Sleep Apnea Therapy Device – Progress Report #7

Client: Dr. John Webster
Advisor: Dr. Megan McClean
Team Members: Calvin Hedberg, Taylor Karns, Jen Rich, Ben Mihelich
Date: March 3rd – Mar 9th, 2017

Problem Statement

Clinically significant sleep apnea is a sleep disorder characterized by interference of breathing during sleep. Those who suffer from sleep apnea experience interrupted sleep which develops an increased risk of heart attack, high-blood pressure, arrhythmia, stroke, and diabetes. Continuous Positive Airway Pressure (CPAP) machines are the current standard for treatment. However, approximately half of all patients suffering from sleep apnea do not adhere to it well due to complications such as nasal congestion, headaches, and continued tiredness. Continuous dead space rebreathing is an alternative that has been researched and shown to stabilize central respiratory output in patients with mild to severe obstructive sleep apnea without the complications of CPAP. Thus, our team has been assigned the task of designing and fabricating a variable dead space device based on guidelines and research conducted by our client Dr. John Webster. This includes developing an algorithm such that the device can detect sleep apnea and consequently regulate the amount of dead space for proper respiration.

Last Week's Goals

- Install and Test Stepper Motor
- Create Circuit for Stepper Motor and Test Algorithm

Summary of Team Role Accomplishments

- Calvin (Leader) - filled out the week's progress report
- Taylor (Communicator & BPAG) – purchased prototyping parts and logged project expenses
- Jen (BWIG) – updated the team website
- Ben (BSAC) – attended BSAC meeting Friday March 3rd

Summary of Design Accomplishments

This week focused on testing new parts and components that had been ordered. The 5V DC stepper motor with its driver has been successfully tested using a stock circuit and code provided by the motor's supplier. The basic circuit was created on a breadboard and hooked up to the Arduino microcontroller. The motor was then operated by entering numbered step commands into the Arduino's serial monitor. The specific motor used in the project is listed to have 513 steps per revolution. Entering a positive number caused that many steps to be turned counterclockwise while negative numbers caused that many steps to be turned clockwise. These movements will be tracked by the Arduino and give the device a relative position for the cover that is to be rotated in the device to vary dead space levels.

After the motor was successfully tested, coding was written for its operation in the current apnea detection algorithm. If apnea is detected the motor will rotate the cover a single increment (number of steps per increment is to be determined experimentally) to reveal more of the holes opening into the expanded volume to increase dead space. If apnea is not detected, no change will be made. If no apnea is detected for one hour then the motor will rotate the cover back one increment to decrease dead space as a method of making the device self-adjusting. An increment count has also been added to help track the position of the cover as to not have it go past having the holes wide open.

The full circuit to be used in the device has been brainstormed. The concept is to have the flow sensor and the motor-driver combo each attached to the Arduino power rails (motor-driver to 5.5V; flow sensor to 3.3V). As the 5V rail is independent of the current shared by the microcontroller, I/O pins and 3.3V rail, it can take much more current and use more power without drawing away from the current required to run the code and other rails. This way we can power the entire device with 7V battery equivalents in parallel (increases mA*h rating to have device run longer). Additionally the circuit will have each component hooked up to a transistor controlled by one of the many I/O pins on the Arduino. This way we can send power to the motor/driver and flow sensor only when collecting data and save energy when the system is in standby mode. This will overall make the device more power efficient making battery operation more practical.

This Week's Goals

- Test stepper motor code with Apnea Detection Algorithm
- Purchase parts for inner breathing tube and begin fabrication
- Design comfort level test for device

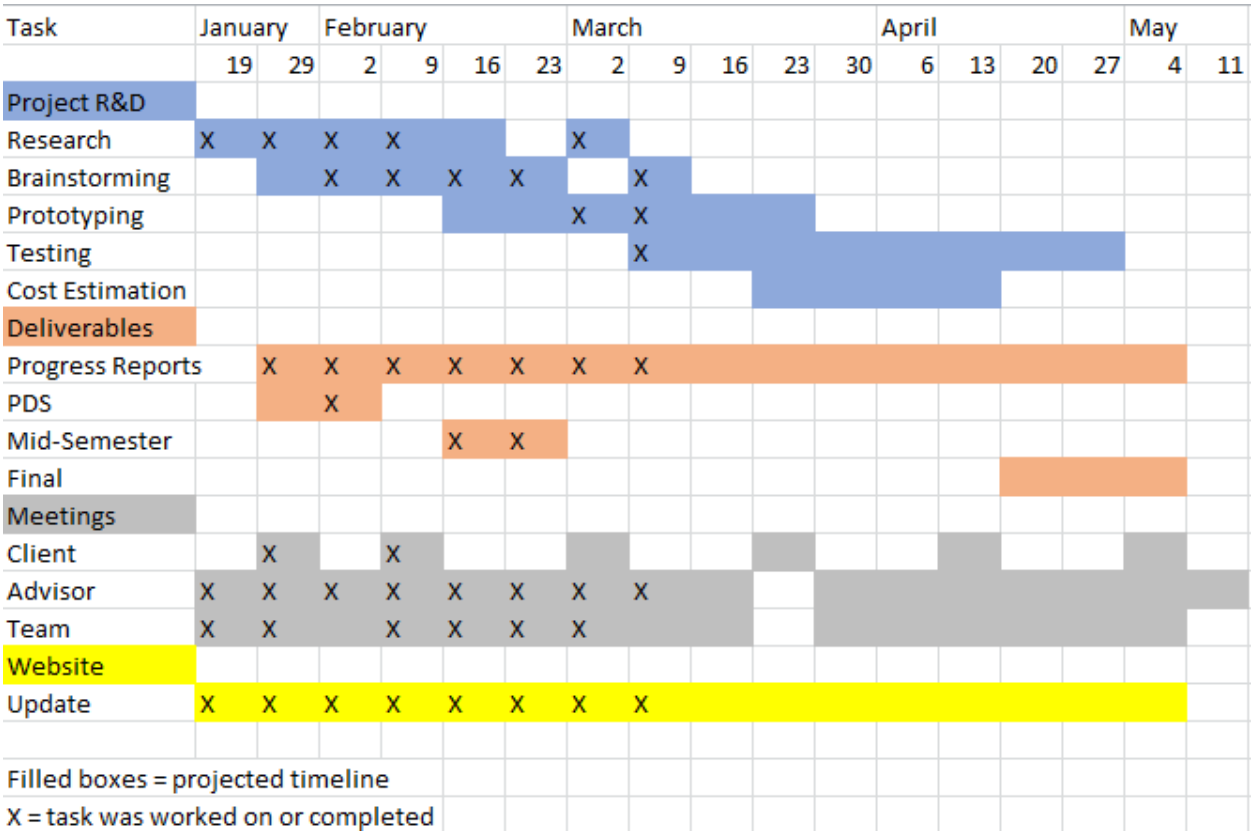
Difficulties with Project

The proposed circuit may work out in theory but in practice we may find that our circuit has too much current draw to actually function properly. Consulting an expert in bioinstrumentation or electrical engineering may give us insight on this potential issue. Likewise, the method/type of battery for providing 7V to the system has yet to be determined

Activities

Date	Person(s)	Task	Time (hrs)	Semester Total
3/7/2017	Calvin	Tested stepper motor, edited algorithm and brainstormed device circuit	2.5	7.5
	Taylor			1.5
	Jen			2.0
3/7/2017	Ben	Tested stepper motor, edited algorithm and brainstormed device circuit	2.5	5.0
	Team			11.5

Project Schedule



Task	January		February				March					April				May	
	19	29	2	9	16	23	2	9	16	23	30	6	13	20	27	4	11
Project R&D																	
Research	X	X	X	X			X										
Brainstorming			X	X	X	X		X									
Prototyping							X	X									
Testing								X									
Cost Estimation																	
Deliverables																	
Progress Reports		X	X	X	X	X	X	X									
PDS			X														
Mid-Semester					X	X											
Final																	
Meetings																	
Client		X		X													
Advisor	X	X	X	X	X	X	X	X									
Team	X	X		X	X	X	X										
Website																	
Update	X	X	X	X	X	X	X	X									

Filled boxes = projected timeline

X = task was worked on or completed

Expenses

Part	Cost	Supplier
Body – Tupperware water bottle	17.51	Tupperware
5V Stepper Motor and Driver	13.04	Amazon.com
Total	30.55	