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HEARTBEAT MONITORING SYSTEM WITH DIGITAL STETHOSCOPE

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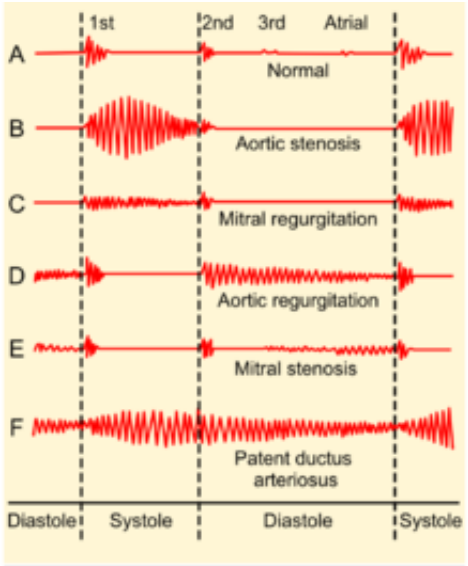
Abstract-*Stethoscope is an essential device for detecting and analyzing heartbeat. For this respect we have developed a device that could show heartbeat graphically on computer as well as in Android Operating System based cell phones. Analyzing the data software would tell Heartbeat per minute, condition of blood circulation, pulmonary condition etc. and prescribe initial steps to do. The device is mainly developed for a user-friendly cardiac monitoring system. Using this, automatic diagnosis of several cardiac and pulmonary diseases would be possible from the analysis of the software. This would also help doctors maintaining regular check-up and release patients from the cost and complexity of diagnosis. This is a cost efficient, user-friendly and reliable biomedical system.*

Keywords: Heartbeat, Stethoscope, Virtual Doctor, Arduino, Matlab, Phonocardiogram

1. INTRODUCTION

Stethoscope is a basic medical tool for analyzing cardiac and pulmonary disease. It works with the heart beat sound. Heart pumps continuously to supply oxygen among the cells and absorption of carbon dioxide by blood. Heart works with a regular electrical signal. This electrical signal relates to the condition of heart, blood pressure and the whole respiratory system. This electric signal creates an equivalent sound signal, called heart beat[1]. Analyzing the sound waves numbers of respiratory diseases could be detected [2], like blood pressure, lung and respiratory diseases like Asthma and chronic obstructive pulmonary disease,emphysema, pneumonia etc.[3-5]. We have plotted the sound wave graphically and shown data of heart beat per minute, the notches, In the circuit, we first taken the sound wave from conventional stethoscope by a condenser microphone. After amplifying and filtering data, it is sent to the microcontroller. As microcontroller we used "Arduino Mega".Via serial communication protocol this amplified data is being sent to Computer. For plotting MATLAB GUI has been used. There is a LCD and keypad in the microcontroller for presetting some conditions before operation started.

Heart Sound: Heart sound is occurred by the mechanical activity of the first sound — mitral valve closure and tricuspid valve closure; second sound — aortic and pulmonary valves closure; third sound — termination of ventricular filling; fourth sound — atria contract Murmurs, which are additional sounds are heard in case of abnormal hearts and are caused either by improper opening of valves, regurgitation or due to a small opening in the septum, by passing the systemic circulation. It lies within a range of 100 Hz-600 Hz.

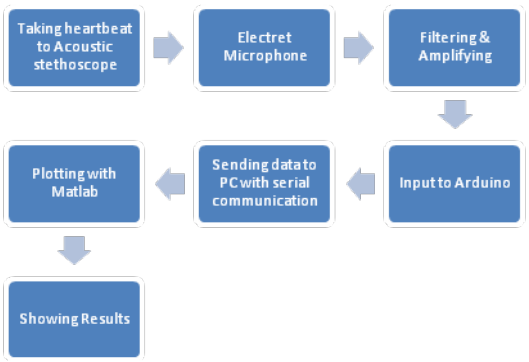


Phonocardiograms from normal and abnormal heart sounds

2. Function Explanation

This is a device integrated with a acoustic stethoscope. It communicates with computer with USB cable. After opening the graphical User Interface (GUI), place the diaphragm on chest and press the switch on device. . Operation of data acquisition will start. Patient will have to breathe quietly during operation. After 20 seconds of reading, software would inform the end of taking data. Then it will show the analyzed results on the screen.

3. BLOCK DIAGRAM



4. SIMULATION

The audio amplifier circuit has been simulated in "Proteus7.7".Figure is given below.

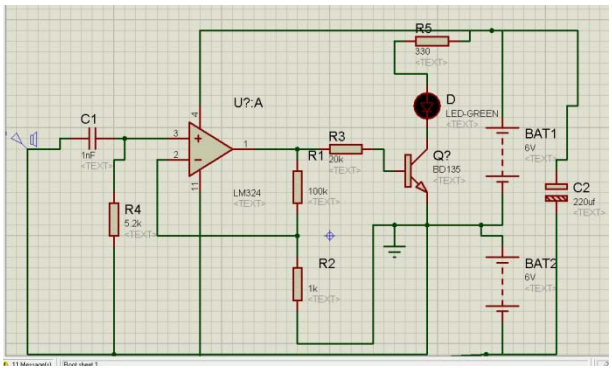


Fig.1: Proteus Simulation of Amplifier Circuit

4.1CIRCUIT DESCRIPTION

Preamplifier Circuit: In this section, some conditions and options are asked by the device on LCD. User does this with input button and keypad. When the start switch is pressed, operation begins.

Amplifier circuit: When sound input reaches to microphone via stethoscope, it is amplified by 100 times in the first stage. The non-inverting amplifier formula for opamp is

$$A_{cl(NI)} = 1 + \frac{R_f}{R_i}$$ ----------(1)

. Here in the circuit the values of resistors are $R_f = 100\ kiloohms$ and $R_i = 1kiloohms$.

This is a first ordersallen key high pass filter.[6] This would pass frequiencies above 100 Hertzs. The centre frequency's equation is,

$$f_c = \frac{1}{2\pi RC}$$ ----------(2)

Therefore the total Gain is 100.Several capacitors had been used to block DC voltages as well as making high pass filters. The Opamp, I used is LM 35 [7].

Microcontroller analysis: Output of the two-staged amplified signal works as an analog input to the analog pin of Arduino[8]. This analog data is sent to Matlab via serial communication protocol. For serial communication, we have used Arduino Serial communication library.

In Arduino, analog value reading, serial communication and external interrupt routine is used.When heart diastoles, it gives a sound of high amplitude, around 3.5 Volt. For each beat it interrupts the program and counts the number of beats. We have taken 20 seconds for Real-time analysis. Multiplying the factor by three, we get heart beat per minute. It shows in the LCD and Software.[9,10]

In Matlab, arduino data is plotted with respect to time. It shows peak to peak amplitude, heart beat per minute. When the analysis ends, it shows the finale output.

4.2 Figures of the analysis

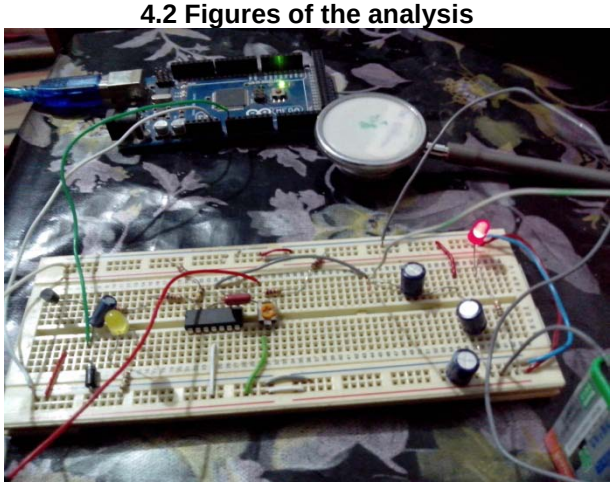


Fig.2: Arduino and Amplifier Circuit

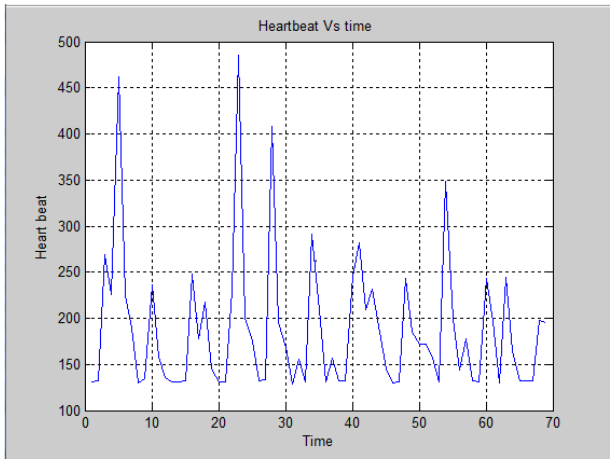


Fig.3: Heartbeat vs. Time

Table 1: A sample data taken from few volunteers is shown

Obs.	Name	Age	Sex	Hb/min (Device)	Hb/min Stetho-scope	Error (%)
1	Akib	21	M	86	82	4.8%
2	Ratul	22	M	80	77	3.8%
3	Rivan	20	M	75	76	1.3%
4	Sharmi	21	F	78	80	2.5%

5. RESULT & DISCUSSION

The sample data shown in Table 1 is got with the help of local volunteers and doctor. The result is almost accurate with the doctor's examined result. As there are numerous noises present in the signal, difference occurred from the doctor's data. The noise may be cancelled by digital filtering and instrumentation

amplifier [12].

6. FUTURE WORKS

In the recent future, we will make an online database of collected data. Data will be uploaded on a host website in the process of real time to the individual account of a patient. Appointed doctor would have access to his/her patient's account. Patient could find doctors from the website of relevant disease. In this paper, it is discussed about only a medical kit. Several devices will be added in total system as a full online based Medicare system.

7. REFERENCES

[1] https://www.cardiosmart.org/Heart-Basics/How-the-Heart-Work

[2] http://www.egeneralmedical.com/listohearmur.html

[3] *The breath sound analysis for diseases diagnosis and stress measurement*, System Engineering and Technology (ICSET), 2012 International Conference on , 11-12 Sept. 2012,Print IsBN 978-1-4673-2375-8

[4] ROBERT J. ADOLPH, JOHN F. STEPHENS and KUMEO TANAKA,*The Clinical Value of Frequency Analysis of the First Heart Sound in Myocardial Infraction,http://circ.ahajournals.org/content/41/6/1003*

[5] S.M. DEBBAL, F.BEREKSI-REGUIG,*Frequency analysis of the heartbeat sounds,Biomedical Soft Computing and Human Sciences*, Vol.13, No.1, pp.85-90 (2008)

[6] Thomas L. Floyd, *Electronic Devices*, Seventh Edition, Page 498.

[7] LM324 datasheet,www.datasheetcatalog.com

[8] www.arduino.cc

[9] http://people.ece.cornell.edu/land/courses/ece4760/FinalProjects/s2012/myw9_gdd9/myw9_gdd9/

[10] Lectures of Bruce Land On Biomedical Engineering, https://www.youtube.com/playlist?list=PLKcjQ_UFkrd7zbPHRkDpB7i113wDG_Rb3

[11] http://www.mathworks.com/matlabcentral/answers/11273

[12] Biomedical Instrumentation And Measurements (2nd Edition) byLeslie Cromwell, Fred J. Weibel, Erich A. Pfeiffer, Page,169.

8. NOMENCLATURE

Symbol	Meaning	Unit
V	Voltage	(V)
I	Current	(A)
R	Resistance	(Ω)