Decoding Life Signals Lab: EMG Hidden Message

Overview

In this lab exercise, you will analyze an EMG (Electromyography) recording from the instructor's right arm to discover a hidden message encoded using Morse code. This exercise will help you understand how to:

1. Install and use the OpenBCI GUI software
2. Load and visualize pre-recorded biosignal data
3. Identify patterns in EMG signals
4. Decode information from biological signals

Part 1: Software Installation

Installing OpenBCI GUI

1. Go to the official OpenBCI website: https://openbci.com/downloads
2. Download the appropriate version for your operating system (Windows, macOS, or Linux)
3. Follow the installation instructions for your platform
4. Launch the application after installation is complete

Part 2: Loading the EMG Recording

Opening the Pre-recorded Data

1. Download the "EMG_Hidden_Message.txt" file from the course website
2. Launch the OpenBCI GUI application
3. In the System Control Panel (left side of the screen), select "PLAYBACK (from file)" from the DATA SOURCE options
4. In the PLAYBACK FILE section, click the text field or browse button to open the file selector
5. Navigate to where you saved the EMG_Hidden_Message.txt file and select it
6. Click "START SESSION" at the bottom of the System Control Panel to load the recording

Configuring the Display

1. After starting the session, the GUI will display widgets for signal visualization
2. If not automatically shown, add a Time Series Widget by clicking the "+" button in the bottom left corner
3. In the Time Series Widget, focus only on the EMG signal:
    - Click on the "Channels" dropdown at the top of the widget
    - Deselect channels 2-8 by clicking on their numbered buttons (they should appear grayed out)
    - Keep only channel 1 (EMG from right arm) selected

4. Adjust the vertical scale if needed (try 1000 μV initially)
5. Set the time window to display 5 seconds at a time
6. Use the playback controls to play, pause, or move through the recording
7. You can adjust playback speed if needed (1x is recommended for initial viewing)

Exploring Additional Widgets

1. Add more visualization widgets by clicking the "+" button in the bottom left corner
2. Try adding these widgets to gain different perspectives on the EMG signal:
    - EMG Widget

      : Shows processed muscle activity with a visual indicator
        - This widget displays a gray circle that expands and contracts based on muscle activity
        - When you flex your muscles (during Morse code signals), the circle expands
        - During rest periods, the circle returns to its normal size
        - This visual representation makes it easier to identify muscle contractions
    - **FFT Plot**: Displays the frequency components of the signal
    - **Spectrogram**: Shows how frequencies change over time
3. For each widget, you can:
    - Adjust the vertical scale for better visualization
    - Modify the time window settings
    - Use the channel selector to focus only on channel 1

Note: If you need to load a different file later, you can return to the System Control Panel by clicking the grid icon in the top right corner of the GUI

Part 3: Decoding the Hidden Message

Understanding Morse Code

Morse code uses combinations of short and long signals (originally dots and dashes) to represent letters and numbers. In this exercise, the instructor has encoded a message using:

- **Short muscle flexes** = dots (•)
- **Long muscle flexes** = dashes (−)

Here's the full Morse code alphabet for reference:

```
A: • –        N: – •
B: – • • •    O: – – –
C: – • – •    P: • – – •
D: – • •      Q: – – • –
E: •          R: • – •
F: • • – •    S: • • •
G: – – •      T: –
H: • • • •    U: • • –
I: • •        V: • • • –
J: • – – –    W: • – –
K: – • –      X: – • • –
L: • – • •    Y: – • – –
M: – –        Z: – – • •
```

Numbers in Morse code:

```
1: • – – – –   6: – • • • •
2: • • – – –   7: – – • • •
3: • • • – –   8: – – – • •
4: • • • • –   9: – – – – •
5: • • • • •   0: – – – – –
```

Your Task

1. Carefully observe the EMG recording looking for clear patterns of muscle activity
2. Identify the short flexes (dots) and long flexes (dashes)
3. Note the sequence on paper, separating what appear to be individual letters
4. Use the Morse code reference above to decode the message
5. Submit your decoded message along with a brief explanation of how you identified the patterns

Tips for Success

- Look for clear starts and stops between letters (longer pauses)
- Count the number of flexes that appear together to identify letters
- You may need to replay certain sections multiple times
- Try adjusting the vertical scale to better visualize the muscle activity
- The message is in English and makes sense when properly decoded

Questions to Answer

Decoding Questions:

1. What is the hidden message in the EMG recording?
2. How did you distinguish between dots and dashes in the signal?
3. What were the challenging aspects of this decoding task?
4. How might this type of signal encoding be useful in real-world applications?

Signal Analysis Questions:

1. When viewing the EMG Widget, what differences do you notice between the raw signal and the processed EMG envelope?
2. Looking at the FFT Plot during muscle contractions versus rest periods, what frequency ranges show the most activity during contractions?
3. What patterns can you identify in the Spectrogram during the Morse code sequence?
4. How does changing the time window affect your ability to distinguish between short and long muscle contractions?
5. What filtering options (if any) helped you better visualize the signal patterns?

Good luck with your signal detective work!