BME Practicum Two

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Part 1: Photoplethysmogram (PPG) and Heart Rate

Introduction:

In this section of the lab, we used a PPG to measure Heart Rate. The PPG essentially detects color changes in the finger, which indicates changes in blood flow. We then measured this heart rate at different levels of exercise and fatigue. The results from this lab show the accuracy of this method of heart rate measurement for simple tasks.

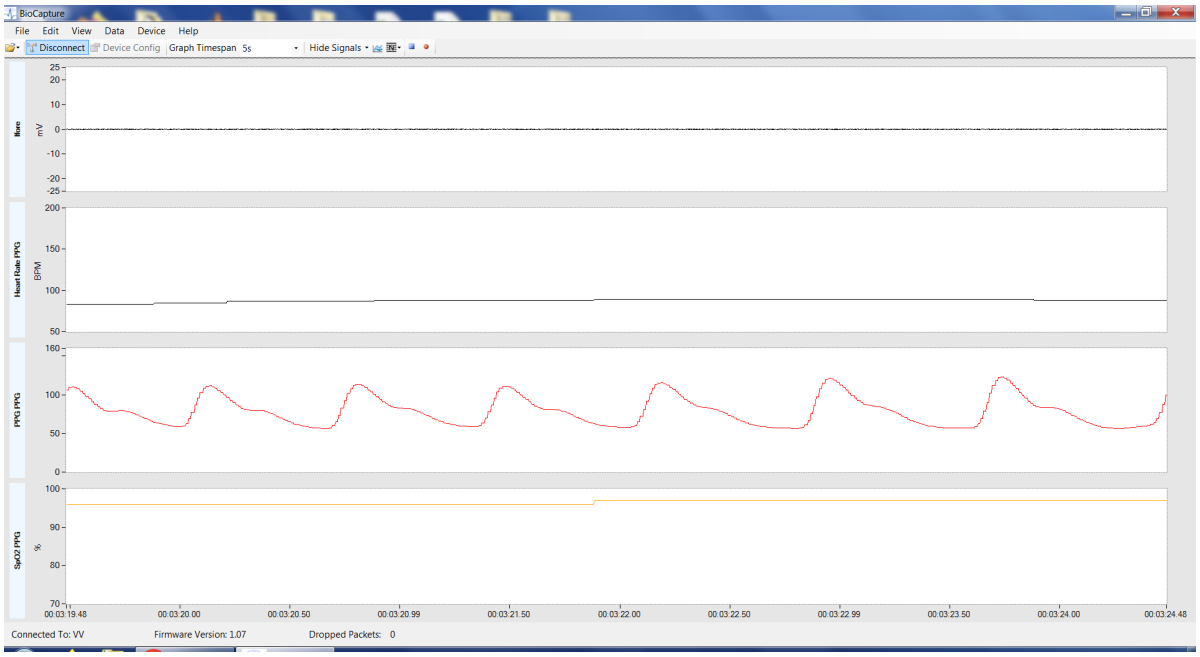
Method:

We put the sensor on our index finger in order to measure the heart rate. The sensor measured changes to the color of the finger, which indicated blood flow. By graphing these changes in color, the program was able to measure the peaks and calculate a heart rate.

Then we tested this measurement at rest, at exercise, and recovering from exercise. While the method was effective at rest and at recovery, the sensor had the risk of being dislodged during exercise. The accuracy of this method in that instance is not as high as at rest.

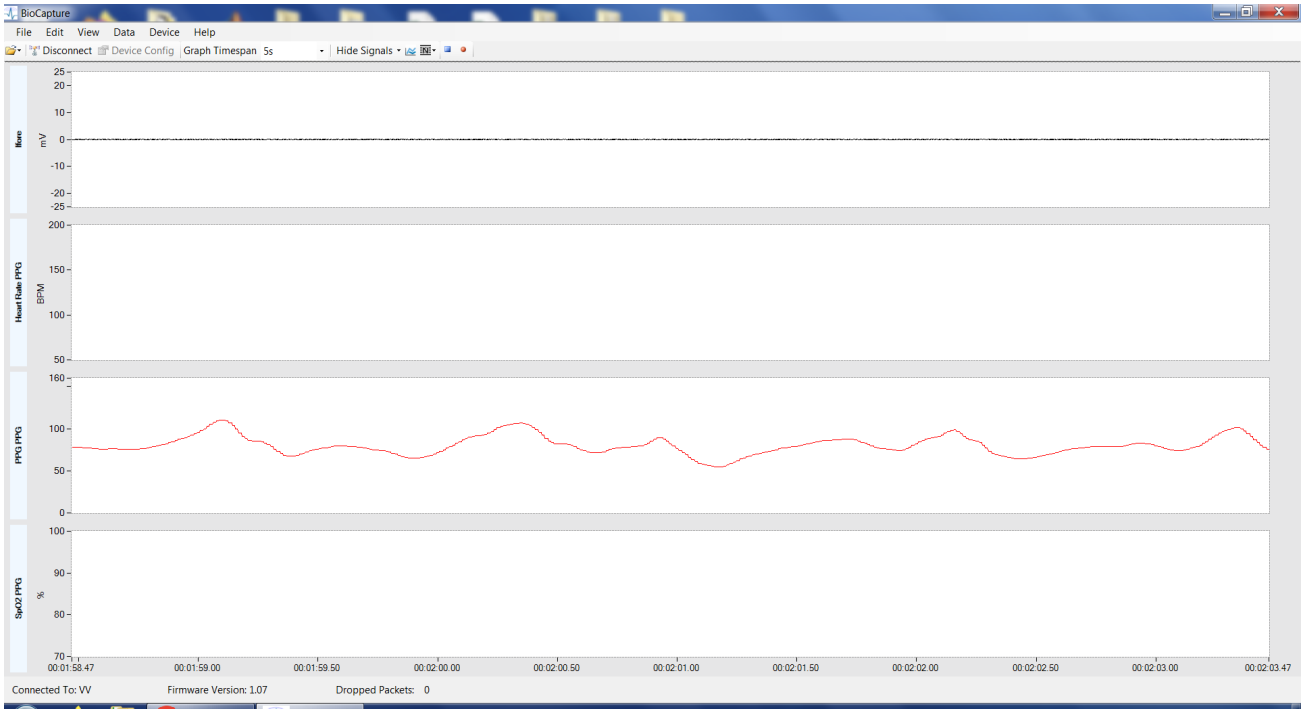
Graphs, Figures, and Measured Values:

PPG during rest:

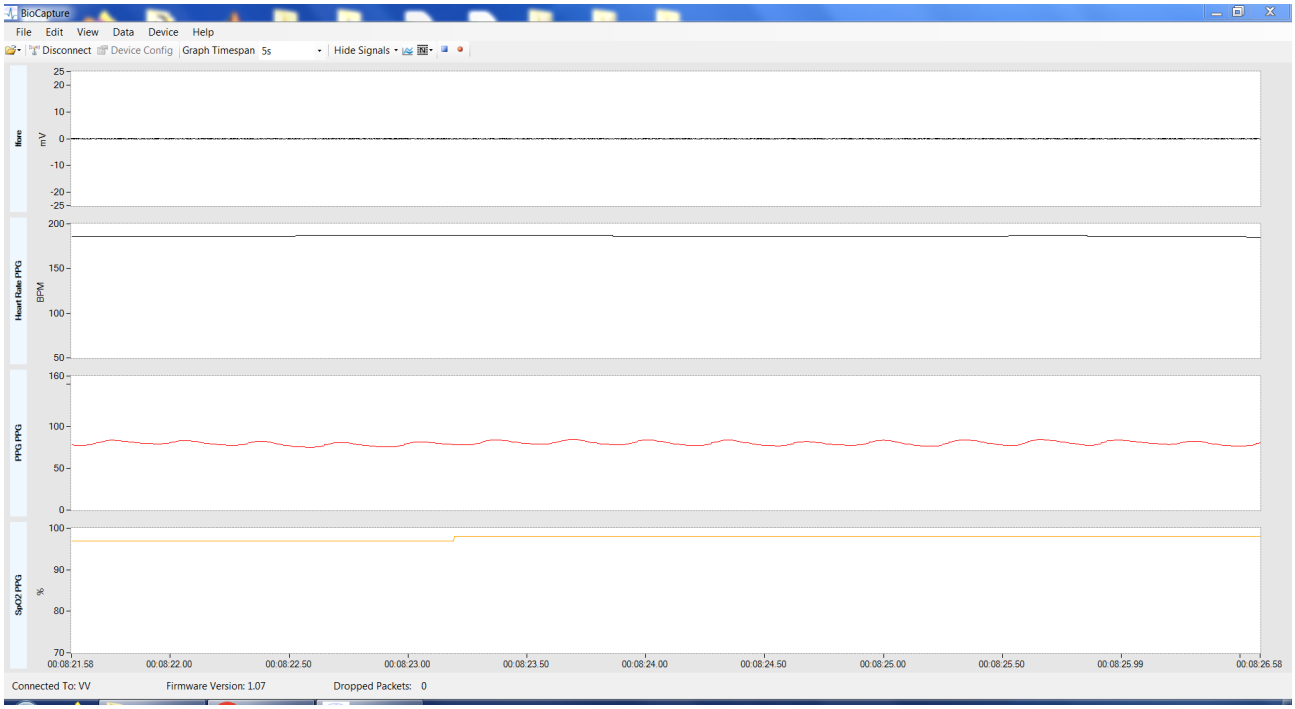


Resting Heart Rate: ≈ 80 BPM

PPG during exercise:



Maximum Heart Rate after exercise: ≈ 180 BPM



Return to baseline time: ≈ 7 min

Analysis:

1. Signal Quality and Heart Rate Variation

The signal quality could be different due how the sensor works. Since the sensor is some color/light sensor, skin color might affect the quality of the signal. Skin that has more contrasting skin colors would be more easily seen, while skin color that has more similar colors might be harder to detect.

Heart rate variation occurs because people are different and have different resting heart rates. People have different health levels which are indicated in the differences of heart rates.

2. PPG signal changes

When the PPG is not on a finger, the data flatlines as it doesn't sense anything. On the graphing program this is simply a horizontal line. Of course when the sensor is on the finger, the sensor sees the periodic heart rate.

When the PPG has pressure applied to it and therefore on the finger, the signal becomes weaker. This is because you are squeezing your finger and preventing blood from filling the digit. Despite the heart continuing to pump, the sensor will not sense it correctly.

3. Signals while Exercising

While exercising, the signal became weaker. I suspect this is more due to the sensor being placed on an appendage that was moving and therefore spoiling the sensor capabilities. This means that the peaks were harder to fully measure and the BPM measurement was difficult to make accurately by the program.

Part 2: Electrodermal activity (EDA) and Sweat

Introduction:

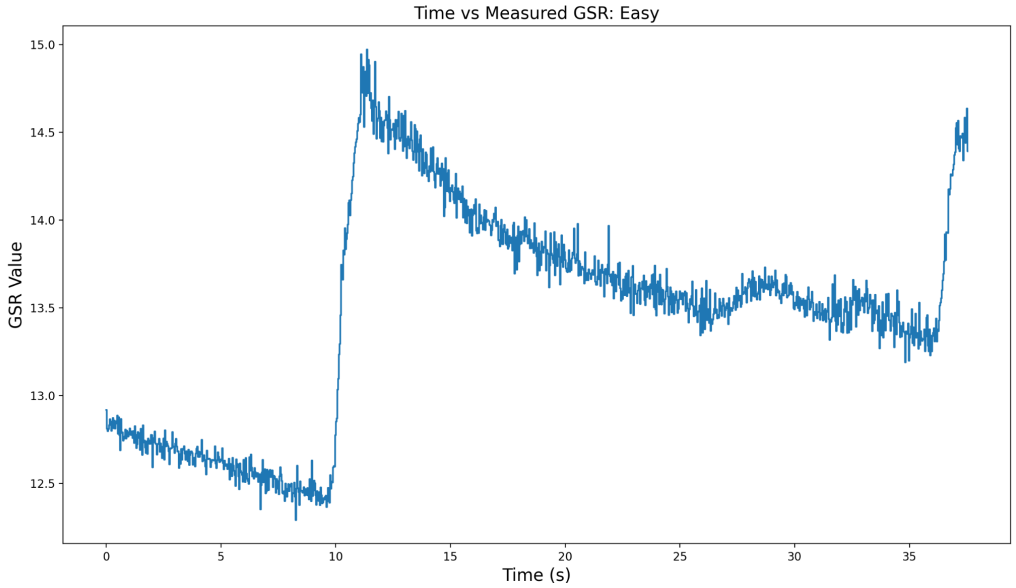
Using an EDA sensor to measure sweat levels on the skin, we measured stress levels when doing a stressful mental activity. This could be important for measuring stress levels when we cannot see a person visibly. This could help alert emergency situations for when we are blind in some way.

Method:

We attached the EDA sensors to the index and middle finger, as well as one on the wrist bone to act as a ground, to measure changes in the voltage on the skin. Then we

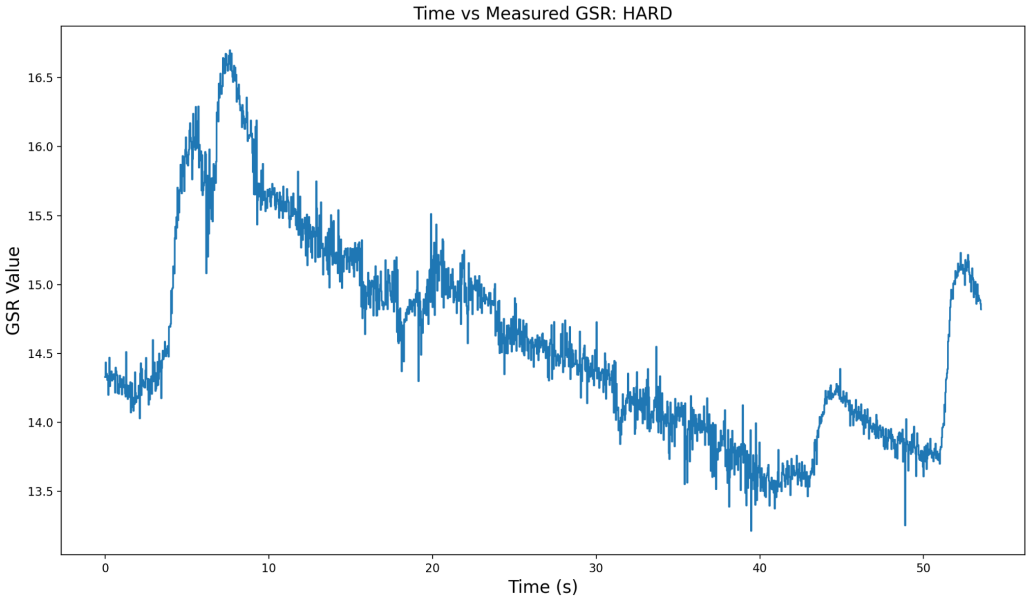
performed two tests (Stroop Color Test), one more stressful than the other, to see if the voltage measured changed in the more stressful situation.

Graphs, Figures, and Measured Values:
Graph of EDA response to Easy ESCW test:



Time it took to complete Easy test: 12.869 seconds

Graph of EDA response to Hard ESCW test:



Time it took to complete Hard test: 36.124 seconds

Analysis:

1. General features of the data

Both graphs seem to have a large voltage increase near the beginning of the test. As the test goes on the voltage goes lower and lower, presumably because the stress lowers as your mind gets into the test. This shows that stress, although sudden, doesn't continuously affect a person but rather goes down over time.

2. Differences between Easy and Hard test:

Both graphs seem to have a voltage increase near the beginning of the graph where I assume the skin reacted to the stress. For the harder test, this spike happened earlier than the other test. The data is also more chaotic in the harder test and fluctuates a lot more although this could be a scaling issue due to the increased time measured in the harder test.

Overall the data in the harder test seems to have a lot more fluctuations and higher amplitude values. This seems to indicate that one could use EDA to measure different stress levels qualititatvely accurately. However this might be a good test on a more quantitative level since the data fluctuates so much.