PSEUDO-ONLINE TRACKING OF EEG OSCILLATIONS DURING SENSORY DISCRIMINATION TASKS FOR CLOSED-LOOP NIBS APPLICATIONS

ANDREJ SAVIĆ

Type: New code & analysis

Where: Online & Belgrade, Serbia

When: April 2023 – March 2024

Methods & techniques: Signal processing, Electroencephalography (EEG), Event-related potentials (ERP)

ABOUT THE MENTOR

Andrej Savić is an Associate Research Professor at the School of Electrical Engineering, University of Belgrade, Serbia.

Andrej is an expert in neural engineering, closed-loop neurotechnology, and brain-computer interfaces. His research interest is mainly in the field of brain-computer interface technology and closed-loop neurotechnology for neurorehabilitation. He is also interested in exploring various electrophysiological (EEG-based) biomarkers of neurological diseases. He works towards developing new methods for driving brain stimulation (transcranial magnetic and transcranial electric stimulation) based on brain state dependency derived from various EEG features extracted in real-time.

Email andrej_savic@etf.rs

Check out one of his works: Savić, A. M., Aliakbaryhosseinabadi, S., Blicher, J. U., Farina, D., Mrachacz-Kersting, N., & Došen, S. (2021). Online control of an assistive active glove by slow cortical signals in patients with amyotrophic lateral sclerosis. Journal of Neural Engineering, 18(4), 046085.

About the Topic

Electrical brain activity tends to organize in various oscillatory patterns which can be recorded in the scalp EEG. Typical are oscillatory activities within the so-called alpha frequency range (8 – 12Hz) recorded over brain areas during rest when they are in an awake but idle state, such as occipital alpha (of the visual cortex) and Rolandic mu rhythm (of the sensory-motor cortex). Additionally, transient bursts of oscillatory activity within relatively narrow frequency bands develop related to certain tasks and/or events. Although they can be seen in various frequency bands (depending on the type of the task/event), for neuromodulation of cognitive functions, bursts in alpha and theta activity are of particular interest.

What will be done?

We will develop methods for online calculation and tracking of oscillatory EEG activity phase and frequency as well as the amplitude (power) and implement them across different data sets.

Identification of the exact frequency and phase of an EEG rhythm would allow precise individual/personalized task and function-specific targeting of an oscillatory non-invasive brain stimulation (NIBS) approach, for the enhancement of the targeted function. A capability to do this online, during task performance, would be a major breakthrough in the development of personalized NIBS for neuroenhancement. Here we will develop methods for online calculation and tracking of oscillatory EEG activity phase, frequency, and amplitude (power) to explore the possibility of online approaches for NIBS control. This will be attempted for different EEG frequencies, with a specific focus on theta (4-8Hz) and alpha bands (9-12Hz). Datasets intended for this purpose were previously recorded and consist of EEG during somatosensory, visual, and auditory sensory-discrimination / oddball tasks. The results of this work will also include an analysis of the relation between the instantaneous phase of brain oscillations and event-related brain responses (ERPs).

The group of up to 5 selected early-stage researchers will be working under the supervision of Dr Andrej Savić in collaboration with Saša Filipović (University of Belgrade) and Paolo Belardinelli (University of Trento).

The research will result in one scientific publication in a peer-review journal and one conference publication (talk/poster).

What will you learn?

- ✓ Basic and advanced EEG processing methods
- ✓ What are the theoretical and practical requirements for developing closed-loop neurotechnology
- ✓ What are the applications and limitations of EEG methods and signal processing
- ✓ How to create EEG processing pipelines and implement them across different data sets.

Career benefits

- ✓ Gain theoretical knowledge on closed-loop systems, and brain-computer interfaces; learn about a wider perspective of closed-loop NIBS
- ✓ Advance your data analysis and coding skills
- ✓ Establishing connections with peers and enhancing your soft skills to work in an international team.
- ✓ Contributing to planned publication as co-authors

What is your role?

You will work in the international team to develop analysis algorithms and pipelines, analyse the data, and write a manuscript for publication. You will participate in regular online meetings throughout the project and have an opportunity to spend 2 weeks in Belgrade/Trento.

ESRs ENGAGEMENT REQUIREMENTS

Time requirements

Each participant is expected to spend 1 week in Belgrade/Trento for training and one more week (optional) for joint work. The work time is approximated at 1 day a week for 12 months. The working hours will be mostly flexible, and the dynamic will depend on work progress.

Physical location

Most of the work will be done remotely. At the beginning, a 1-week training in Belgrade or Trento will be organized. Team members will have the opportunity to participate in one-week intensive joint work in Belgrade at the later stage of the project.

Skills and knowledge

For joining the group, you should have basic knowledge about neural and brain physiology and be able to work in MATLAB.
The advantage will be given to candidates with strong programming and signal processing skills, EEG analysis experience, scientific writing, and literature review.