Continuous Monitoring of Asthma Control
Progress Report 12

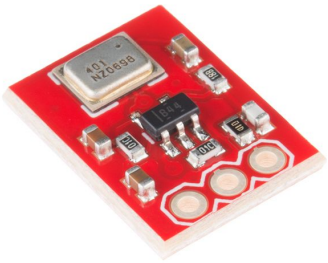
Client: Dr Sameer Mathur
Advisor: Dr Chris Brace
Team: Tim Lieb tlieb@wisc.edu (Team Leader/ Communicator)
Luke DeZellar ldezellar@wisc.edu (BSAC)
Kelsey Linsmeier klinsmeier@wisc.edu (BWIG/ BPAG)
Date: Friday, April 14th - Thursday, April 20th

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 5-10% 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 more promptly notified to start their asthma action plan (AAP). This could potentially save significant amounts of time, money and resources while also reducing the effects of the exacerbation.

Restatement of Previous Team Goals
- Installed correct version of LabVIEW
- Began preliminary testing
- Wrote executive summary

Summary of Team Role Accomplishments
- Luke (BSAC) - No BSAC updates to report.
- Tim (Leader/ Communicator)- Worked on/ submitted the progress report.
- Kelsey (BWIG/ BPAG)- Uploaded progress report to website.
  Ordered microphone.

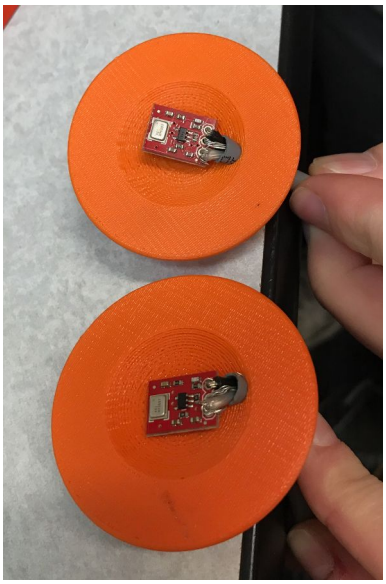
Summary of Design Accomplishments



The team decided on an encased microphone design. First, it will feature a 3D printed casing in order to make the design slimmer/more ergonomic. In addition, the microphone be completely enclose in the new casing. The reduced bulk will increase patient comfort and enable the device to be more easily integrated into a shirt. The team will use the same microphone as last semester: Sparkfun MEMS Microphone Breakout-INMP401 (ADMP401). The idea behind this is that we know that microphone has worked well and it should be compatible with our code written last semester.

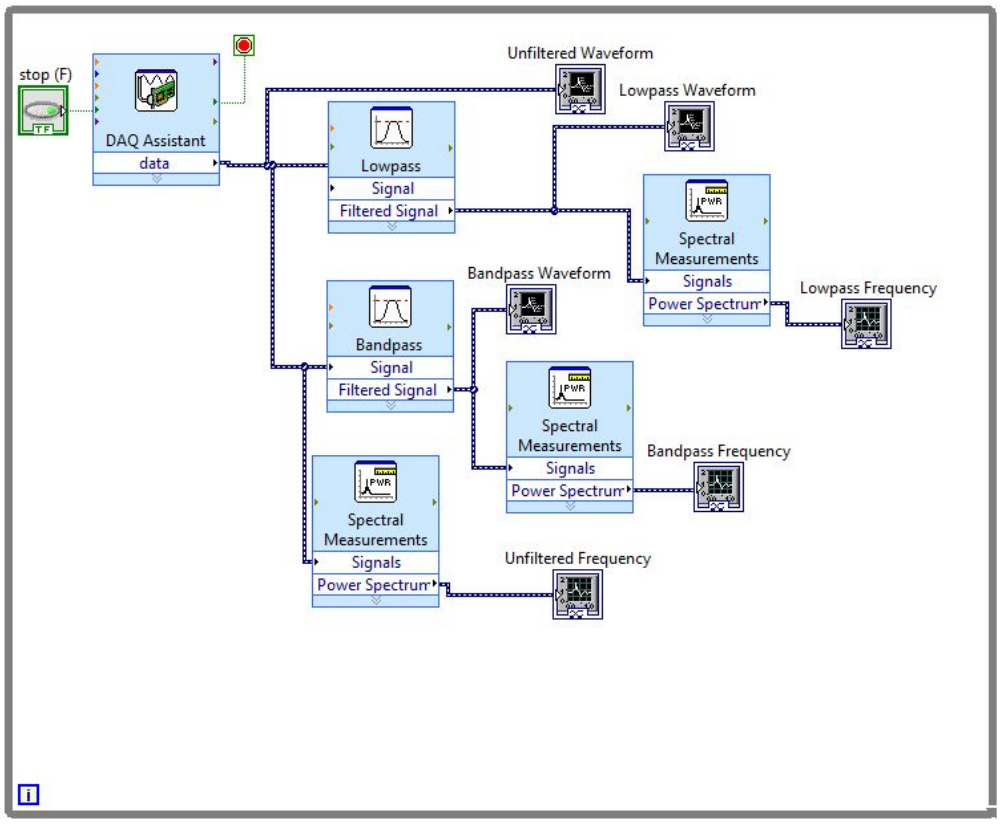
The team decided to use a two conductor shielded cable with drain wire (Digi-Key C2534-50-ND). This will allow one conductor for the audio signal, one conductor for the voltage supply, and the drain wire to be connected to ground. The team began to assemble and test the prototype today and will continue working on it later tonight.

Below are images of the final prototype. We fed the cable through the hole in the casing. Once through we soldered the cable to the microphone. The black cable was attached to audio input, the white cable to the VCC power supply, and the drain wire was attached to the ground.



To begin testing, we set up an old, non-CAE computer so that we could download the necessary files. The NI-DAQmx software did not work with the 2010 version of LabVIEW that was previously on the computer. We downloaded the 2015 version of LabVIEW and the NI-DAQmx 16.0 instead. This will also help with compatibility since the laptop used for patient testing also has the 2015 version of LabVIEW.

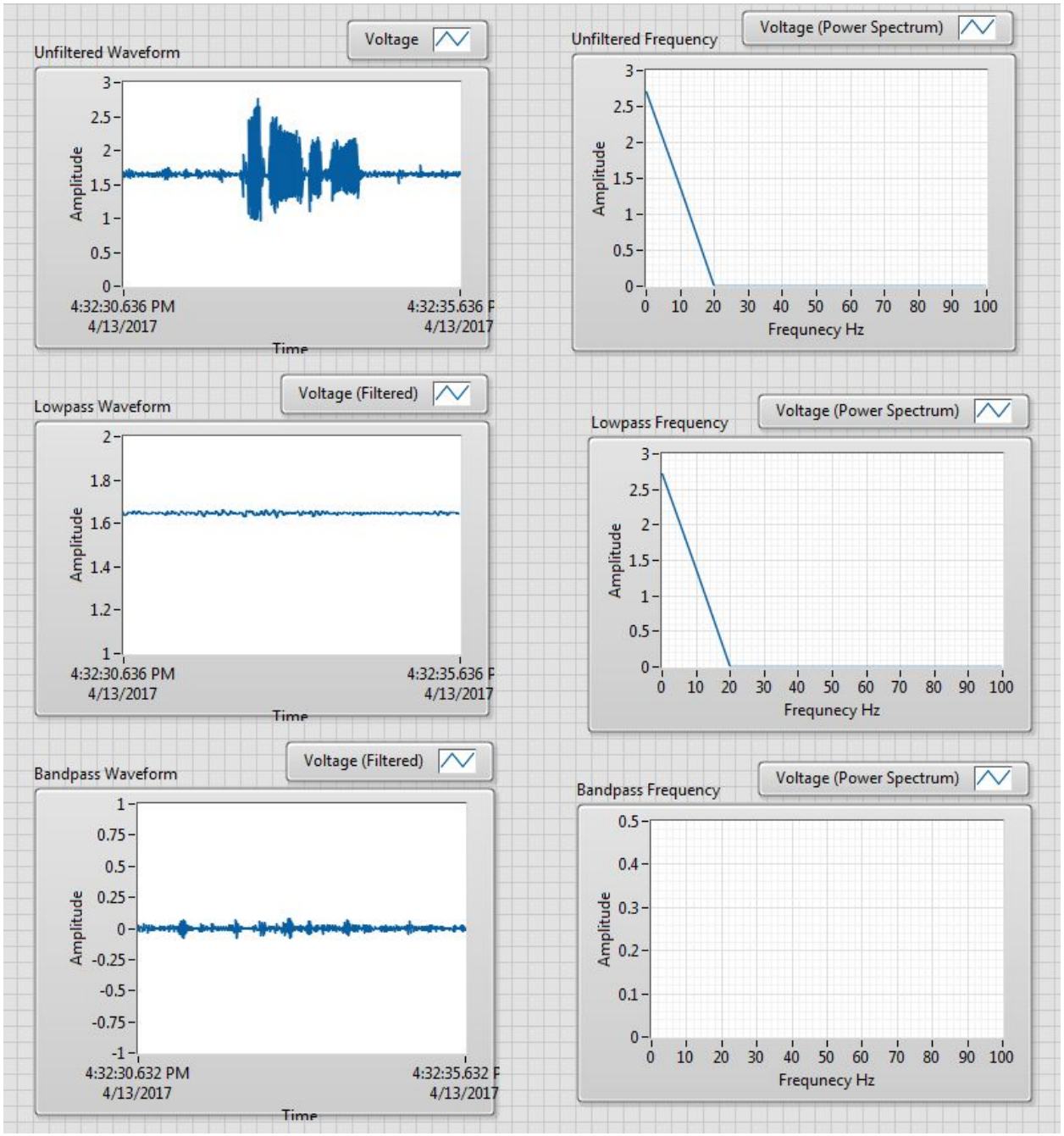
To begin testing, the team built a LabVIEW program that was almost identical to the program used for testing last semester (shown below). This features 3 waveform graph to plot the input voltage over time and 3 waveform charts to plot the frequency in real time. We applied a 10Hz lowpass filter on 2 of the signals, a 20-40Hz bandpass filter of another 2 signals, and left 2 of the signals unfiltered.



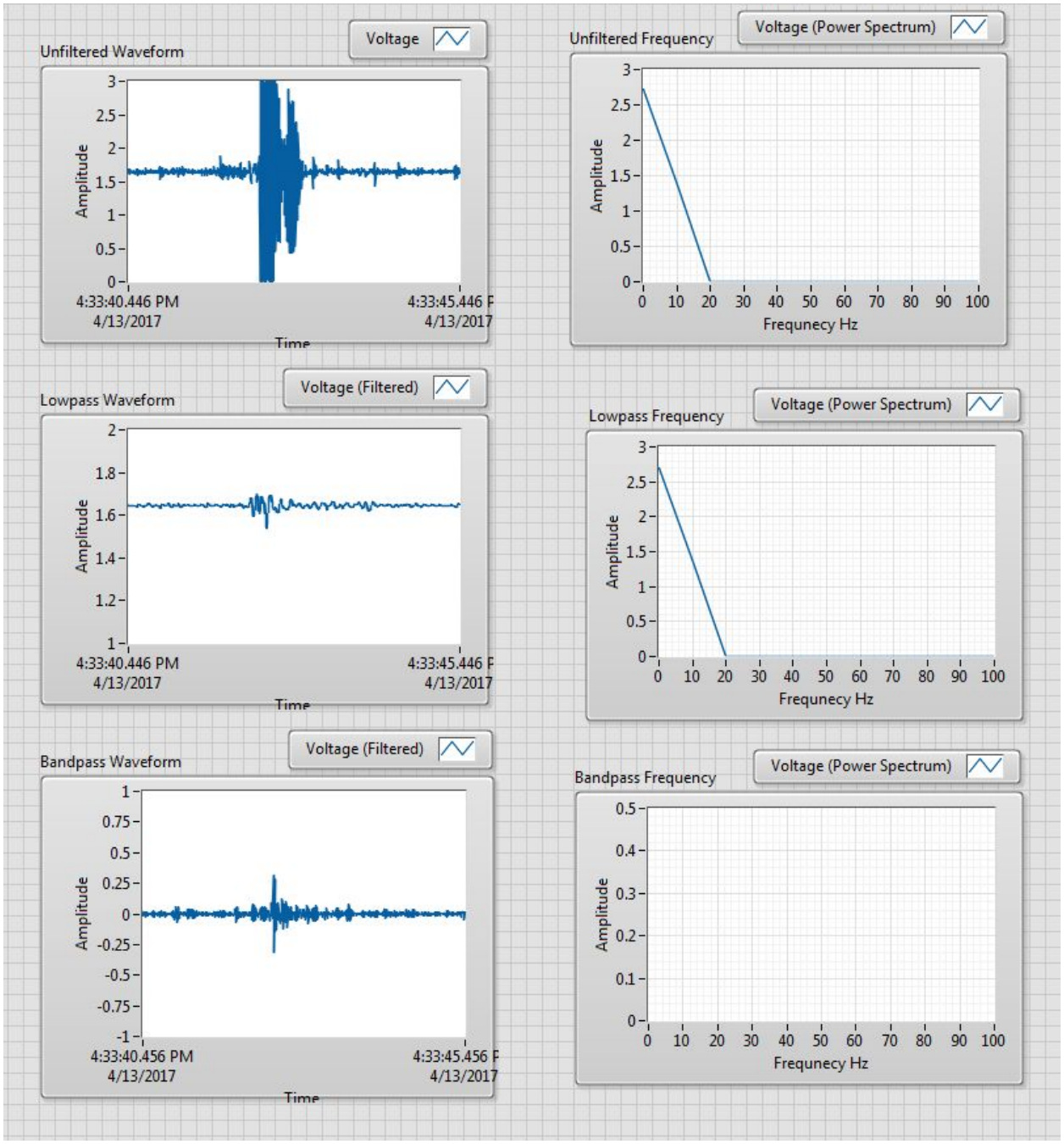
Block Diagram LabVIEW code

For initial testing, we only used a single microphone, placing it near the middle of the subject's back. In order to determine how well the device isolated coughing and wheezing, we first tested whether the microphone would pick up ambient noise from the room or talking from the subject. We then had the subject cough to see if that signal was correctly isolated.

The images below show the front panel from the LabVIEW software during testing. The first one shows the output while the patient was talking. The lowpass and the bandpass filters both nearly blocked out the entire signal when compared to the unfiltered data. The second image shows the outputs while the subject was coughing. This signal was picked up by both of the filtered outputs. This shows that the software was able to detect coughs while accurately blocking out other noise.



Output of talking



Output of coughing

First this week, the team worked on integrating the microphones into the band. We used an elastic bandage wrap for the band with a velcro strap. One end is fixed to a metal piece and the other is fed through, wrapped over, and velcroed to stay in place. This allows for the device to be adjustable while also being secure.

We then started performing tests on the entire device which includes gathering data from both microphones at the same time. We had the DAQ assistant gather the data from both the a0 and a4 inputs and used a split function to separate the two voltage signals. We would then send the data through identical functions. When we tried testing, one of the output signals appeared as expected, but the other was not being amplified. Our first thought was that the microphone was not receiving the 3.3V power supply. We checked all the connections/ components but the signal was still not amplified. Our only other solution was to replace the microphone. We tried to salvage and reuse the microphone from our design last semester. We could not get all the solder off and it was very difficult to attached the new cables. The team decided to order a new microphone that will ship on Friday. After soldering the new microphone, gathering the data will not be very difficult. We will also add data storage to the LabVIEW in anticipation for potential patient testing on Monday.

Activities

Date	Member	Task	Time (hrs)	Week Total	Sem Total
4/17	Tim, Luke	Prototyping/ Testing	1		
4/18	Tim, Kelsey	Integrated microphones into band, finished prototype	1		
4/19	All	Testing, fixing device issues	2.5		
4/18	Tim	Independent research	2		
4/20	Tim	Progress Report	1	7.5	41
4/20	Kelsey	Independent research & progress report	1.5	5	38.5
	Luke	Progress Report	1	4.5	35.5

Statement of Team Goals

- Solder the new microphone once it is shipped
- Test the whole device together, gathering both microphone inputs at once

- Add the data storage to the LabVIEW
- Test on asthma patient on Monday (if possible)
- Continue research on comparable lung sound data

Individual Goals

- Luke: Finish prototype for patient testing next week.
- Tim: Finish prototype and testing. Continue research
- Kelsey: Finish prototype and testing.

Difficulties

As described above, we had difficulty receiving output from both microphones. After checking the connections of the microphone and determining that all were connected and soldered correctly, we decided the problem was most likely the microphone itself. This led us to remove the microphone and attempt to attach the microphone that was used in the previous semester. However, this proved to be unsuccessful and caused us to order a new microphone. We will now attach the new microphone to the cable wires after it has been delivered.

Project Schedule/Timeline

Task	Jan		February				March					April			
	20	27	3	10	17	24	3	10	17	24	31	7	14	21	28
Deliverables															
Progress Report	X	X	X	X		X	X	X		X	X	X	X		
PDS			X												
Preliminary Presentation					X X										
Preliminary Report/Notebooks					X										
Final Presentation															
Final Report/Notebook/Evals															
Team Goals															
Select 3 final design ideas				X											
Design Matrix				X											

Presentation Powerpoint					X										
Decide on final design						X									
Presentation poster															
Meetings															
Team	X		X	X	X	X				X	X	X	X		
Advisor	X	X	X	X	X	X	X				X	X			
Client	X					X					X				
Website															
Update info	X	X	X	X	X	X	X	X		X	X	X	X		

Expenses

Date	Item	Cost
3/8/17	Digi-Key 2 conductor Shielded Cables with drain wire (C2534-50-ND)	$41.64
3/16/17	Microphone casings	$9.51
4/11/17	6” Cotton Elastic Bandage	$13.95
4/20/17	MEMS Sparkfun Breakout Board	$11.95