BME Practicum Two

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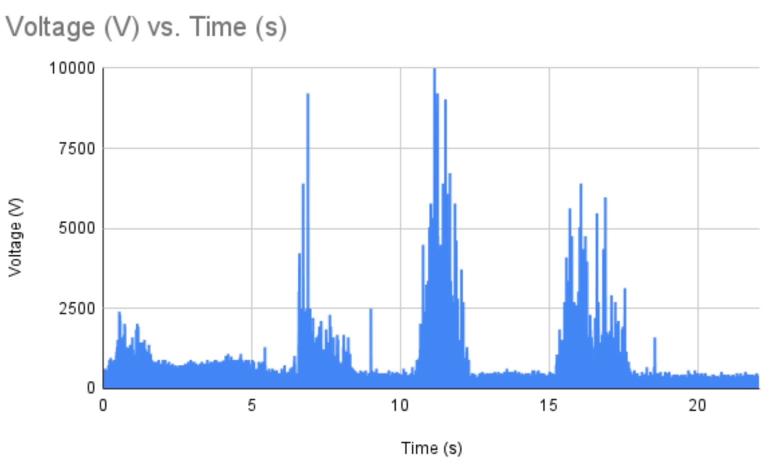
Part 1: EMG and Muscle Measurements

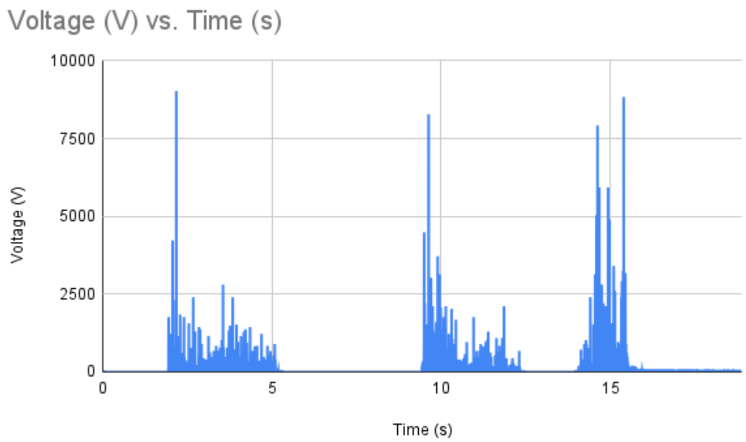
Introduction:
For this part of the Practicum, I did the Arduino option. There were several issues to this process as the Arduino IDE, the Arduino itself, and the MATLAB program didn't work at various parts of our process. However we were able to collect the data in the end.

Method:
Using the Dry and Wet sensors attached to the Arduino, we measured the voltage values coming from muscles while undergoing different levels of physical strain. For the dry sensor we used the DFRobot Gravity EMG and for the wet sensor we used MyoWare Muscle Sensor. We used a Handgripper in order to create variable differences between different tests. At three levels of exertion, we watched the rise and fall of the voltages, holding the last one longer before releasing to show fatigue or overstrain.

Graphs and Figures:
Dry Electrode with 3 levels of exertion + Muscle fatigue:



Wet Electrode with 3 levels of exertion + Muscle fatigue:



Analysis:

1. Dry vs Wet Electrode:

Based on our experience with the two sensors, I think that the both sensors required a close proximity to the skin and muscle being observed, and this was the most important factor in either case. For the Dry electrode it was easier to adjust this factor since you could just tighten the strap and that would bring the electrode closer to the muscle. For the Wet electrode it was harder to adjust without just manually pressing the electrode down since the attachment process was purely based on the adhesive. It would also seem like the Wet electrode was less sensitive since its base state (muscles at rest) had a baseline of zero, while the dry electrodes still had a fluctuating voltage. This might be a matter of how we applied either sensor.

2. Ability of each sensor to see levels of exertion and muscle fatigue

Both sensors were able to see when the muscles were strained but not necessarily showed the three levels of exertion. I presume that this is because of how we applied the sensor and not necessarily because the sensor itself is flawed but in our findings one would not be able to see the difference of the three exertion levels without pre-knowledge of what was the experiment conducted. Furthermore, neither sensor was really able to see muscle fatigue. Personally I think that this was due to the experiment not actually reaching muscle fatigue.

3. Improving signal quality

I don’t really know how to improve signal quality. I would need to do more research on the specific electrodes to see how we could improve the signal quality. I suspect it has a lot to do with the placement of the electrodes and the calibration part at the beginning of the experiment.

4. Maximal grip strength and time of the Fatigue Test

During the Fatigue test, the Maximal grip strength was 1 lbs and the time that this weight could be sustained was for around three seconds.

5. Why does the EMG signal amplitude decrease with time?

The amplitude decreases with time because your muscle becomes fatigued as it is working. Similar to how you feel tired while exercising, your muscles become strained after time so the electrical activity around the muscle becomes less and less as it is strained.

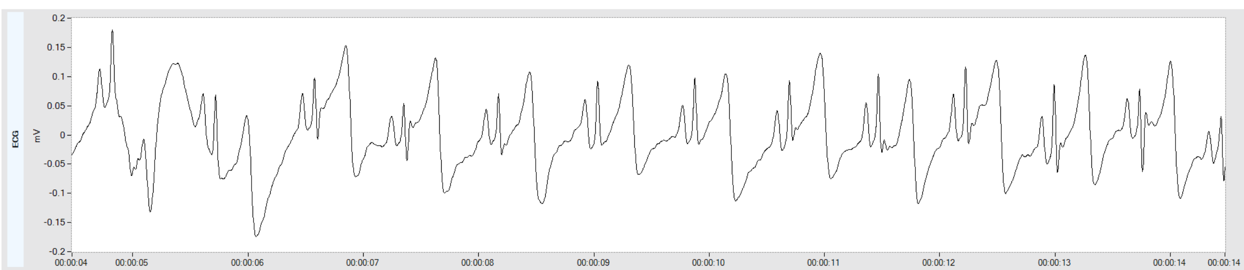
<u>6. Why is the EMG amplitude different with increasing applied force?</u>
The amplitude is different with different forces because when you strain your muscles more, you have different amounts of voltage going through the muscles. This is shown in the graphs above since the different strain amounts have different amplitudes.

Part 2: ECG, Breathing and Heartbeat

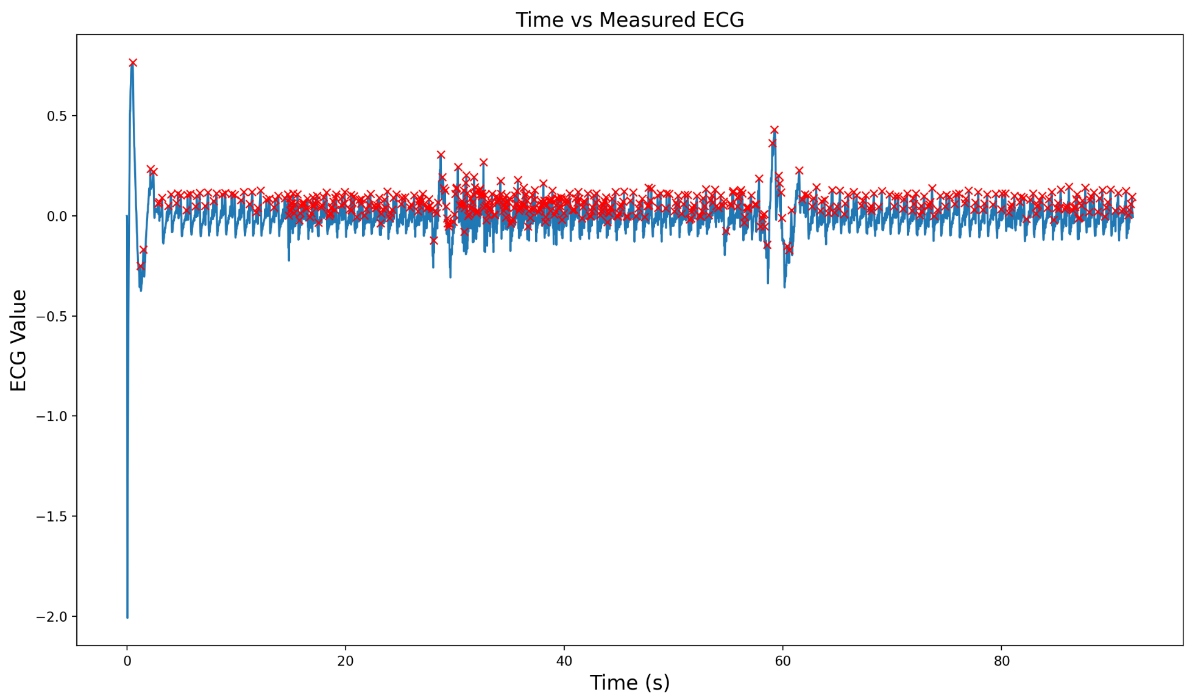
Introduction:
For this part of the Practicum, I did the Bioradio option due to our issues with the Arduino from before. This was done rushed so any errors are probably due to the time constraint.

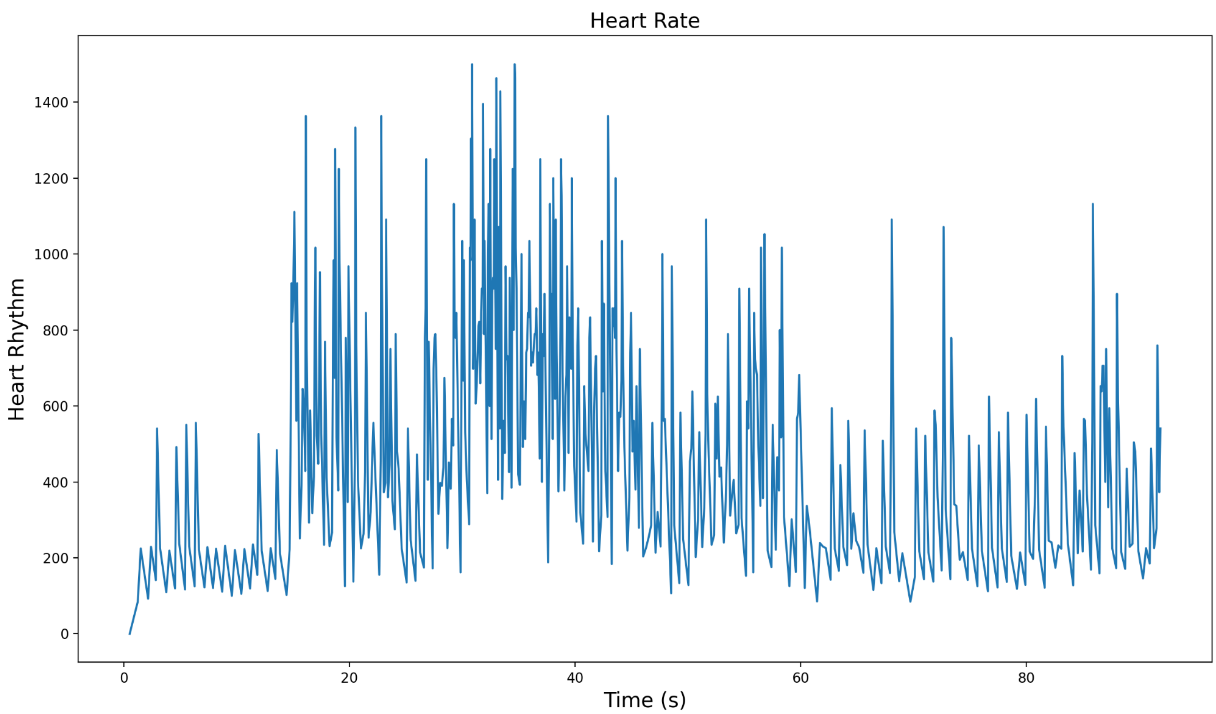
Method:
Using the Bioradio and Wet electrodes, we measured breathing rate in the two different styles. This would let us measure heart rhythm through post-processing the data.

Graphs and Figures:
Raw ECG data:

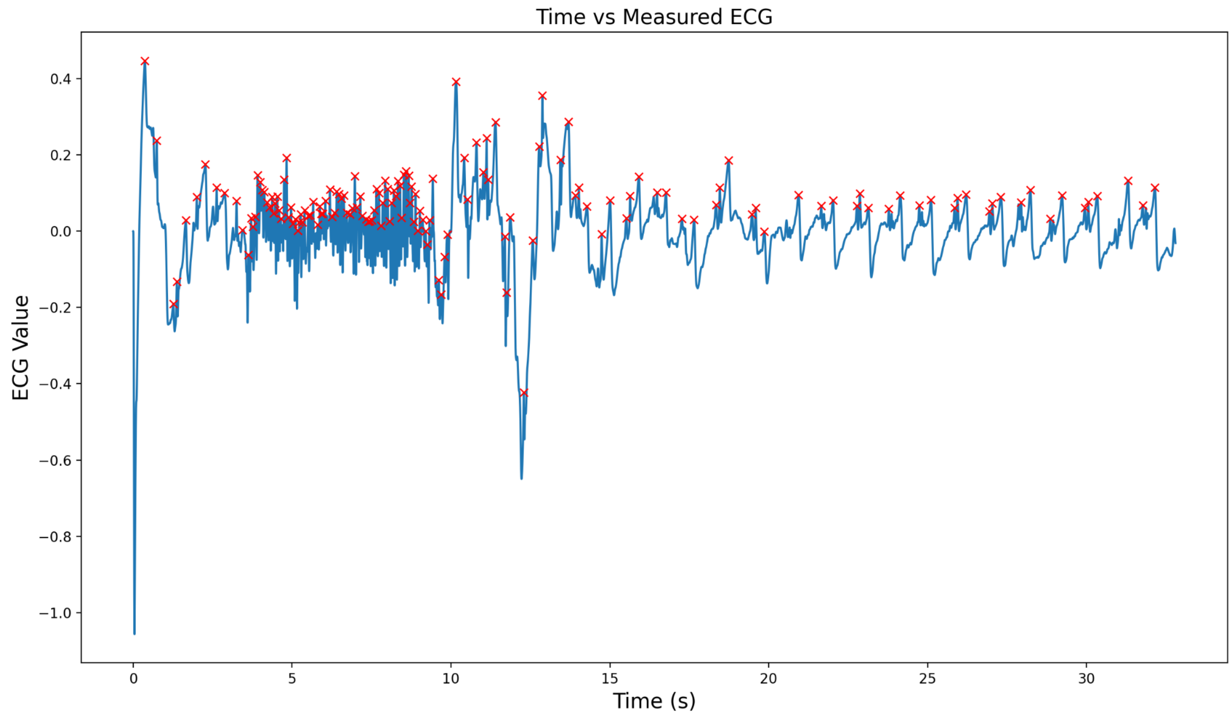


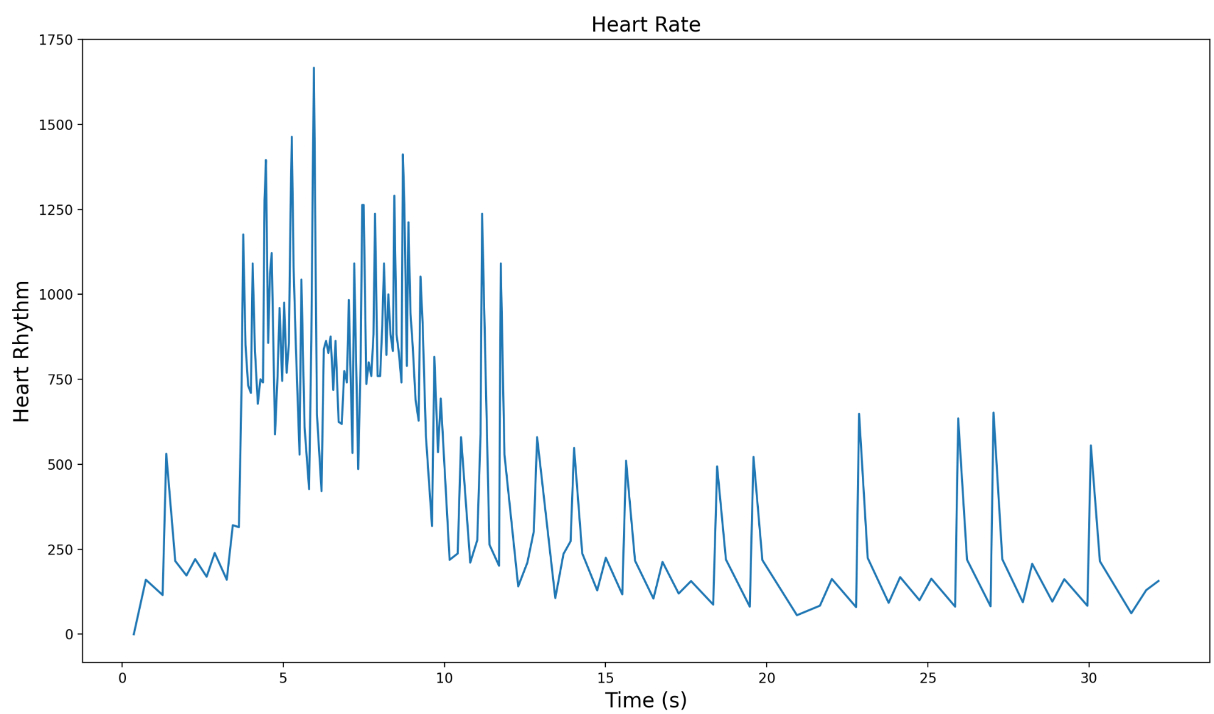
Heart Rate and Breathing Rate graphs for the hold style:





Heart Rate and Breathing Rate graphs for the force style:





Analysis:

1. <u>Heart Rate Prior to Breath Hold</u>

The actual value seems to be somewhere close to 400 bpm but that doesn't make sense since humans have a resting heart rate of 60-100 on average. Something clearly went wrong in the post-processing. However I will say that the heart rhythm is smaller before the breath holding and seems pretty stable.

2. Heart Rate Change during Breath Hold

The heart rate seemed to increase in amplitude and frequency. Even after the breath hold was released, the heart continued to beat at this elevated frequency.

3. Resting Heart Rate before Valsalva Maneuver

Similar to above the specifics of this answer is not applicable since something went wrong with the post processing. It seems that this time the resting heart rate starts out more frequent than the later time.

4.Heart Rate during Maneuver

It seems like throughout the maneuver, the heart rate actually slowed down. It's possible then that this maneuver actually relaxes the heart then, rather than accelerate it to make it more frequent.

5. Did you notice any changes in the signal when you moved versus staying still? What would have caused these changes?

Moving would cause changes to your heart rhythm, depending on if you were moving a lot or a little. This could also manipulate the actual sensors causing some irregularities. But in general movement would cause slight changes to the signal.

6. What do to PQRAT components correlate to physiologically? :

A. P wave: The P wave is the first positive deflection on the ECG and represents atrial depolarization, which is the electrical activation of the atria before they contract.
B. QRS complex: The QRS complex is a series of three deflections on the ECG and represents ventricular depolarization, which is the electrical activation of the ventricles before they contract.
C. ST segment: The ST segment is the period between the end of the QRS complex and the beginning of the T wave and represents the plateau phase of the ventricular action potential.
D. T wave: The T wave is a positive deflection on the ECG and represents ventricular repolarization, which is the electrical recovery of the ventricles after they contract.
E. PR interval: The PR interval is the period from the beginning of the P wave to the beginning of the QRS complex and represents the time it takes for the electrical impulse to travel from the atria to the ventricles.