SAPA CAPSULE PROJECT

Electronic Stethoscope

Introduction:

The stethoscope has been around for nearly 200 years and is still draped across every physician's neck or tucked into lab coat pockets [1]. Digital stethoscopes (DS) are convenient, cost-effective, and easy to use devices, designed to enhance the auscultation capabilities of the modern-day clinician. These devices have been effective for capturing normal and abnormal breath sounds [2].

Goal:

The main goal of this capsule project is to build an electronic stethoscope system to acquire the acoustic sound that is coming from various parts of the body and convert that sound to a digital signal. These electronic signals can be further processed and digitalized to transmit to a personal computer or a laptop. This system will have hardware and software parts [3].

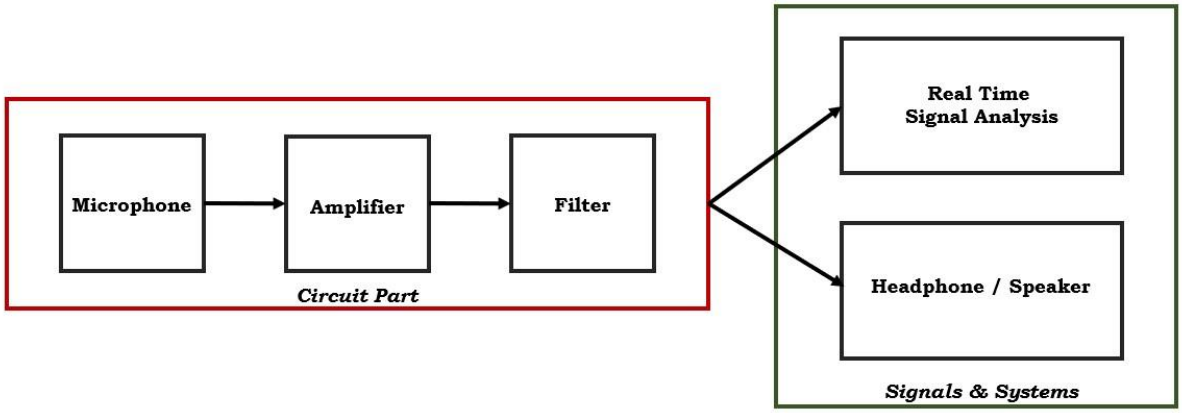

Figure 1. Project flow chart

Details:

In this project, we focus on developing a digital stethoscope which acquires heartbeat, lung, and various organ sounds. The device amplifies and filters acquired sounds and then plays it through speakers. Additionally, the device sends digital data to a computer for real-time signal monitoring and further analysis.

You are expected to develop your own amplification and filtering circuits for the microphone. Therefore, no commercial module is allowed in the project. As for the digital conversion, it is possible to use Arduino or similar devices.

You can use MATLAB or Python for the signal monitoring and analysis part. Make sure the monitoring and analysis has a smooth GUI for the demonstration.

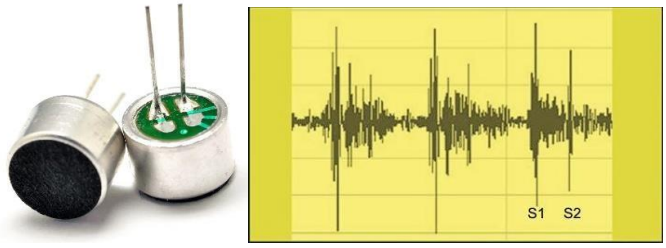

Figure 2. Example microphone sensor and acquired heartbeat sound

References

[1] https://health.clevelandclinic.org/what-your-doc-listens-for-in-the-stethoscope/

[2] Ramanathan, A., Marzbanrad, F., Tan, K. *et al.* Assessment of breath sounds at birth using digital stethoscope technology. *Eur J Pediatr* **179**, 781–789 (2020). https://doi.org/10.1007/s00431-01903565-8

[3] Swarup S, Makaryus AN. Digital stethoscope: technology update. Med Devices (Auckl). 2018 Jan 4; 11:29-36. doi: 10.2147/MDER.S135882. PMID: 29379321; PMCID: PMC5757962.

Rubric Set:

Rubric for Circuit Part (20%) (Due date: Week 12 Lab Day)				
Criteria	**Ratings**			
	20 points	10 points	5 points	0 points
Design and Simulation (5%)	SPICE based simulation of all stages of the amplifier and filter/s	SPICE based simulation of only amplifier	Incomplete SPICE based simulation	No design at all
Amplifier circuit (10%)	Noise free, clear sound acquisition	Noisy but sound signal still recognizable	Hard to detect sound from noise	No circuit at all
Circuit Presentation (5%)	Box is available ready to use	Build on bread board	Incomplete and not ready to show	No circuit at all

Rubric for Signal Processing Part (25%) (Due date: Week 15 Lab Day)				
Criteria	**Ratings**			
	20 points	15 points	10 points	5 points
GUI (15%)	Real-time signal; •Raw signal and its spectrum •Filtered signal and its spectrum Customizable filter settings Real time monitoring of Heartbeat rate and Respiration rate	Real-time signal; •Raw signal and its spectrum Real time monitoring of Heartbeat rate and Respiration rate	Real-time raw signal and its spectrum	Offline plot
Demo/Presentation/Report (5%)	TBA	TBA	TBA	TBA
Bonus (5%)	Github repository with plug & play demo			

Remarks

We may provide an Arduino card for data acquisition if you ask for it. Please note that you need to purchase the required components.

Also please note that, after your circuitry has been checked and graded, you can still work on your circuit to improve it, however your grade will not be updated. It is still important to obtain clear sound signals for the signal processing part of the project.