MSc in Computational Cognitive Neuroscience

Goldsmiths
UNIVERSITY OF LONDON

EEG-based Brain-Computer Interface using Visual Imagery

Ilenia Salaris[1], Giuseppe Lai[1,2], Maria Herrojo Ruiz[1], David Landi[2]

[1] Department of Computing, Goldsmiths, University of London

[2] LiquidWeb s.r.l.

1. Background

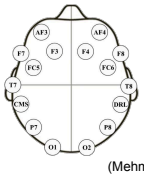
Brain-Computer Interface (BCI) allows users to control external devices through the decoding of brain activity, usually recorded with non-invasive techniques such as EEG and fMRI. To date, most of the BCI systems are based on motor imagery (MI) paradigms, and only recently have been explored the possibility to employ visual imagery (VI) tasks. Specifically, the former, involves the mental imagination of a motor act, while the latter consists in imagining a perceptual representation. However, this new emergent approach presents several limitations such as low decoding performance.

2. Aim

- Establish an efficient EEG pre-processing pipeline
- Identify which features and machine learning methods can advance the current BCI state-of-the-art in terms of classification accuracy for VI tasks

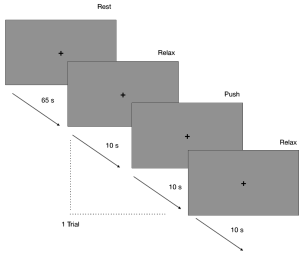
3. Study Design

- Data collected using Emotiv Epoc X, which consists of 14 channel wireless EEG headset



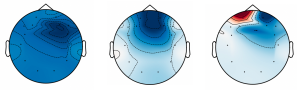
(Mehmood, 2016)

- One healthy subject performed 30 experimental sessions
- Each session is composed of 65s resting state + 5 trials
- Two VI conditions: Relax and Push

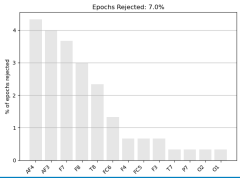


4. EEG Processing

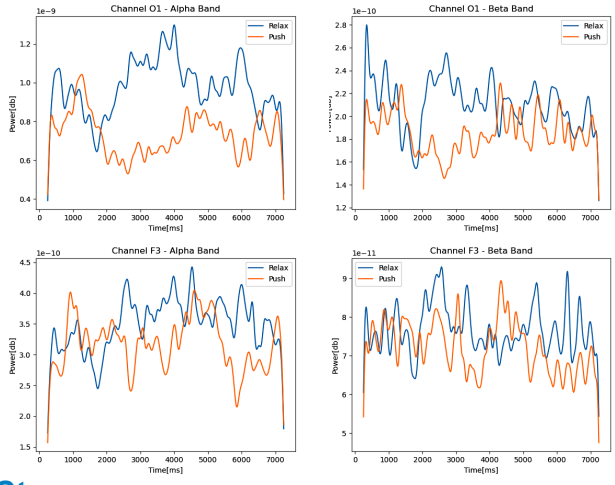
- Apply a band-pass filter with cutoff between 1Hz and 40 Hz
- Segment continuous data into epochs of equal length (7s)
- ICA-based artefact correction with manual component rejection



- Epochs rejection based on peak-to-peak amplitude (200uV)



5. Time-Frequency Power Analysis



6. Next Steps

- Apply statistical analysis (e.g. Non-parametric cluster-based permutation test)
- Compare Feature Extraction Methods (e.g. Morlet Wavelets, Common Spatial Pattern, Spatio-Spectral Decomposition)
- Machine Learning Techniques to classify two types of VI, Relax and Push (e.g. Linear Discriminant Analysis, Support Vector Machine, K-nearest neighbours)

- Kosmyna, N., Lindgren, J. T., & Lécuyer, A. (2018). Attending to visual stimuli versus performing visual imagery as a control strategy for EEG-based brain-computer interfaces. *Scientific reports*, 8(1), 1-14.
- Sousa, T., Amaral, C., Andrade, J., Pires, G., Nunes, U. J., & Castelo-Branco, M. (2017). Pure visual imagery as a potential approach to achieve three classes of control for implementation of BCI in non-motor disorders. *Journal of neural engineering*, 14(4), 046026.
- Monaco, S., Malfatti, G., Culham, J. C., Cattaneo, L., & Turella, L. (2020). Decoding motor imagery and action planning in the early visual cortex: overlapping but distinct neural mechanisms. *Neuroimage*, 218, 116981.
- Mehmood, R. M., & Lee, H. J. (2016). A novel feature extraction method based on late positive potential for emotion recognition in human brain signal patterns. *Computers & Electrical Engineering*, 53, 444-457.

In collaboration with LIQUIDWEB