Multi-Channel Stethograph System Development

M. Z. Atashbar, B. B. Narakathu, Xingzhe Zhang, Amer Abdulmahdi Jabbar Chlaihawi, Vikram Shreeshail Turkani, Dinesh Maddipatla

Department of Electrical and Computer Engineering
Center for Advanced Smart Sensors and Structures (CASSS)
Sensor Technology Lab (STL)
Western Michigan University, Kalamazoo, MI, USA

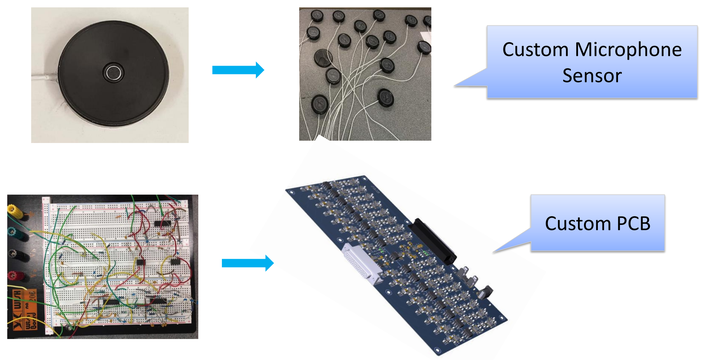
Abstract

A multi-channel stethograph system was designed and developed to graphically record heart and lung sounds through a set of 16 microphones. A foam pad based holder for the microphones was fabricated to acquire sounds from the lung and the heart. The sounds acquired from the 16 microphones were processed through a custom designed and fabricated 16 Channel PCB for signal conditioning. A National Instruments NI 9205 data acquisition system (DAQ) along with NI 9191 wireless chassis were used to acquire and wirelessly transmit the data from the 16 Channel PCB to a PC. A custom LabVIEW program was developed on the PC to record the data from the DAQ. In addition, a MATLAB program was developed to convert the recorded data from 16 microphones into 16 audio files and plot the audio waveforms to analyze the heart and the lung conditions.

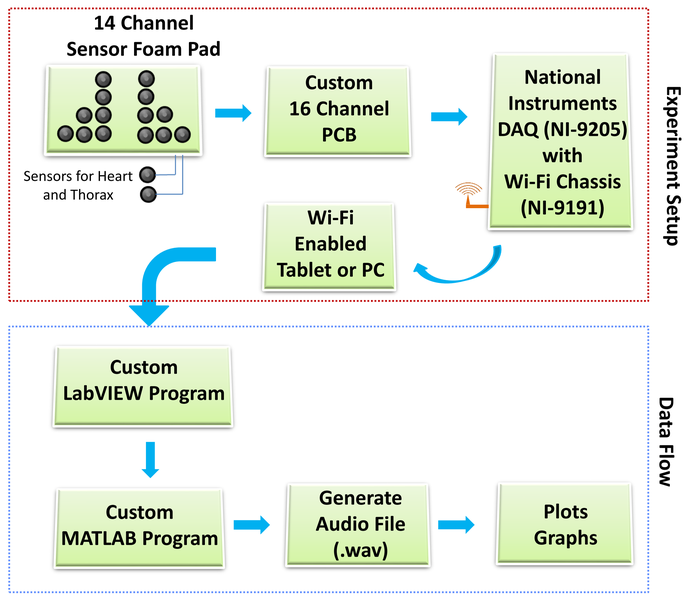
Introduction

- Cardiovascular diseases (CD), which often affect the heart and blood vessels, are one of the major causes of mortality in the modern world.
- To identify and treat the CD, the heart beat and lung sounds of the patients should be monitored continuously.
- An effective way to monitor/measure the heart and lung sounds non-invasively is by using acoustic transducers since they use low-power electronic instrumentation and consumes very less energy.
- In this project, microphones with custom designed CNC machined Delrin casings were used to fabricate the multi-channel sensors to acquire heart and lung sounds with high sensitivity.
- These sensors are placed in a memory foam pad to provide comfort to the patient by conforming to the patient's body contour when lying/leaning on the pad and to proving acoustic isolation from microphone-to-microphone.
- The acquired data from the microphone sensors was conditioned and wirelessly communicated to a PC for further analysis using a custom built PCB and DAQ.

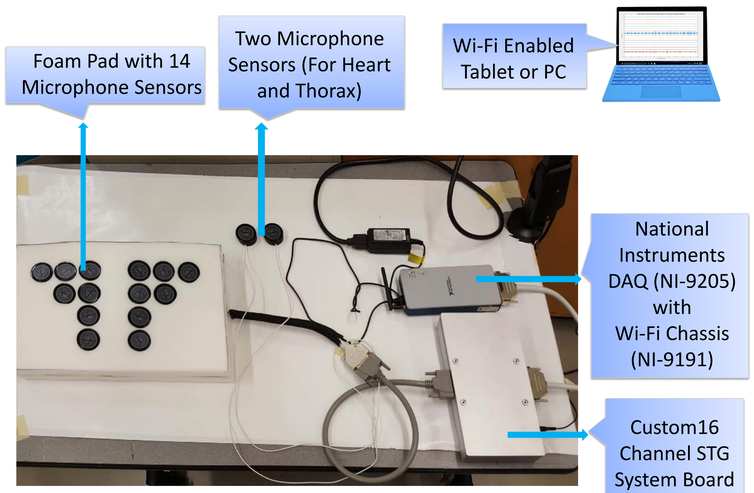
Custom Microphone and PCB



Setup and Data flow

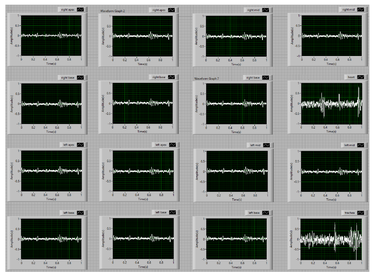


Multi-Channel Stethograph

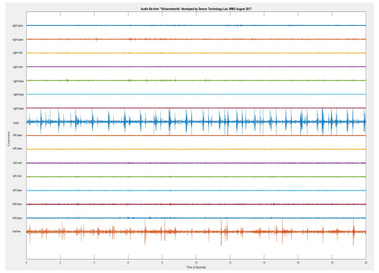


Multi-Channel Stethograph (STG) System

Results



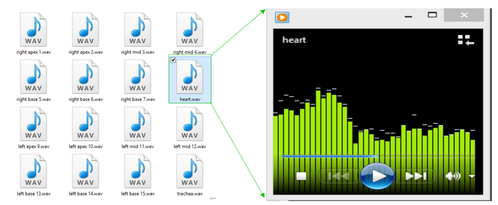
Custom LabVIEW program showing heart and lung sound waveforms



Custom MATLAB program plot each audio file

MATLAB

MATLAB



MATLAB program convert data to 16 .wav audio files

Conclusions

- A multi-channel stethograph system was successfully designed and developed to graphically record heart and lung sounds through a set of 16 microphones.
- Designed and fabricated a foam pad based holder for microphone sensors to be placed on a patient testing chair.
- Designed a custom 16-channel PCB and integrated with the selected DAQ.
- Developed a custom LabVIEW and MATLAB program to wirelessly record and plot the microphone based sensor data from DAQ as well as to generate and plot audio files (.wav).

Acknowledgement

This work has been funded by Stethographics, Inc.