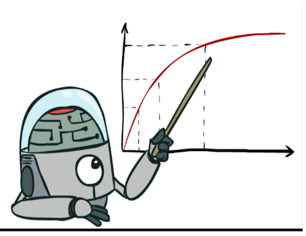
Lab 2: Intro to EOG and ECG Signals



ABSTRACT

The goal of this lab experiment is to introduce the student to EOG and ECG signals, feature processing and extraction for those signals, and simple classifications.

Please read through the entire document before completing the lab.

1 FILES

There are two files you will **edit**:

1. *Lab_2_EOG_ECG_analysis.ipynb*: Jupyter notebook that guides you through the EMG analysis process.
2. *config.ini*: Config file for setting code paths and directories.

All other files should not be changed.

2 BACKGROUND

2.1 EOG Signals

The cornea-retinal dipole theory is one of the most widely accepted descriptions for the potentials produced by the human eye. It postulates that an electric dipole is formed through the eye due to the positive charge of the cornea and the negative charge of the retina. This dipole creates an electric field that can be measured in the form of an electro-oculogram or EOG. As the eye changes direction as does the dipole, its electric field, and electrical potential.

EOG as like EMG can be recorded on the surface of the skin and it has an amplitude range in the millivolts and a frequency range of 0 – 100 Hz. The DC component of the EOG signal can be used to measure eye movement within +/- 30 degrees. The EOG signal can also become contaminated with other biopotentials especially EMG signals. EOG also can be a common artifact in other biopotentials especially EMG and EEG recordings that are located around the head and facial regions.

3 CODE SET-UP

- Download and extract zip file from https://github.com/BioRobotics-Spring-2020/Lab_2_2022
- Open a command prompt.
- Check the python version in the prompt

```
py
```

  - If python 3.7.3 (or 3.7.9) does not pop up, type software center in the windows search bar. Then search for python and install python 3.7.3
  - (You can type exit() and enter in the command prompt to exit the python kernel.

- Update pip

```
py -m pip install --upgrade pip -user
```

- Change your current directory (cd) to the download lab folder
- Install required libraries using

```
py -m pip install -r requirements.txt -user
```

- Edit the path to where you want to store your physiological data in config file (config.ini).

  - Make sure *BioHarness* is set to True while *Myo* and *Decibel* are set to False under Devices.

4 BIORADIO 150: EOG

This section guides you through setting-up and collecting data from the BioRadio 150 using Lab Recorder.

1. You will need five snap electrodes for this laboratory. Properly prepare and clean the surface of the skin with an alcohol swab before applying any snap electrodes.
2. Place one snap electrode below the left eye and one above the left eye. These electrodes will be used to measure vertical displacement of the eye.
3. Place one snap electrode to the left of the left eye on the left temple and one to the right of the right eye on the right temple. These electrodes will be used to measure horizontal displacement of the eyes.
4. Finally, place the last electrode behind one of the ears or the forehead. This electrode will be used as a ground.
5. Open Bio-Capture, Turn on BioRadio150, connect Open Bio-Capture to the BioRadio150, and then configure the BioRadio150 so that two channels are selected with the type of EOG.
6. Click on the EOG raw data Tab and then on the green "Start" button. You should see data scrolling across the screen. You may want to use the auto scale axis feature.
7. Examine the Signals by performing different movements of the eye to see if the signals change over time. An auto-scale might be necessary to see the changes.

4.1 Collecting data using Lab Recorder

The above process streams data from the BioRadio over a network. Now, we need to access this data stream. One such way is to use an application called Lab Recorder. Please follow these steps

- Open LabRecorder
  LabRecorder.exe from the downloaded github folder
- Set the storage location (make sure the file extension is .xdf or it will close without a warning)
- Click update to get all the LSL stream names. For now, it should just be a BioRadio.
- Select the stream you want to record.
- Click on start/stop to start/stop recording the data.

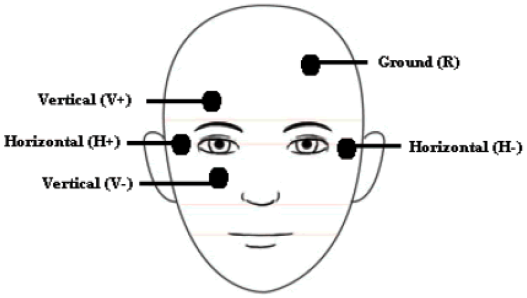


Fig. 1. EOG Channel Locations

Fig. 2. Wearing BioHarness sensor: hook and loop mechanism

5 BIOPAC BIOHARNESS

The BioPac bioharness is a chest-strap device that records ECG, Respiration Rate, and IMU data. We will be focused on ECG in this lab.

1. BioHarness is a chest-strap device which you will have to wear under your clothes, touching your skin. **Please sanitize the chest-strap before and after using it.**
2. Select the right size of the strap (S or L) and lightly moisten the sensor pad surfaces with water to aid conductivity. Turn on the Zephyr sensor device by pressing the center button and fit the device to the strap garment.
3. There is main attachment hook which will go in a loop sewed in the strap. You can use the tension slider adjuster to adjust the length of the strap.
4. The strap should be a snug fit, so as not to move when the subject is active. A tension loop is sewn at the rear of the strap. When the subject has inhaled and the chest fully expanded, the tension loop should be flush with the main strap.
5. When size is adjusted, rotate the strap so that the device is located under the subject's left armpit, with Zephyr brand label at the front – the brand label may not be exact centre.

    - In our experience, aligning the white tag with strap's information (size) to the front centre helps position the sensor properly.

6. When correctly located, a line through the centre of the device should be directly beneath the subject's arm pit, or slightly (1/2") to the rear.
7. You can get the User guide from https://www.biopac.com/wp-content/uploads/BioHarness_Guide.pdf manual for the Zephyr Bioharness 3 from https://www.zephyranywhere.com/media/download/bioharness3-user-manual.pdf

5.1 Recording Data with Code

Now we are going to use some of the code downloaded from Github to collect data from LSL.

1. Edit config.ini

    a. Directory should be the directory you want to save to.
    b. Set participant name, session, and prefix to what you want (e.g., prefix to resting.csv).
    c. Make sure BioHarness is set to true and all other devices are set to False.

2. From a command line, cd to the code directory and run
    ```
    py main.py
    ```
    If this does not work, try to double click the file to run it.
3. You should see text populate the command prompt that shows stream information.
4. Hit ctrl+c to stop the collection process.
5. Check your csv file in the specified directory and make sure it filled out correctly.

5.2 Collecting data using Lab Recorder

The above process streams data from the BioHarness over a network. Now, we need to access this data stream. One such way is to use an application called Lab Recorder. Please follow these steps

- Open LabRecorder
  LabRecorder.exe from the downloaded github folder
- Set the storage location (make sure the file extension is .xdf or it will close without a warning)
- Click update to get all the LSL stream names. You only need the Raw ECG stream for this lab. You can also collect the ZephyrGeneral and ZephyrSummary for additional information.
- Select the stream you want to record.
- Click on start/stop to start/stop recording the data.

6 DATA COLLECTION:

For each device, record data from each lab member using the previously specified methods (lab recorder and code for the BioRadio and BioHarness, respectively).

EOG: Your data should consist of 5 files for eye right, eye left, eye up, eye down, and eye blinking for roughly 5 seconds each. This will result in 25 separate files per person.

ECG: Your data should consist of 1 files for resting, push-ups, and jogging in place for approximately 2 minutes each. This will result in 3 files per person.

7 DATA ANALYSIS

Please open the Lab 2 jupyter notebook and follow the directions there.

8 ITEMS TO TURN IN

Please upload your jupyter notebook and a pdf of the notebook (with all the cells ran) to MyCourses. Create a lab report, based on the lab report example on MyCourses.