Designing of Wireless Electronic Stethoscope

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***Abstract—** Taking into consideration the effect of the COVID 19 pandemic we have come up with the idea of the wireless stethoscope which will help not only doctors but also patients to follow the social distancing norms. It can also report patient metrics from the comfort of the patient's house, while remote teams act as a counselor as they engage patients in their journey toward health. Doctors can auscultate remotely, which will help the doctor to monitor the patient's health from a remote location as well as in COVID ICU without having to compromise on PPE kits. So come up with the idea of the wireless stethoscope in which doctors and patients can arrange a virtual appointment and the doctor could guide the patient depending on the patient's symptoms and how he wants to check him. As patients do that the data will be sent to the doctors and will get stored for future references. The project's conclusion will indicate that due to the non-complexity of the system, a non-medical profession can use this electronic stethoscope without any difficulty.*

Index Terms— heart sounds, monitoring system, remote auscultation, virtual appointment, wireless stethoscope

I. INTRODUCTION

The stethoscope is a medical device used to listen to sounds in the human body, this process is called as auscultation in medical language. The pounding of the heart and the flow of blood during circulation in it produce cardiac sounds.

We've recently noticed a surge in the use of smartphones by both healthcare professionals and the general population. In this day and age of digitalization ,the way sounds related to the heart are auscultated will alter with the introduction of an electronic stethoscope that works digitally. The examined results will be displayed on the screen, as well as saved for future reference.

"Computer aided auscultation" was coined with the introduction of the electronic stethoscope.

With recent advances in acoustic sensor design, improved digital signal processing, and computer-based machine learning approaches, acoustic-based automatic detection of heart disease using an electronic stethoscope has gotten a lotof attention [2].

In a global epidemic like Covid-19, it's critical to know how patients' lungs are doing. As a result, patients, specially the elderly and pregnant women, do not need to drive large distances for an appointment and may speak directly with the doctor about their worries. We've come up with the notion of a wireless stethoscope in which doctors and patients may plan a virtual appointment and the doctor can advise the patient depending on the patient's symptoms how he wants to check him. Patients' data will be sent to clinicians and preserved for future reference when they provide it.

II. PROCEDURE

Fig. 1 shows the block diagram of the complete system for hardware implementation.

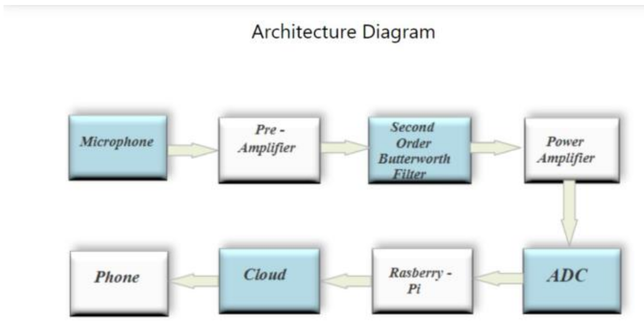

Figure 1. Block DiagramEXPLANATION IN DETAIL:

The suggested system is depicted in detail in the diagram above.

1]The heartbeats are recorded using the microphone.

2]The microphone's output is then delivered to the circuit of a preamplifier

3]It is then passed on to a Butterworth Low Pass Filter of second order, which cancels out all frequencies above 1KHz.

4]The output of LPF is sent to the power amplifier, which then sends it to the ADC chip.

5]The ADC chip will provide input to the Raspberry Pi, and python code will be created on the Raspberry Pi to plot the audio.wav file.

6]The website was built in order to transmit our information to the doctors.

A. Condenser Microphone:

Condenser Microphone acts as a sensor to detect and acquire the heart and lung sounds. Sound produced by heart cannot be heard by human hearing. As a result, a medium isrequired to obtain the signal.

Figure 2. Condenser Microphone

B. Pre amplifier circuit :

Preamplifier is used to amplify the signal before giving it asan input to LPF. Simulation of preamplifier is done using LTspice software.

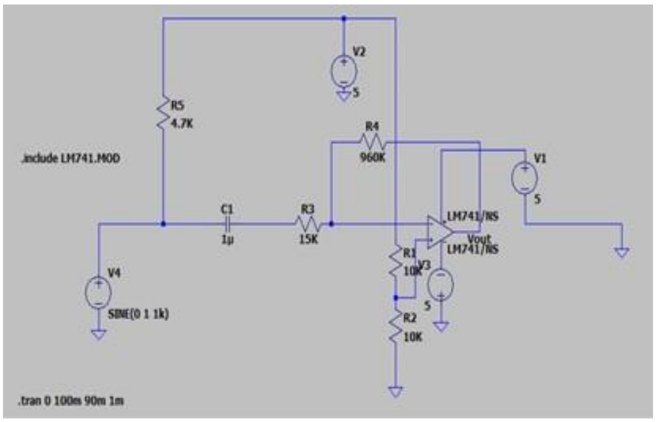

Figure 3. Preamplifier circuit

C. Second order butterworth low pass filter :

Second order Butterworth low pass filter is used to Cut-offall the frequencies above 1,000 Hz.

Clinically important Heart and lungs sound : 20 -1,000Hz So we have designed our LPF which will cutoff all the frequencies above 1,000KHz.

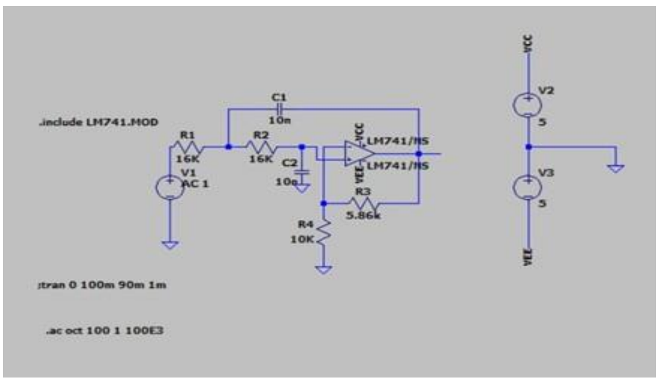

Figure 4. Second order Butterworth low pass filter

D. Power amplifier :

Power amplifier is used to amplify the output of LPF before sending it to raspberry pi via ADC

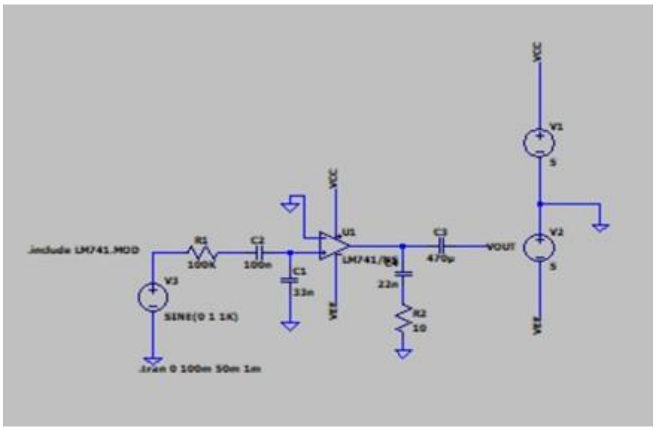

Figure 5. Power amplifier

III. SIMULATION RESULT:

The simulation for all the circuits was done using LTspice software .LTspice is a SPICE-based analogue electrical circuit simulator computer programme developed by AnalogDevices, a semiconductor company.

a) Preamplifier circuit gives us output as shown in the fig6.

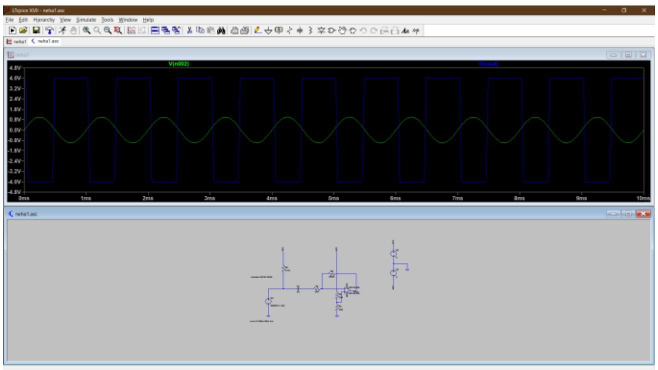

Figure 6. Output of Preamplifier Circuit

b) Second order butterworth filter has output as shown inthe fig 7.

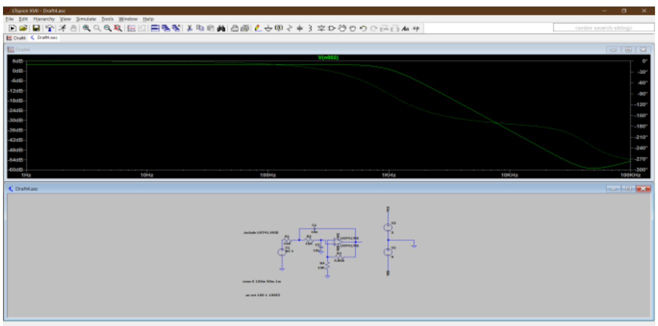

Figure 7. Output of Second Order ButterworthLow Pass Filter.

c) Power Amplifier gives us output as shown in the fig 8.

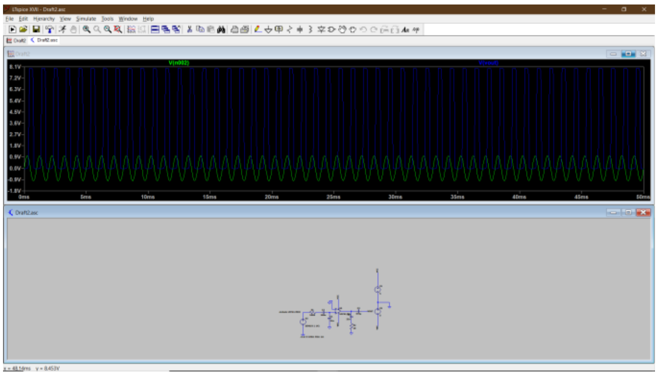

Figure 8. Output of Power Amplifier.

d) Output of the heart beat recorder in the Think labsPhonocardiography Audacity software.

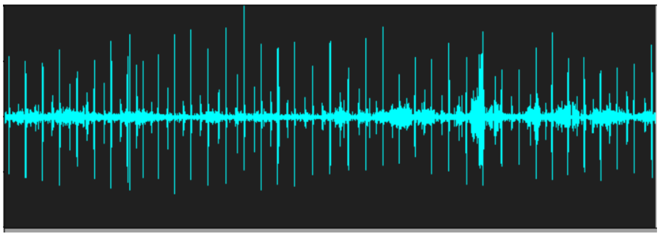

Figure 9. Output in Audacity Software

e) Output of the heart beat recorder using python code

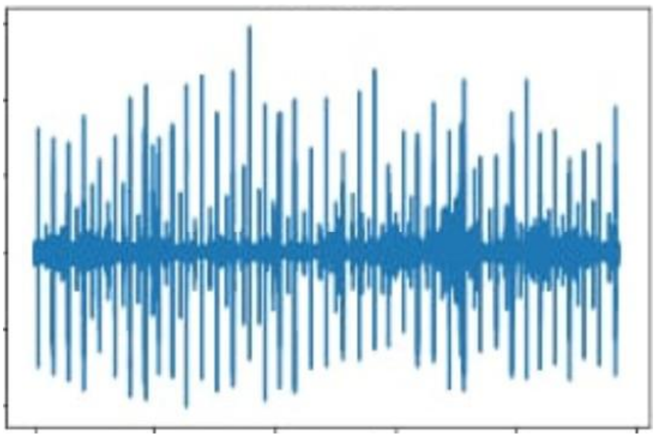

Figure 10. Heart sounds plotted using python

IV. CALCULATIONS

Designing a Second Order Butterworth low pass filter :

Required cutoff frequency is 1000Hz as Clinically important Heart and lungs sound : 20 -1,000Hz

Circuit allows frequencies which are lower than 1000Hz to pass through it and it consists of two resistors and two capacitors as it is a second order filter .

The gain of the second order filter is set by R_1 and R_F and the high cut-ff frequency f_H is determined by R_2, C_2, R_3 and C_3.

Formula to calculate cutoff frequency for 2nd order butterworth filter:

$fh = 1 / 2\pi\sqrt{R2R3C2C3}$

To simplify the design calculations, it is following assumptions are made

C = C2 =C3 = 10 nFR= R2 = R3

$fh = 1kHz$

$fh = 1/2\pi RCR = 1/2\pi\, fh\, C$

∴ R = 16 KΩ

The voltage gain magnitude is given by:

$vo/vi = G / (s * 2 + 1.414s + 1)$

from normalized butterworth polynomials

$1.414 = (3 - Af)/ 2$

(for second order butterworth filter the middle term must be1.414)

$\therefore 3 - Af = 1.414$

∴ Af = 1.586

Pass band gain of 2 nd order Filter is always 1.586 .This gain is necessary to guarantee Butterworth response. Because if the gain is increased from this it gives distortions in output waveform.

Af = 1 + Rf /R1

1.586 =1 +Rf / R1Rf/R1 =0.586

Choose the value R1 to be 10KΩ then Rf comes out to be 5.86 kΩ

Terms	Values
fh	1000 Hz
C	10nF
R	16KΩ
R1	10KΩ
RF	5.86KΩ
Af	1.586

Table 1. calculated values

V. WEBSITE

Website is created to send, store and view the recorded heart / lung sounds to the doctor . Data can be sent with ease using websites. It makes communication between doctorand patient very convenient, safe and comfortable.

Website consists of 4 pages.

a) Introduction page

b) Record and Send

c) Show the recorder sound

d) About the Project

1) In fig 12, First page of website is shown which gives brief idea about the project

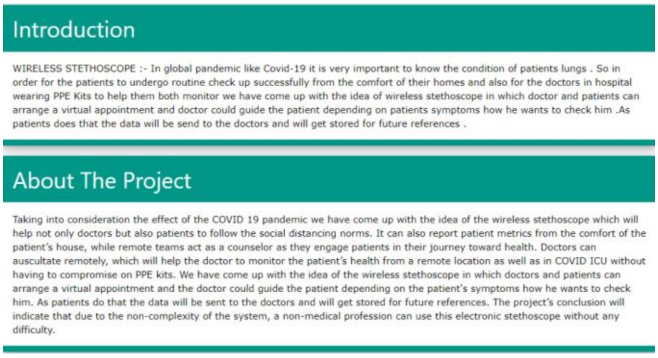

Figure 12. page 1

2) In fig 13, Second page of the website is shown which is used to record and share the recorder file to the doctor.

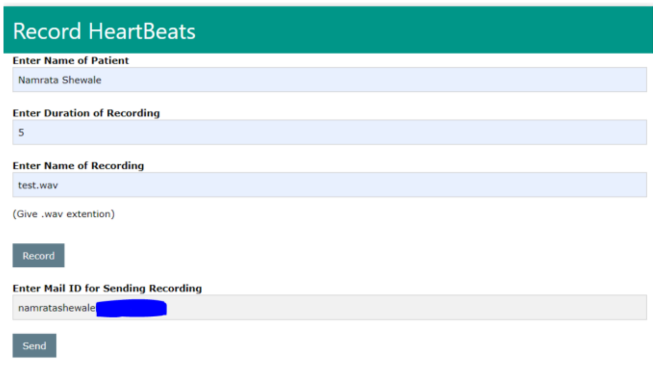

Figure 13. page 2

3) In fig 14, Mail is being received by the doctor itcan be seen.

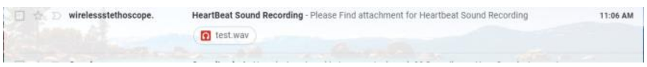

Figure 14. mail received on mail

4) In fig 15, page on which the recorder sounds can be seen in shown

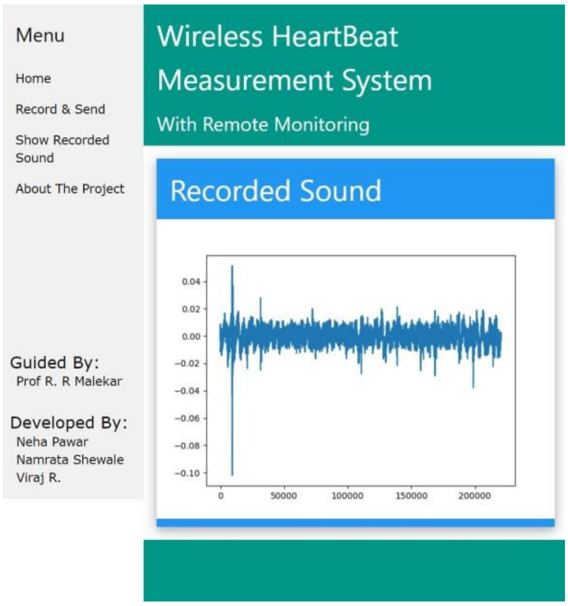

Figure 15. page 3

5) In fig 16, The last page of the website general information of telemedicine is given to spread awareness about it .

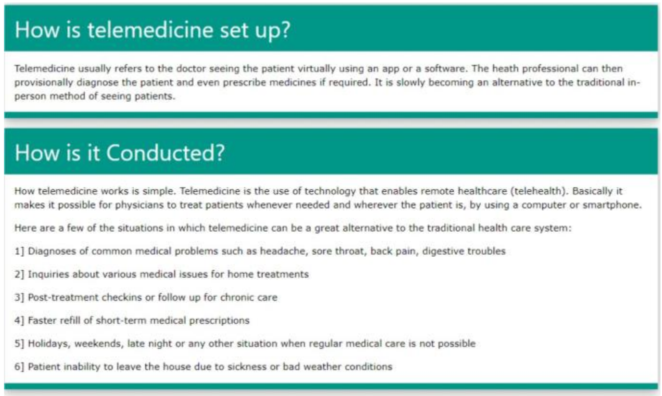

Figure 16. page 4

VI. CONCLUSIONS

There is no question that everybody is dealing with a highly infectious virus, and containing its spread is the top concern right now. Every measure is minor in this case, because even with control measures in place, the illness continues to spread because not all hygienic features allow for better isolation.

A comprehensive history of all recorded auscultations done on a patient is available to us. Medical practitioners can follow the patient's progress in this way. Similarly, it will enable non-specialized people to record auscultations inisolated patients for eventual transmission to an expert.

The project's conclusion will state that owing to the non-compliance, the project will be terminated.

VII. REFERENCES

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