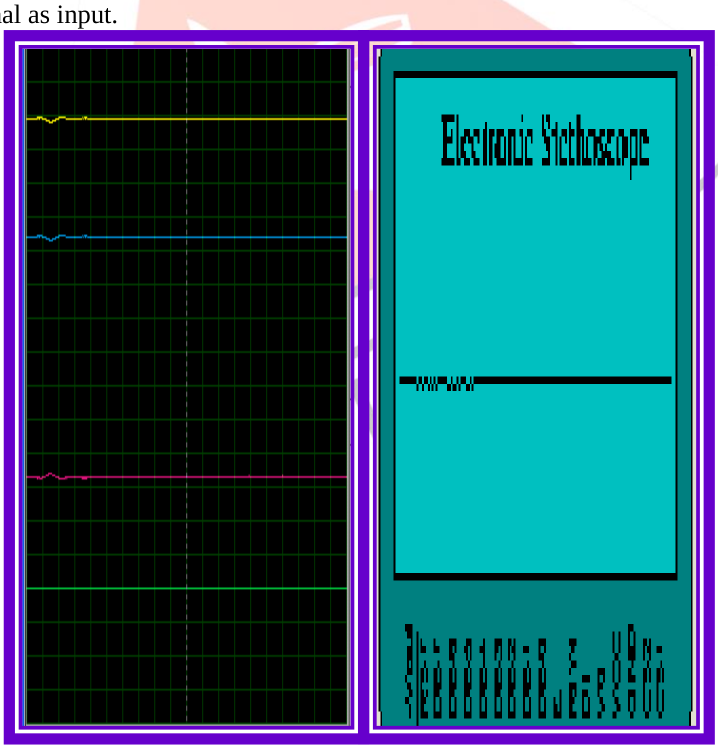


Fig. 8(a) DOS Displaying Normal Heart Sound Signal

Fig.8 (b) GLCD Displaying Normal Heart Sound Signal

CONCLUSION

Electronic stethoscope is a device that detects and investigates the activity of the heart sound. It consist ofprocedures such as to identify the heartbeat signal using a transducer, then to amplify the signal using amplifiers, subsequently the signal produced by the amplifier will be transformed into a digital signal using ADC or microcontroller and it will be finally shown using a display device.However the scope of present work is the amplification part whereby part amplifier is used to amplify the small signal of heartbeat.

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