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EEEE 536/636– Bio-robotics/Cybernetics

Experiment #1: Collecting EMG Signals using "BioRadio150" and Lab Stream Layer

I. OBJECTIVE:

The goal of this lab experiment is to introduce the student to biopotential and how they can be recorded using the Cleve Med Bio Radio 150 and "Bio Capture" software. This experiment includes data collection and analysis of electromyograms EMG. Students are expected to learn how to use Lab Stream Layer, import Data into MATLAB

II. INTRODUCTION:

The human body is very complex and consists of many systems including mechanical, electrical, and chemical systems. The electrical system within the human body includes electrical potentials that propagate down nerve cells and muscle fibers. Numerous events that occur the body such as brain functions, muscle movements and eye movements are invoked by these electrical potentials. Physiological potentials arise from the ionic currents that flow in an out of the nerve and muscle cells of the human body. These biopotentials are typical measured using various electrodes in combination with electronic instrumentation. Through the collection of data from biopotentials further insight can be acquired on how the different systems within the human body are functioning.

III. THEORY

A. Electromyography

There are three categories of muscles in the body including cardiac, smooth, and skeletal muscles. Focus will be placed on skeletal muscles are for they are the muscles attached to the bones and are under voluntary control. Muscles are attached to bones via tendons and during a muscle contraction the tendon pulls the bone and movement occurs. Muscle contraction is invoked by an action potential and it can be measured with electrodes on the surface of the skin. The measurement of these action potentials is called an electromyogram or EMG. As like EEG, EMG is also a summation of all the action potentials occurring in a muscle during a period.

A single action potential, an average, lasts for 1-3 milliseconds and can relate to a muscle contraction lasting, on average, 10-100 milliseconds. A contraction as a result of a single action potential is referred as a twitch. Twitches occurring in high frequency are called a tetanus response and are further categorized as fused and unfused. In unfused tetanus the twitches are still noticeable, whereas in fused tetanus individual twitch can no longer be distinguished. Most muscle contractions correspond to action potentials with frequencies in the range of 8 – 25 Hz.

EMG can be recorded from the surface of the skin with a frequency ranging from 2- 500Hz and amplitude between 50µV – 5mV. Movement artifacts within an EMG are generally lower in frequency and can be attenuated with a high pass filter. A simple method for processing an EMG signal is to rectify the signal (take the absolute value) and determine the average value of the waveform. Another method is to find the average power of the EMG signal by calculating the RMS power or root mean squared power of the waveform.

B. Electrodes

The type of electrodes used to measure biopotentials are dependent on the biopotentials being recorded and their application. The two electrodes used in this lab are the metal plate snap electrodes and the gold cup electrodes. The metal plate snap electrodes are composed of a small silver or silver plated with chloride disc surrounded by a foam padding with an adhesive. The metal plate snap electrode can perform DC readings with low noise and small drift, making them suitable for ECG, EMG, and EOG recordings. The gold cup electrodes are most common is EEG reading for their small size an ease of placement. The gold cup electrodes require a paste to adhere the electrode to the skin.

IV. LAB

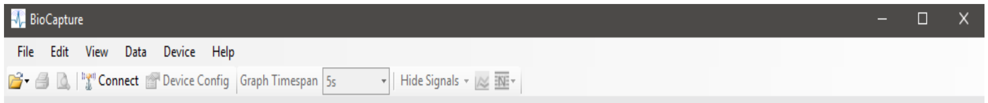
A. Safety Precautions

Before performing the experiment, it is important to know and exercise caution with regards to some of the potential safety hazards associated with bioinstrumentation. There has been a great amount of effort placed by the designers of the Bio Radio 150 to ensure the user is never connected directly to ground. If a user is directly connected to ground, equipment failure could result in electrical currents passing directly through the user and to the ground. When used in normal operation the Bio Radio 150 couples the user using battery powered RF isolations. However, it is extremely important that you do not attempted to dissemble the Bio Radio at any time and in any way. Also, for extra precautionary measures, while using the Bio Radio 150 avoid meeting large sources of ground such as the back of a PC, power supplies, function generators, oscilloscopes, etc.

B. Electrode Placement

1. Review the setup movie for EMG in this link: https://www.youtube.com/watch?v=3L7jpQA_5AI.
2. **Placing the Electrodes** (In a muscle area where you can collect strong signals) Place two electrodes at the inner side of the forearm or (close to the inner side of the wrist). Place two other electrodes at the outer side of the forearm or (close to the outer side of the wrist). Place one electrode at the elbow (muscle free area)
3. After the electrodes have been placed on the subject, connect one snap lead to each electrode. Then, connect those snap leads to the harness inputs for channels 1, 2, and the ground using the picture above as a reference (Fig 1). The leads on the harness are stackable allowing one snap lead to be plugged into more than one connector lead.
4. Plug in the "**USB Receiver**" into the PC
5. **Configure the "Latency Timer" of the USB serial port to be "1msec":**
   i) Double click on the specified serial port.
   ii) Click "Port Settings".
   iii) Click "Advanced
   iv) Set "Latency Timer" of the USB serial port to be "1msec"

6. Connect and Program the Bio Radio



Once the **BioCapture** SW connects to the **BioRadio** 150, the “**Device Config**” tab will be active.

7. Configuring the **Bio Radio**.

There are two options for the Configuration of the Bio Radio: the (Standard view) and the (Advanced view). Select the Standard view option. The main configuration Options are:

a) Sampling Rate (Samples per second) also they measured in Hz and Resolution (number of bits per sample)

b) Enable Channel: Select the number of channels in the Programmable list

c) Select the type of each selected channel (EMG, EOG, or EEG).

d) Deselect the fixed channels that includes other sensors.

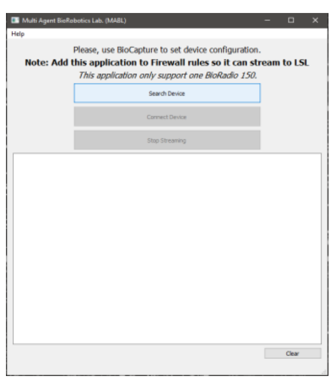
Note 1: The sampling frequency must be at the least twice the maximum frequency component of the collected signals.

Note 2: Choose the appropriate values of the sampling rate and resolution such that the total transmission bandwidth is less than maximum bandwidth of the Bio Radio 150.

8. Click on “Program Device” to activate the desired configuration.

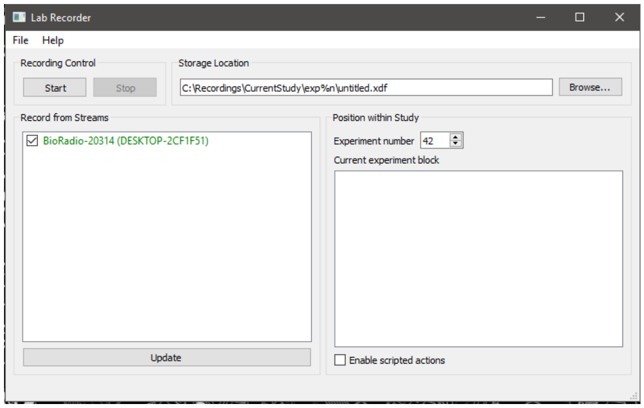
9. Connecting the Bio Radio to Lab Stream Layer

Search for Bio Radio Connect and Stream Data into LSL.



10. Acquiring Data using Lab Recorder.

The Lab recorder acquires Lab Streams and synchronizes them, make sure you acquire the correct stream and record them into .xdf files which will be imported into MATLAB.



All streams will show up on the lab recorder, select the correct streams and hit start on the Lab recorder to store continuous stream data in an xdf file.

Use load xdf function available from the provided library and perform data preprocessing.