**Neurorobotics Signal Processing Protocol**

**Purpose:**

This proposed research project aims to develop a Brain-Computer Interface (BCI) with a robotic component capable of movement in different directions based on imaginative motion. The project will investigate the movement of a joystick that occurs when someone imagines or makes a movement. Here we developed a protocol such that the acquired data can account for changes in directional movement.

**Materials Needed:**

* 8 Channel BCI (OpenBCI Cyton Board) and 8 Connective Wires Electrodes, or
* Custom 8 Channel Full MI Compatible BCI Interface
* 2 Grounding Electrodes (Earlobes)
* Conductive Gel
* Cleaning Agent
* Binary Visual Stimulus Testing Mechanism
* Optional: EEG Electrode Placement Headpiece

**Testing Environment:**

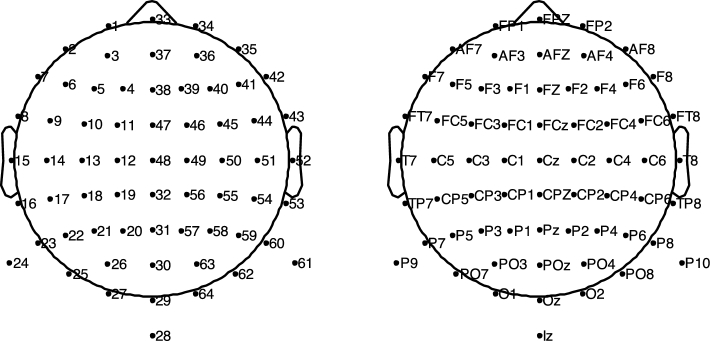
The testing environment for optimal results should be a quiet, dimly lit room. The screen displaying the stimulus should be positioned 65 cm from the participant and should be reasonably lit (approx. 200 cd/m^2, half brightness of a computer screen). The participant should try to reduce physical movement and blinking, especially for changing shape size.

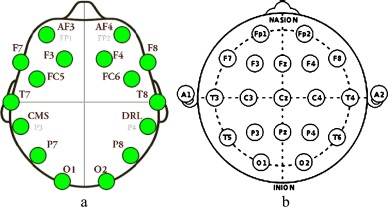
**Methods**:

Preprocessing is conducted mostly through bandwidth high-pass and low-pass filtering, incorporated into the electrical board itself. Optimal Materials and Testing Environment provide a control mechanism over the reliability for the outcome of the procedure. Post Processing is done through linear-time filtering as well as baseline correction and amplitude averaging.

**Procedure**:

Connect all 10 , which consists of either 8 for Electrode Channels and 2 for Grounding, to the Cyton OpenBCI board, using the Conductive Gel. Apply these electrodes at positions at the following positions in Image 1.1 below, based on how many channels.





If using 8 channels, use electrode positions: for Electrode Channels, C3, C4, P3, and P4 positions can cover a region of the motor cortex, AF3 and AF4 electrodes to eliminate the artifacts such as EMG and EOG artifacts and the two reference electrodes, and A1, A2 for Grounding Channels. This layout is in accordance with the universal 8-8 EEG spacing system used for data collection and other general MI BCI operations. It allows for very low variance in signal data collected and more precise predictions for this specific number of channels. Evidently, the more the channels the more precise, however for an 8 Channel setup, the above is optimal.

| Channel 0 | Channel 1 | Channel 2 | Channel 3 | Channel 4 | Channel 5 | Channel 6 | Channel 7 |
| --- | --- | --- | --- | --- | --- | --- | --- |
| C3 | C4 | F3 | F4 | AF3/FP1 | AF4/FP2 | P3 | P4 |

Once the setup is complete, optimising the surroundings to minimise noise is completed. The aforementioned testing environment is required. The experiment itself follows a binary output between the imagined activation given a visual cue.

Multiple samples would be required for consistent results from a singular test subject or participant. Other than the intrinsic electrode noise that all EEG’s must accommodate for EMG noise , given the purpose and function of this experiment. As such, many samples from each test subject or participant of unique and separate electrical stimulus must also be collected. To elicit a response to a motor response, the participant will hold an object and move it in the direction specified on the interface. Also we want to reduce eyeball movement as that can result in unwanted waves being recorded.

Experiment Procedure is completed.

Sources:

<https://www.sciencedirect.com/science/article/pii/S195903181830037X>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9414220/>

<https://ieeexplore.ieee.org/document/8733482>

<https://ieeexplore.ieee.org/abstract/document/6214617?casa_token=VHzLAe6SYVwAAAAA:a2MEBIHOF76B0iE_PiQFjfLGpffoxZD2GzY2lfEB2dynexfQurwRsW6ULIzB4cYi3kKMH46INw>

<https://www.mdpi.com/2079-9292/8/12/1387>

Data Collection:

BIAS - left earlobe

N8 - P3

N7 - FP2

N6 - C4

N5 - FP1

N4 - C3

N3 - P4

N2 - CP2

N1 - CP3

SRB - right earlobe

Every 6 seconds, starting at second 10:

10 - 16 Right

16 - 22 Center

22 - 28 Left

28 - 34 Center

34 - 40 Up

40 - 46 Center

46 - 54 Down

54 - 56 Center