2018-00781 - Postdoctoral position: Redefining EEG Signal Processing and Machine Learning to ensure efficient Mental Imagery-based BCI user training

Contract type : Public service fixed-term contract
Level of qualifications required : PhD or equivalent
Fonction : Post-Doctoral Research Visit

About the research centre or Inria department

The Potioc project-team explores new approaches “beyond the mouse” in the field of Human-Computer Interaction. More specifically, we are interested in approaches that favor rich interactions, both regarding interaction possibilities and perceptive feedback. Our objective is to increase immersion and engagement of users with regard to the interaction tasks. Final goals are the stimulation of creativity, improvement of learning or contribution to the well-being of people. For achieving these goals, we focus on the design, development and evaluation of new methods for “popular interaction” targeted at a large variety of users.

Context

Brain computer interfaces (BCI) are communication and control tools that enable their users to interact with computers by using brain activity alone.

A prominent type of BCI is Mental Imagery (MI) BCI, that translate changes in brain activity due to mental imagery tasks performed by the user (e.g., imagination of movements or mental calculation) into control commands for a computer. Using a MI-BCI requires dedicated training, and the more the user practices the better he/she will get at it, i.e. the user’s mental commands will be more often correctly recognized by the system. Current BCI are rather unreliable, and one current hypothesis to explain this lack of reliability could be inadequate user training.

We are thus currently conducting researches to understand this user training to then improve it and make it suitable. Such researches are conducted as part of ERC starting grant project BrainConquest (https://team.inria.fr/potioc/brainconquest/ – Principal Investigator : Fabien Lotte) at Inria Bordeaux Sud-Ouest, France, in team Potioc (https://team.inria.fr/potioc/).

Assignment

As part of this research, the goal of this Post-doc would be to contribute to the improvement of BCI user training by redefining the EEG signal processing and machine learning tools used in MI-BCI in order to ensure they can lead to efficient user training.

Indeed, current MI-BCI user training mostly relies on providing the user with a single simple feedback: the classifier output. However, this feedback is only corrective, i.e., it only tells the users whether they did well, but not why they did well or not. Current feedback thus lacks explanatory power.

Moreover, this feedback is directly mapped to the classifier output, without considering whether the user can actually self-regulate the features used by the classifier or whether the user can actually make sense of such feedback. We thus need a new generation of EEG signal processing and machine learning tools that would ensure the feedback provided is explanatory and understandable, and can lead to efficient user training.

The goal of this post-doc position is thus to design and validate this new generation of EEG signal processing tools. In particular, the post-doc could try to identify EEG features that could explain and predict successful mental command recognition by the BCI, in order to be able to provide explanatory feedback. The post-doc could also incorporate instructional design principles into EEG machine learning optimization algorithms in order to obtain features and classifiers whose resulting feedback makes sense to the users and ensure they can learn from it. We have data from multiple BCI users who trained over multiple days with MI-BCI. These data sets will be the basis for creating testing and validating different initial EEG signal processing tools. The post-doc could also design and run MI-BCI experiments to validate online and in real-time the designed EEG signal processing tools for MI-BCI user training.

Main activities

- Contribute to the improvement of BCI user training by redefining the EEG signal processing and machine learning tools used in MI-BCI in order to ensure they can lead to efficient user training
- Design and validate the new generation of EEG signal processing tools
- Incorporate instructional design principles into EEG machine learning optimization algorithms in order to obtain features and classifiers whose resulting feedback makes sense to the users and ensure they can learn from it

Skills

Skills required:

- EEG signal processing (temporal/spatial filtering, subspace identification, source reconstruction, etc)
- Machine Learning & Pattern Recognition for EEG classification
- Python / Matlab programming
- Able to speak, write and work in an English speaking environment
- Willingness to learn and exploit knowledge from educational psychology and cognitive sciences (experience and knowledge in these fields would be a strong plus)

About Inria

Inria, the French National Institute for computer science and applied mathematics, promotes “scientific excellence for technology transfer and society”. Graduates from the world’s top universities, Inria’s 2,700 employees rise to the challenges of digital sciences. With its open, agile model, Inria is able to explore original approaches with its partners in industry and academia and provide an efficient response to the multidisciplinary and application challenges of the digital transformation. Inria is the source of many innovations that add value and create jobs.

The keys to success

Related literature:


Conditions for application

Send CV, motivation letter, recommendation letters and publications/achievements list to fabien.lotte@inria.fr

Defence Security:

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy:

Open to all nationalities.
- Experience with ElectroEncephaloGraphy (EEG) and/or BCI experiments

**Benefits package**
- Subsidised catering service
- Partially-reimbursed public transport

**Remuneration**
2653 € / month (before taxes)

As part of its diversity policy, all Inria positions are accessible to people with disabilities.

**Warning:** you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.