Measurement of Electrical Activity in Skeletal Muscle

Honors 200

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Purpose:

The purpose of this project is to obtain experimental data for signal analysis in a course taught by Dr. George Bekey.

Background Information

In order to sustain life bio-potentials, voltage differences, must be maintained throughout the body. These potentials are maintained through continual consumption of energy. A bio-potential allows for signals send information throughout the body. These signals and bio-potentials are important to the function of body systems including: muscle movement, neural activity, and sensory functions. Some signals travel throughout our body, while others are localized. In our project we will be experimenting with the signals located in the bicep muscle. Knowing more about these complex signals not only expands our understanding of the human body, but it can also aid in efficiently diagnosing problems. In our project we are going to use the CleveMed BioRadio as an electroencephalogram (EEG). The EEG will record the signals through electrodes connected to our bicep.
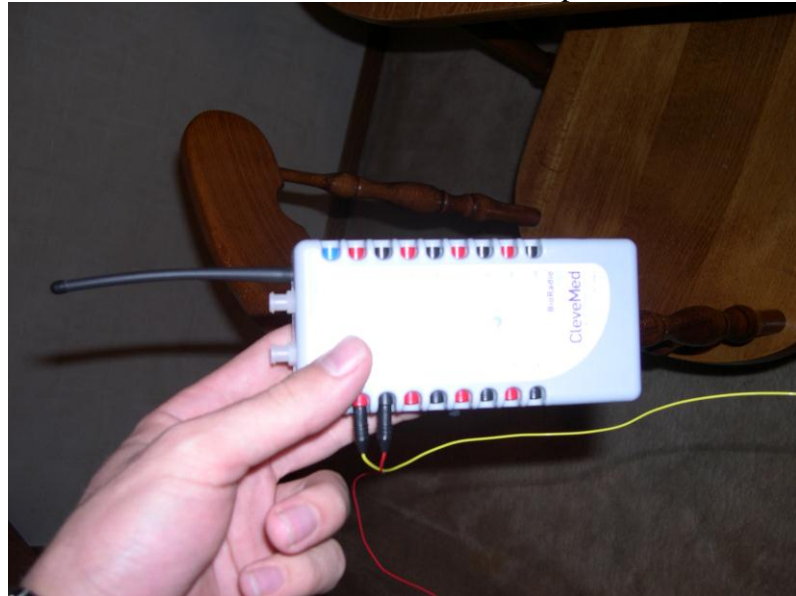
Procedure:
1. Install the CleveMed BioRadio program on the computer hard drive.

Image 1 - Software Installation

2. Follow the instructions from the CleveMed Installation Wizards to connect the wireless Bio Radio to the computer.


Image - 2 Bio Radio Hardware

3. For sterile purposes, use alcohol prep pads and an abrasive skin prepping gel to prepare the subjects for testing. Gently wipe the pads and apply the gel on the desired surface.

Image 3 - Preparing for the connection

4. Locate the targeted muscle and place EEG disc electrodes, which are connected to the wireless CleveMed BioRadio, on the surface of the muscle group to detect muscle signals (in Hertz) and a controlled muscle group.

5. Set up the preferred configurations in CleveMed BioRadio software for best results/data. Configure the DSP filter, frequency cut-off and sampling rate.
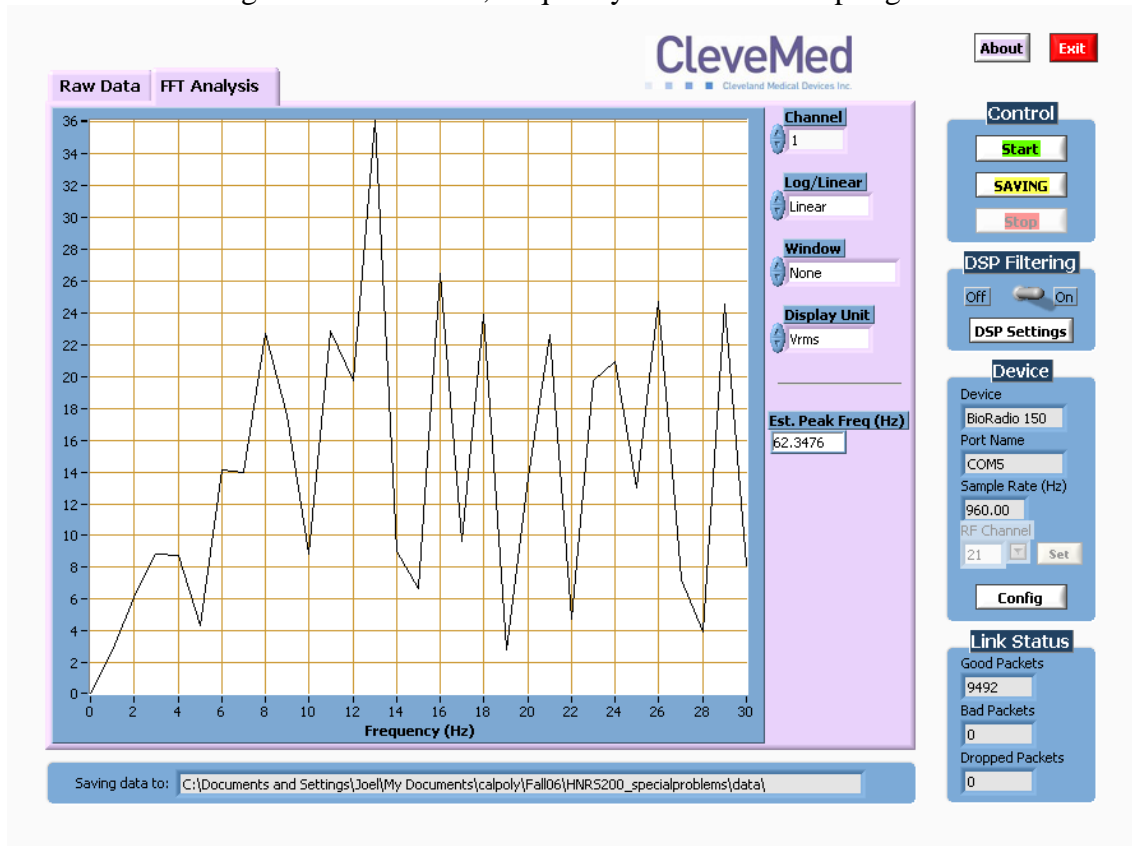
Image 5 - Cleve Med Software

6. Set the muscle group in motion in order to detect impulses. The data collected is saved in Microsoft Excel's workbook format. The data can be graphed through Excel using the scatter plot option.


Image - 5 Data Collection

(For this particular experiment, the right bicep was targeted muscle group and the left anterior deltoid was the control. A twenty-pound weight was lifted from fifteen to twenty repetitions. This procedure was repeated, at least, three times to obtain data variations for the best analysis. Moreover, all team members participated in the experiment to gather different types of data.)

Data Obtained:

Utilizing a filter within the BioRadio 150 software package, we were able to get reasonably accurate muscle impulse data. The filter we used was a High frequency cutoff filter, which eliminated all data coming in at frequencies higher than a given frequency, which we defined within the software as 150hz. Looking at the voltage versus time graphs, one can see that the voltage spikes within very short intervals of time, these spikes are observed in the data whenever the subject utilizes the muscle being tested. Figure 1 shows that spikes occur once for every repetition of the test exercise. In this

case, the subject preformed 20 bicep curls, and there are approximately 20 spikes within the data.

MicroVolts vs Time
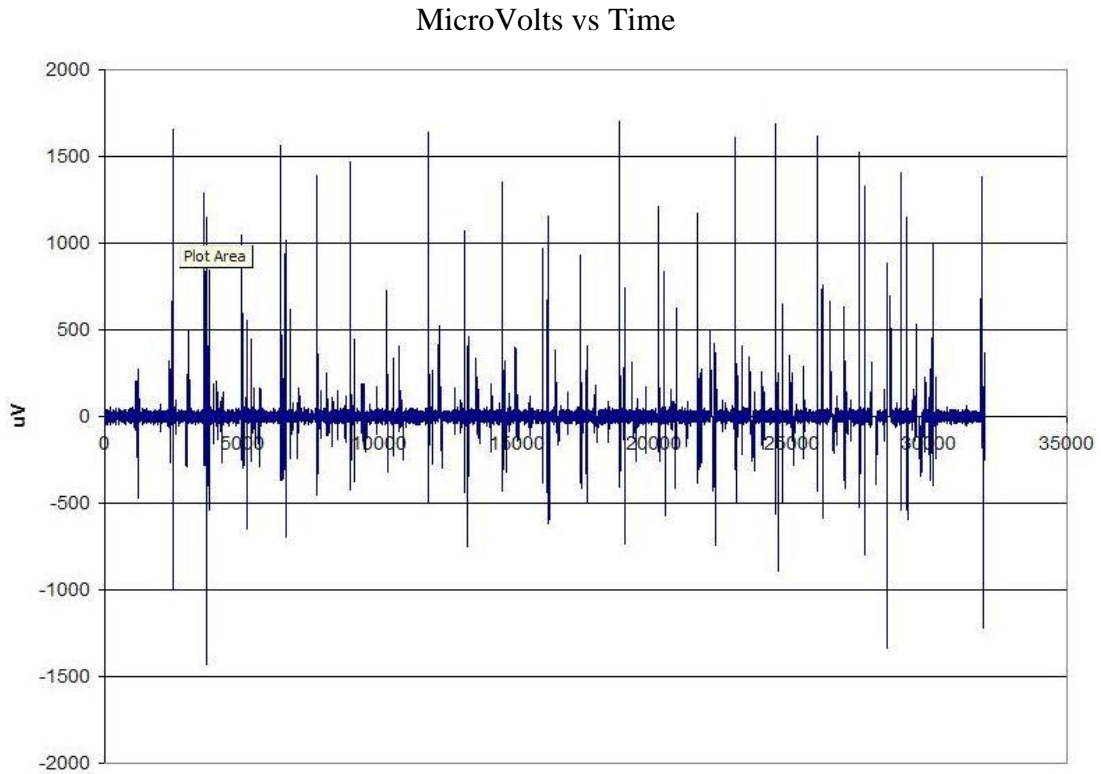
Figure 1 - Signal Output

In Figure 2 on the top of the next page, which is a zoomed in view of one section of the first graph, one can see that the impulse of electrical potential occurs incredibly rapidly, in this case, within approximately 15 milliseconds.
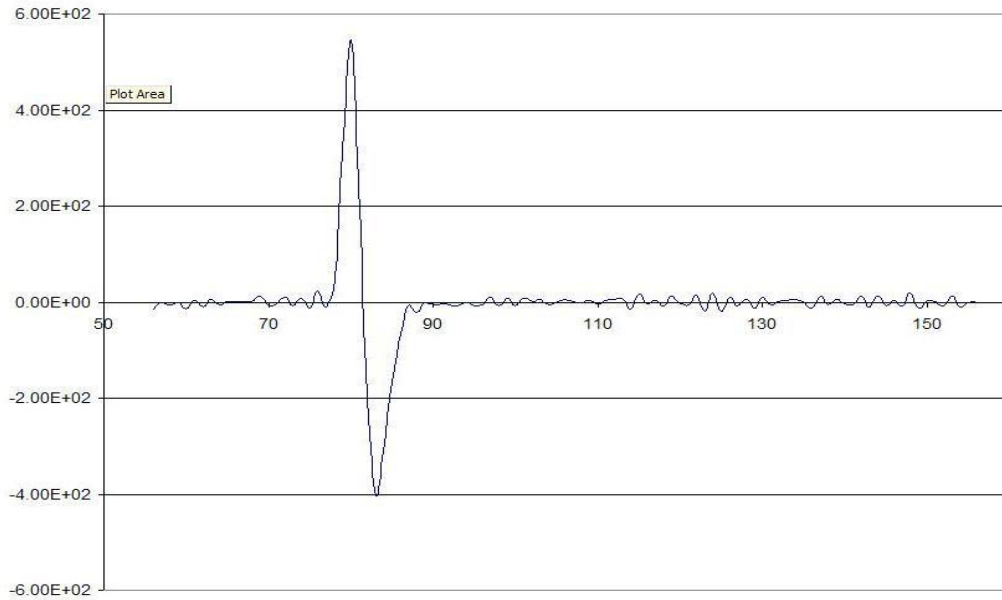
MicroVolts vs Time

Figure 2 - Zoomed Muscle Stimulation

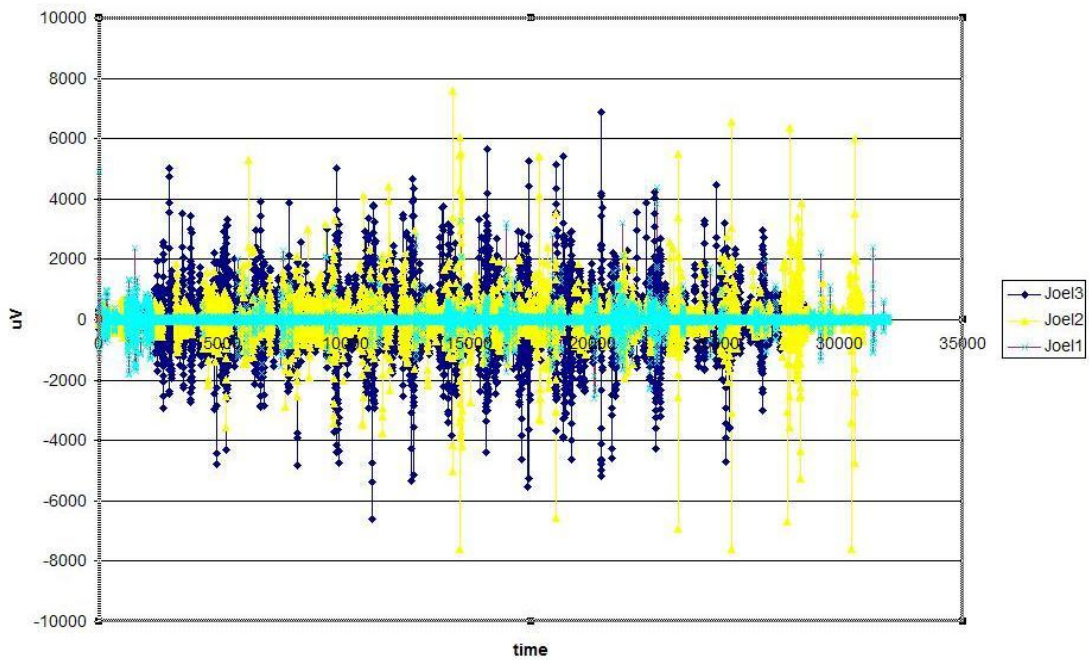Figure 3 below shows three consecutive tests for the subject.

MicroVolts vs Time

Figure 3 – Multiple signal recordings

File naming convention:

To ensure that future users of our data know exactly how the data was obtained, we developed a file naming convention that contains all the crucial information needed for each set of data collected. The naming convention makes note of the subject that the data was obtained from, the chronology of the test, the sampling rate of the test, the type of filtering used on the data, the range samples were taken at, and what the subject preformed during the test.

An Example file name is:

Subject3_T3_960hz_CF@150hz_+-12mV_11lbWeight

- "Subject#" is the subject from which the data set was obtained (Subject1 is Joel, Subject2 is Jeri, and Subject 3 is Alan)
- "T#" is the order in which the data sets were obtained, from each subject (T1 was obtained from the first set of weight lifts, T2 from the second etc.)
- "#hz" is the sampling rate at which the data was obtained
- "CF@#hz" describes the filter used when sampling the data (CF@100hz means a cutoff filter was used at 100hz, noCF indicates no cutoff filter was used)
- "+-#mV" indicates the range at whch the data was sampled
- "#lbWeight" is the weight lifted by the subjects bicep (in curling position) during the test

Conclusion:

This project proved to be very interesting. We were able to make a few conclusions through analyzing our data with the aid of Dr. George Bekey. Our data showed that there is an increase in signal voltage as a bicep muscle is contracted shown in figure 1 above. Our data in Figure 3 showed that as the muscle becomes fatigued the amount of noise in the muscle is increased. Dr. Bekey confirmed our data, and indicated that it should work well for future signal analysis in his course. This Project proved to be very interesting, exposing us all to an area of experimental scientific research, which we hadn't had any experience in before.

Bibliography

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The Input-Output Relations of Skeletal Muscle

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