Continuous Monitoring of Asthma Control
Progress Report 1

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Date: Friday, January 20th - Thursday, January 26th

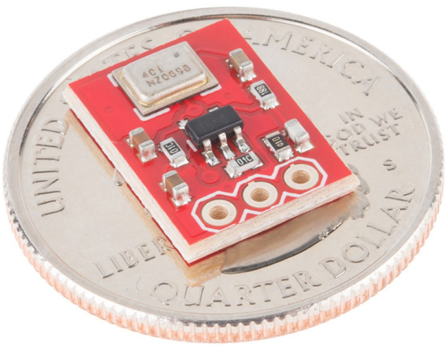
Problem Statement
Asthma patients often do not experience the the symptoms of asthma exacerbations, such as coughing, wheezing, and increased respiratory rate, for up to 2 days after it has begun. In severe asthma patients, where the exacerbations are more frequent, prolonged detection can lead to more serious symptoms, longer recovery times, and extended tissues destruction. These severe asthma patients only account for 10% of all asthmatics, but they account for a disproportionate amount of health-care costs, hospital admissions, doctor visits, and emergency services. By creating a device that can detect the symptoms of an asthma exacerbation earlier, the patients could be notified to start their asthma action plan (AAP) sooner. This could potentially save significant amounts of time, money and resources while reducing the effects of the exacerbation.

Summary of Team Role Accomplishments
- Luke (BSAC) - No team role accomplishments to report.
- Tim (Leader/ Communicator)- Set-up the team notebook. Organized meeting times with both the client and the advisor. Worked on/ submitted the progress report.
- Kelsey (BWIG/ BPAG)- Created the team website. Worked on progress report.

Summary of Design Accomplishments
This is a summary of design accomplishments from last semester. Nothing new has been changed so far.

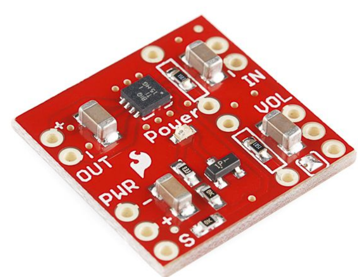
The team has decided on a final design featuring two microphones to listen to lungs sounds. This was chosen because of it is more cost-effective and adjustable. Each will feature a microphone inside of a casing that will be placed on the lower back of the shirt to try to capture 3 distinct lung sounds-- coughing, wheezing, and respiratory rate. The microphones chosen are Sparkfun MEMS Microphone Breakout-INMP401. These feature a built in amplifier, so we will not need to amplify the signal later one. The casing will be made of actual stethoscope heads with the microphones placed just inside the tubing. We intend to use pockets and the tension of the dry-fit shirt to hold the microphones in place. The team will use shielded cables to transfer the signal from the microphone to the data acquisition device. The team chose the National Instrument USB-6002 for a few reasons. Firstly, National Instrument makes the LabVIEW software, so getting the data to the software will be very simple. Also, this specific model was chosen since it is able to take analog inputs. This eliminates the need for an external analog to digital conversion. Lastly, this device has output voltages. The goal is to have this output voltage power the microphones. The output voltage is 5V, but the microphones can only take in a max of 3.3V. This can be fixed with an inexpensive linear voltage regulator. We will use a different power source (maybe even an arduino) for ensuring everything works properly first before ordering this piece. Once we get the data to LabVIEW, we will do all the filtering a signal processing there. This is useful for testing since we do not need to rebuild a circuit each time we want to change the corner frequency or such, we can simply change the value in the program.

<u>Microphone</u>



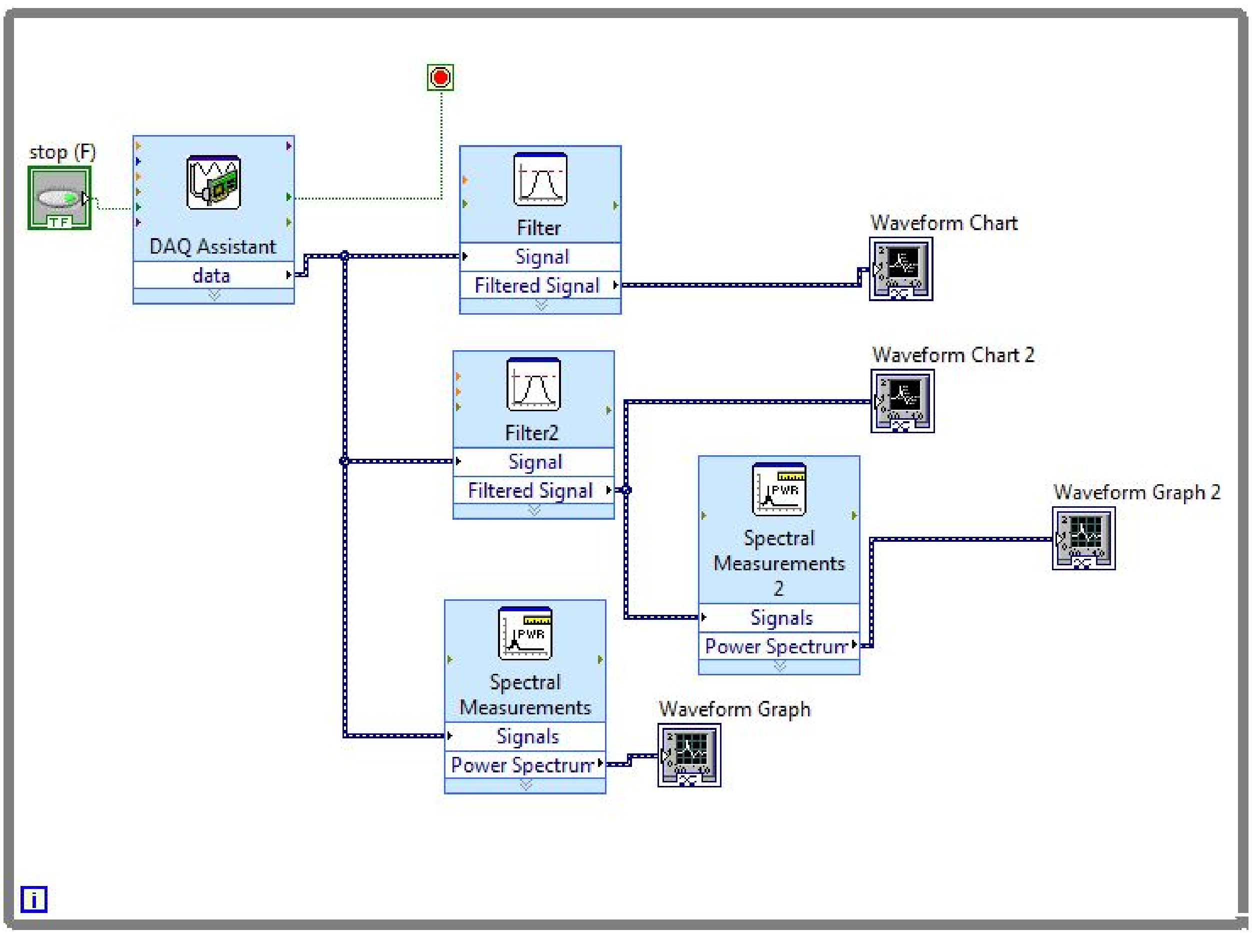
<u>Data Acquisition Device</u>

The DAQ shipped on Tuesday to the team finally began testing. We did a little bit of preliminary testing with the microphones using the oscilloscope and the arduino just to see the output. Then we started testing the DAQ. We tested it using a sine wave from a function generator, a potentiometer with varying output voltage, and then with the microphone. After initial testing, we attached a soldered a shielded cable to the microphone to power the it, ground it, and transfer the analog signal to the DAQ. We connected the microphone to the stethoscope using a plastic, bubble like piece that holds the microphone inside. Then we could do testing using the stethoscope head. We tried different filters, corner frequencies, etc to see how the signal varied. We got some preliminary data, but a problem we seemed to have is that even with the amplifier built into the microphone, the signal was still very small. This makes the differences in the signal very hard to see. We are going to order and cheap amplifier: a Sparkfun Mono Audio Amp Breakout- TPA2005D1 (Pictured to the right). We decided to focus on just one of the microphones at the time. We figured that is it better to devote our time to one rather than trying to get two that might not even work. We will perform more testing in the following week, and hopefully the amplifier will help to get even better results. The picture below show some of the initial testing.

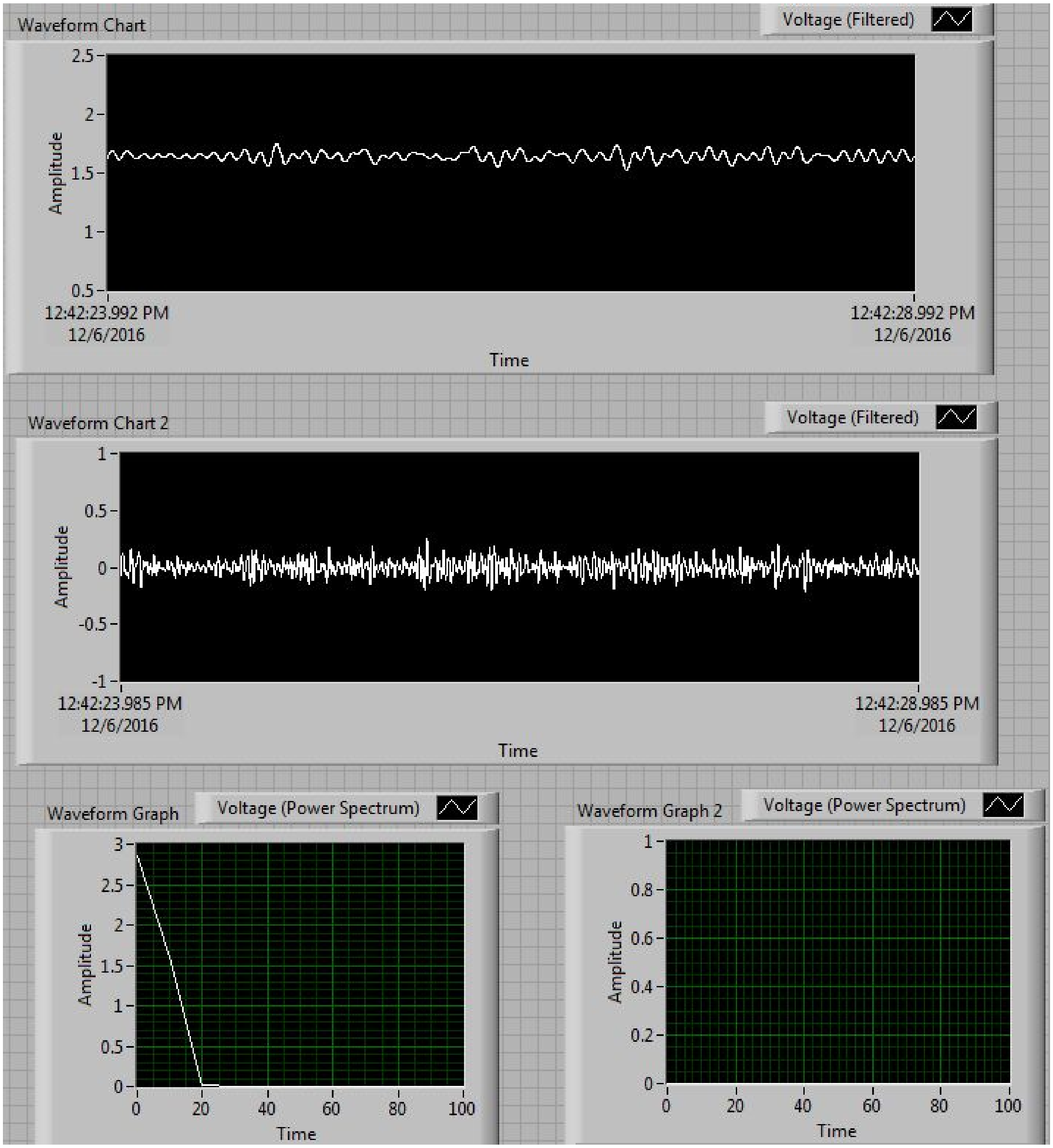


We originally had the microphone encased in a plastic, bubble like piece, but the microphone was picking up a lot of ambient noise. We instead found a rubber piece from an old blood pressure pump and decided to try that. Rubber is a better insulator of noise, and so the microphone basically did not pick up any ambient noise. In addition,we were not able to get the amplifier in time in order to use it. We built our own amplifier in the lab using an operational amplifier, but this did not produce better data. The signal was saturating and part of it was being cut off when using the amplifier. We were able to add another waveform chart that allows us to see the frequencies being recorded while testing. We included one unfiltered chart in which we see signals in the 0-20 Hz range during normal breathing and spikes during a cough. We included another chart with a bandpass filter from 20-40 Hz. On this chart, no data is shown during normal breathing, but a spike occurs when the patient coughs. Screenshots are shown below.

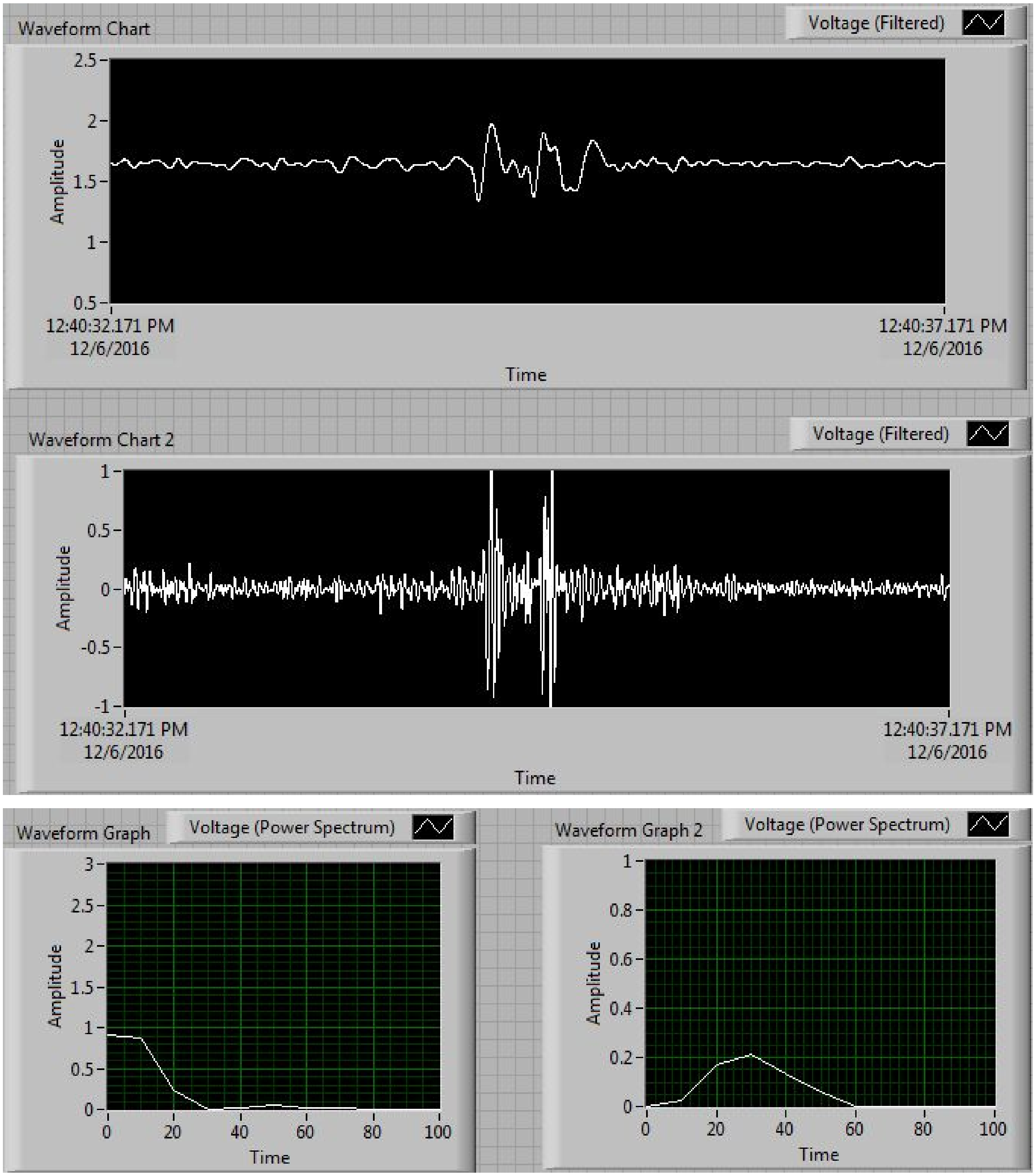
Final Block Diagram



Normal Breathing Output



<u>Coughing Output</u>



Waveform Chart
Voltage (Filtered)
2.5
2
1.5
1
0.5
Amplitude
12:40:32.171 PM
12/6/2016
12:40:37.171 PM
12/6/2016
Time
Waveform Chart 2
Voltage (Filtered)
1
0.5
0
-0.5
-1
Amplitude
12:40:32.171 PM
12/6/2016
12:40:37.171 PM
12/6/2016
Time
Waveform Graph
Voltage (Power Spectrum)
3
2.5
2
1.5
1
0.5
0
Amplitude
0
20
40
60
80
100
Time
Waveform Graph 2
Voltage (Power Spectrum)
1
0.8
0.6
0.4
0.2
0
Amplitude
0
20
40
60
80
100
Time

Activities

Date	Member	Task	Time (hrs)	Week Total	Sem Total
1/26	Tim	Set up design notebook; met with client; worked on progress report	1	1	1
1/26	Kelsey	Met with client; created website; worked on progress report	1	1	1
1/26	Luke	Met with client; worked on progress report	1	1	1

Statement of Team Goals

- Meet with our advisor
- Complete the IRB protocol
- Figure out how to save data/ review it in LabVIEW

Individual Goals

- Luke: Will attend the BSAC meeting on 1/27.
- Tim: Submit deliverables/ weekly progress reports
- Kelsey: Setup the website, learn more about the previous semester's progress on the design

Difficulties

One potential difficulty might be getting the DAQ software to work with the version of LabVIEW on the laptop for testing. We had issues with the LabVIEW on the instrumentation computers being too old and incompatible last semester, so we might run into similar issues again. Another potential issue could arise with adding more inputs into the DAQ. Although the DAQ is able to handle many inputs, we will have to figure out how to import the different signals into the LabVIEW program.

Project Schedule/Timeline

We will update this part once we have a better understanding of the direction/ timeline of this project.

Expenses

No expenses at this time