Neuroinformatics: Project Proposal

EEG Motor Movement/Imagery Dataset

Introduction:

In this project, we focus on a real-world EEG dataset that primarily examines Motor Imagery and Motor Movement. Essentially, it is a cognitive process in which a subject performs a movement and imagines performing that movement without actually doing so, without even tensing the muscles. This dataset is recorded using the Brain-Computer Interface: BCI2000.

- ★ A key question in neuroscience and brain-computer interfaces (BCIs) is whether the brain's activation patterns during motor execution (ME) and motor imagery (MI) are distinct or similar.

Data website: https://physionet.org/content/eegmmidb/1.0.0/#files-panel

Data Description:

Subjects performed different motor/imagery tasks while 64-channel EEG were recorded using the BCI2000 system (http://www.bci2000.org). Each subject performed 14 experimental runs: two one-minute baseline runs (one with eyes open, one with eyes closed), and three two-minute runs of each of the four following tasks:

1. A target appears on either the left or the right side of the screen. The subject opens and closes the corresponding fist until the target disappears. Then the subject relaxes.
2. A target appears on either the left or the right side of the screen. The subject imagines opening and closing the corresponding fist until the target disappears. Then the subject relaxes.
3. A target appears on either the top or the bottom of the screen. The subject opens and closes either both fists (if the target is on top) or both feet (if the target is on the bottom) until the target disappears. Then the subject relaxes.
4. A target appears on either the top or the bottom of the screen. The subject imagines opening and closing either both fists (if the target is on top) or both feet (if the target is on the bottom) until the target disappears. Then the subject relaxes.

Proposed Analysis:

- **Preprocessing the data:** We are planning to use the techniques that are taught in class.
    - Filtering
    - Rereferencing
    - Artifact Removal
    - Epoching
    - Baseline Correction (If needed)
- **Event Related Potentials:**
    - Average EEG responses time-locked to stimuli.
    - Compare ERP amplitudes and latencies across conditions (e.g., left-hand vs. right-hand imagery or comparing motor imagery vs actual motor execution)
    - Perform statistical methods like t-tests/ANOVA on ERP peaks across participants.
- **Time Frequency Analysis:**
    - We can perform time-frequency representations (TFRs) for each trial, channel, and subject.
    - Use wavelet transform or short-time Fourier transform (STFT) to analyze event-related desynchronization/synchronization (ERD/ERS).
    - We can also compare TF patterns across conditions (left vs. right hand, execution vs. imagery).
- **Spectral Analysis:**
    - Calculate the power spectral density (PSD) to examine baseline rhythms.

We will add more analytical techniques and statistical methods as we learn through the classes.

Resources:

https://www.researchgate.net/publication/373636806_Motor_Imagery_EEG_Signals_Marginal_Time_Coherence_Analysis_for_Brain-Computer_Interface

https://pubmed.ncbi.nlm.nih.gov/15188875/

https://physionet.org/physiotools/wag/rdedfa-1.htm

https://physionet.org/lightwave/?db=eegmmidb/1.0.0

What these analytics teach us:

We'll get to know how we can approach real-world EEG Datasets, and the answer to the question of whether there is a difference in EEG output patterns for Motor Imagery and Motor Execution.

Team: Neuro Nexus

Teammates: G.Harshitha 2022102005

R. Shaanal 2022102071
