Surface electromyogram

How to work as a group

This lab involves three parts. First, assembling your lab equipment, taking measurements and writing a report.

As usual, you only need to turn in one report. But feel free to have fun and each collect your own data and compare the readings with each other. If there are substantial discrepancies, feel free to put the graphs for multiple people in the same report (you don't have to tell me whose pictures are whose unless you want to).

Building the board

The main work in this lab is building your equipment. This lab uses the equipment to collect a *surface EMG* (sEMG), which is a reading (at the skin surface) of the electrical voltage that your body's neurons use to drive your muscles. Later, we will use the same equipment to take an *ECG*, which measures the electrical voltages that your heart produces.

There are separate documents on how to build the equipment and how to use a scope; you can find both on the course web page. There is also a safety document and a legal document, both of which must be read before doing the lab.

Where to attach the skin pads

For this lab, you should attach:

- The blue electrode is the positive input. Attach it right at the middle of your biceps muscle (the belly of the muscle, which is the largest-diameter part of the muscle).
- The black electrode is the negative input. Attach it slightly above your elbow, trying to ensure that it is not on top of any muscle (bone or fat is fine).
- attach the RLD (red) electrode to your wrist on the same arm as the other electrodes.
- we have skin-prep tape available. It is essentially very fine sandpaper; if you scrape your skin *lightly* with it (don't scrape yourself red!) then you get a better connection and stronger signals. Most people do fine without it until cold weather comes and your skin becomes drier.

For all three electrodes, as usual, if you can avoid locations with a lot of hair you'll get better skin contact – as well has having a less painful time removing the pad later.

What to measure

You should get four or five readings.

1. With your arm completely relaxed and your lower arm resting on a table.
2. Use your arm muscles to hold your entire arm horizontal (and off of the table!)
3. Put your arm back on the table, but now "make a muscle" – clenching your biceps as hard as you can.
4. Gradual increase in force from your arm quite relaxed to a maximal contraction.
5. Optionally, if you have plenty of extra time, we have plenty of AD8232 boards, and our scopes have two channels. You can thus probe two different muscles at the same

time; e.g., biceps and triceps. Put yourself in the place of an amputee who would like to, e.g., use their biceps and triceps sEMG to independently control their artificial hand (e.g., use their biceps to make their wrist bend and use their triceps to pinch their thumb and forefinger together). Can you operate these muscles independently at will?

Discussion questions

1. Compare the results you got for the four main readings. Can you explain how they differed and why?
2. Humans exert more muscle force both by increasing how many motor units they activate, and also by increasing the frequency of activation.
    a. Can you explain why recruiting more motor units might result in you seeing a larger signal amplitude (which hopefully you did see)?
    b. Can you see any correlation between the increasing forces and the frequency of the signal you read? If not, then why do you think you're not seeing it?
3. An artificial-hand prosthetic might have two movements: thumb/forefinger gripping and wrist rotating. You've shown that it's easy to read an sEMG from the biceps muscle; in fact, the triceps is also easy to access. For an amputee who has lost their hand, what might be pros and cons of using the biceps & triceps sEMGs to control a prosthetic hand's gripping and wrist rotation respectively?

What to turn in

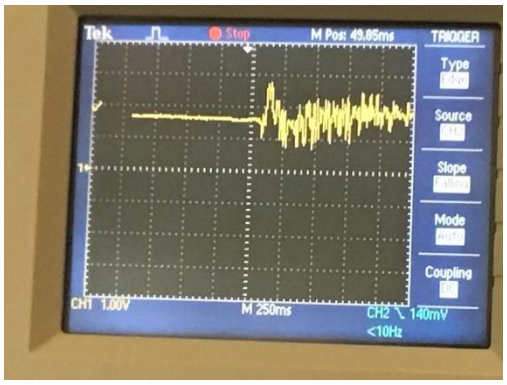
- Turn in your four sEMG pictures, along with the answers to the three questions above.
- You only need to turn in one lab report per group (though, again, you're encouraged to all do the experiment).

Extra credit

Here are a few interesting things you can do if you choose. Turn in pictures or videos showing what you did.

Sample waveforms

Here are some waveforms that I collected. They can give you an idea what to look for. And if you don't want to turn in your own readings (which do constitute protected medical records), feel free to use these as your own.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Slope
Mode
Coupling
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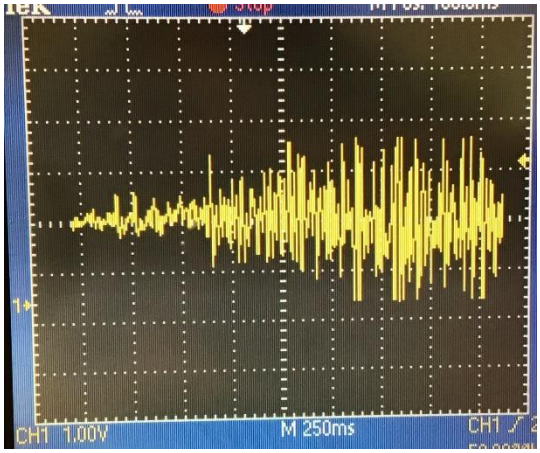
CH2 140mV
<10Hz


CH1 1.00V
M 250ms
CH1