Laboratory 2 | Electromyography

SYSC 4203: Bioinstrumentation | Lab Manual

Guidelines

Instructions

Indicates the step requires a screenshot. These screenshots may be useful in answering the questions. Only the screenshots listed in the Lab Write-up instructions will be graded. They must be printed and attached to your lab report.

Indicates the step requires saving 30 seconds (though it's sometimes 10 or 60 seconds) of data. Save your data files with the name indicated. This will make your postlab quicker to complete.

Lab Write-up

Step 1

Complete the Lab and take screenshots requested. They will be used to answer the questions.

Step 2

Print and attach the following plots

1. Data from **bicep_isometric** file and identify when weights are being added.
2. RMS envelope of **bicep_isometric** calculated with the 1s analysis window.
3. Plot of mean RMS it as a function of the number of books (x axis).
4. Data from **bicep_isotonic** file and identify the time instances when the muscle length is varied.
5. RMS envelope of **bicep_isotonic** calculated with the 1s analysis window.

Step 3

Write your answer to all questions.

Step 4

Labs will be submitted to the drop box for ‘sysc4203” outside ME4460 before 2:00pm one week after the lab. All Matlab/Excel figures should have a title, legend (if more than 1 signal per plot), x axis label and y axis label with units indicated.

To load a collected data file in matlab, you can use `a = load('normalairflow.data');` to load the file as a double array.

Laboratory 32 | Electromyography

Learning objectives

- Observe the EMG waveform
- Observe the relationship between force and EMG amplitude during isometric contractions; to understand spatial and temporal recruitment
- Observe the relationship between joint angle and EMG amplitude during isotonic contractions; to understand effect of muscle length

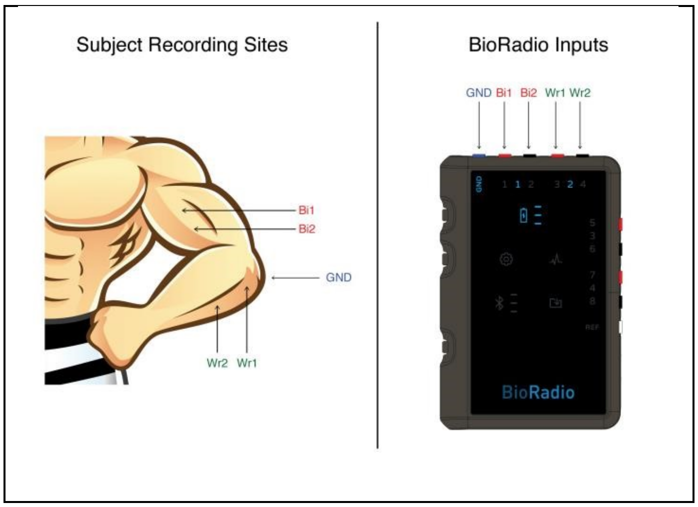
Materials:

- Wireless BioRadio System x3
- Snap electrodes x3
- Alcohol wipes x2
- Grey snap leads x3
- Each student should bring 2 textbooks to use as weights to elicit moderate contractions.
- Space on the lab benches should be sufficient to rest elbow. It is preferable for subject to be sitting comfortably while doing lifting tasks.

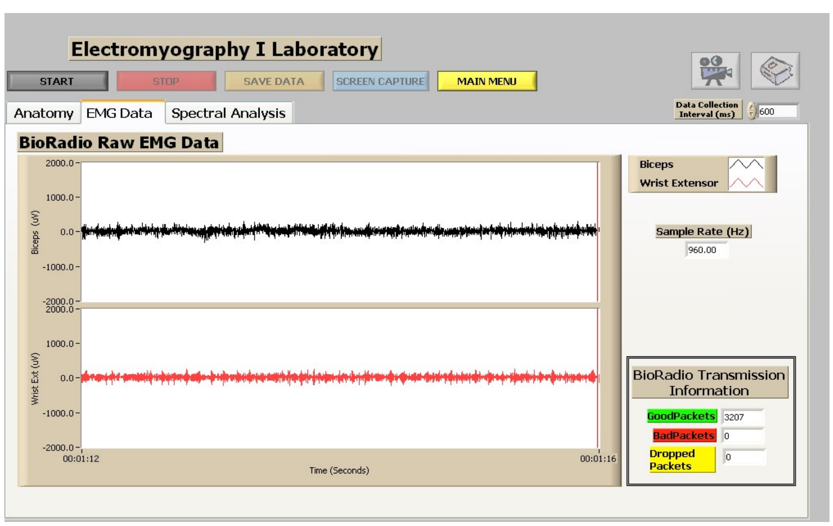
1.0 – Equipment Preparation

1.1 Run the *BioRadio_Lab_Course* software. Login and select *Electromyography I* from the *Basic Physiology* laboratory section on the left. Select *Begin Lab*. Turn on your BioRadio and pair it with the software.

1.2 Attach snap electrodes to the recording sites as shown, wiping the skin with an alcohol wipe first. Connect snap wires to the electrodes and connect the wires to the BioRadio inputs as shown.



1.3 Click on the EMG data tab and then on the green "Start" button. Two channels of EMG should begin scrolling across the screen. The top plot shows your bicep EMG. We are not using the second plot. When you look at your data files later, there may be a column of 'noise' from this plot, ignore or delete it.

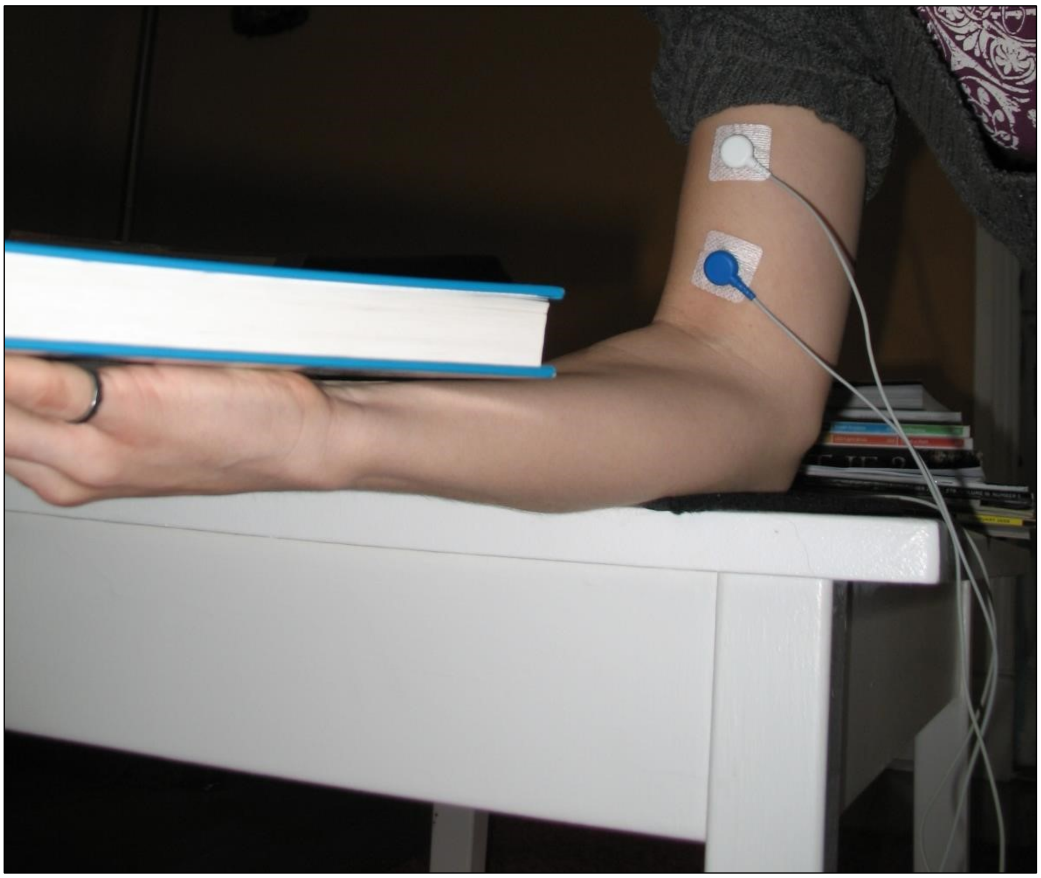


2.0 - Isometric Contractions

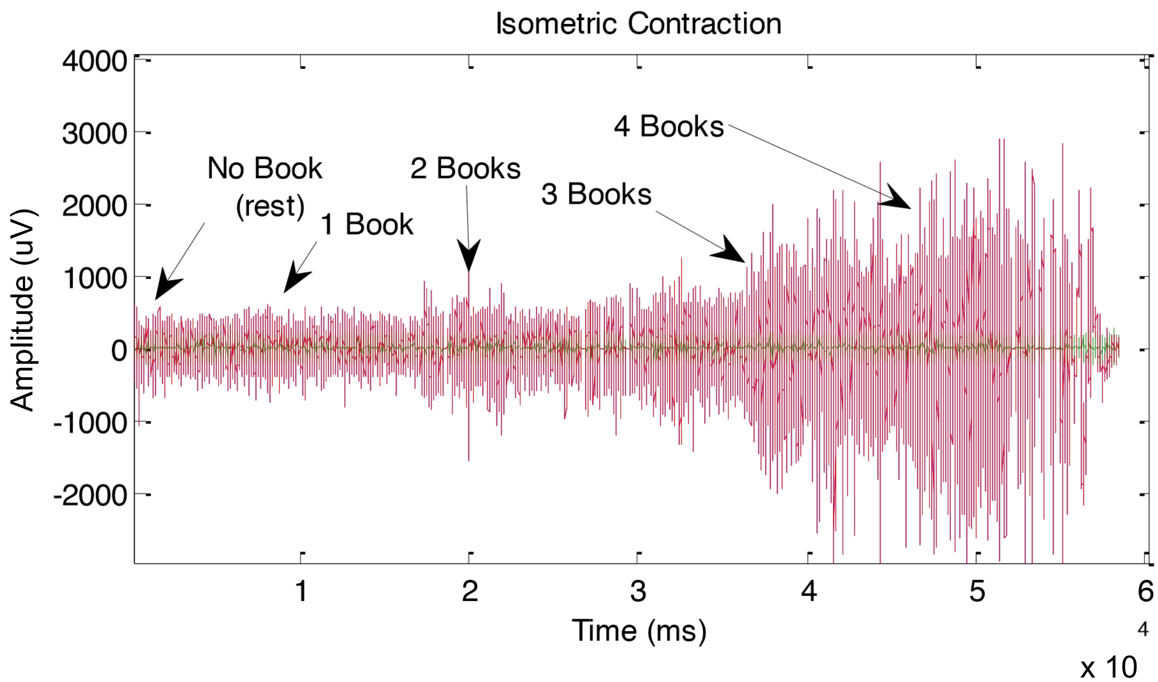
In this section, we observe the relationship between force and EMG amplitude during an isometric contraction. The angle of the elbow must remain constant during this experiment.

Procedure and Data Collection

2.1 Rest your elbow on the edge of a table and bend it at 90 degrees. Try to maintain the angle of your elbow throughout the experiments as shown in the following figure.



2.2 Start the data collection (SAVE DATA) and save the file as **Bicep_Isometric**. The lab partner should place the first object (textbook) in your hand, leave it there for 15s, then add another one every 15s. Proceed only while you feel comfortable doing so. Stop the data collection. In the Post Processing Toolbox verify that the amplitude of the EMG signal increases slightly with the weight of each added object like in the figure below. If you can't see a similar shape, collect data again. Maybe the books are too heavy (or light) for you.



Report

a) How do you expect the EMG signal to change as more force is applied to an isometric contraction? (max 100 words)

b) Plot the signal of the **Bicep_Isometric** file and identify when weights are being added (as in figure above). Print, label, annotate and attach this plot to the report.

c) Calculate the RMS envelope of the signal using a sliding 1s analysis window. nb. sliding 1s analysis = moving average using 1s of data to calculate each value. Plot the RMS envelope calculated with the 1s analysis window.

d) For each 15s interval of lifting 1, then 2... books, what is the average RMS value of your signal? Plot it as a function of the number of books (x axis).

# books	Average RMS (µV)
1	
2	
3	
4	

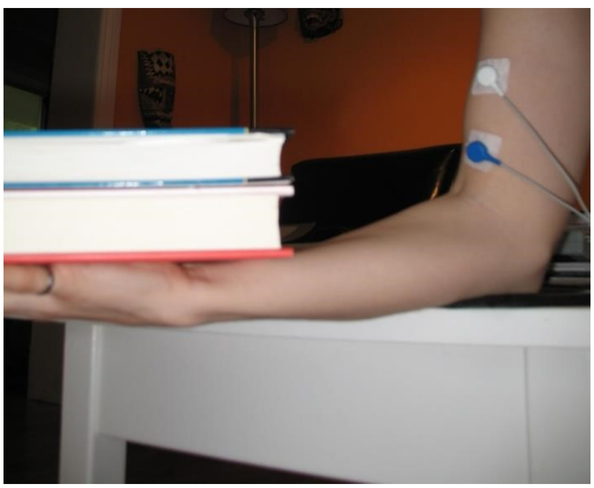
e) What happens to the number of activated motor units and their firing rates when the weight is increased? (max 100 words)

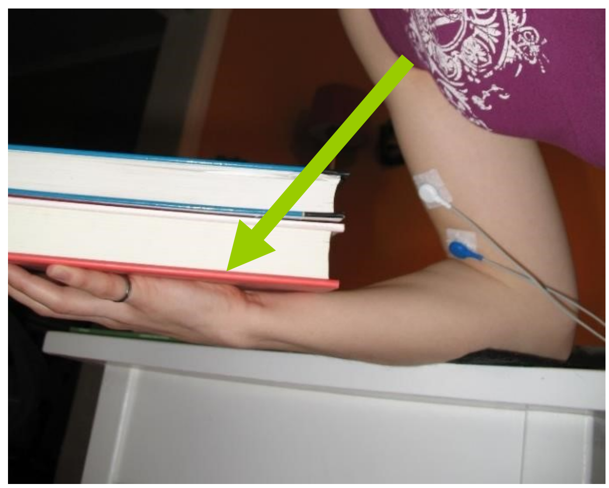
3.0 - Isotonic Contractions

In this section, we observe the relationship between joint angle and EMG amplitude during an isotonic contraction. During this experiment, the angle of the elbow will vary.

Procedure and Data Collection

3.1 Rest your elbow on the edge of a table and bend it at 120 degrees. ask your lab partner to place 1 to 4 textbooks in your hand. Start the data collection and save the file as **bicep_isotonic**. Every 15s bend your elbow 30 more degrees, keeping your forearm parallel with the ground. Your shoulder will progressively get closer to your hand as shown in the pictures below as your arm bends to 120° then 90° then 60° then 30° degrees. Stop the data collection when you are done.





3.2 Make sure you have all the data and screenshots you need. Save the data folder(s) and the reports folder(s) onto a USB stick. Turn your BioRadio off and neatly put away all other accessories.

3.3 Do not forget to remove your USB drive!

3.4 Read through the postlab to make sure you understand the questions before leaving the lab.

Report

a) Plot the signal of the bicep_isotonic file and identify the time instances when the muscle length is varied. Plot the RMS envelope calculated with the 1s analysis window.

b) What is the average RMS value of your signal for each position (ignoring time when the arm is moving from one position to another)? Plot the value (y axis) as a function of the angle (x axis).

Angle	**Average RMS (μV)**
120°	
90°	
60°	
30°	

c) What changes occur in your muscle to create the shape of the plot in question 8b? Draw the sliding filament model diagram of a muscle fibre and use this model to support your answer. (max 100 words)