Phd thesis in Machine Learning for Neural Engineering

Title

Adaptive neural decoder for neuroprostheses for limb movement restoration for disabled subjects

Context

The PhD research project will be carried out at the research technological center CEA (Commissariat à l'Energie Atomique et aux Energies Alternatives) at CEA/LETI/CLINATEC research institute (Grenoble, France). The particular objective of the PhD project will be to explore novel solutions for functional rehabilitation and/or compensation for people with sever motor disabilities using Brain-Machine Interface (BMI) / neuroprosthetics. Neuroprosthetics record, and decode brain neuronal signal to activate an effector directly without physiological neural control command pass way interrupted by e.g. spinal cord injury. A set of algorithms to decode neuronal activity recorded at the level of the cerebral cortex (Electrocorticogram, ECoG) were developed at CLINATEC and tested in the frame of 2 clinical research protocols at Clinatec-CEA / CHU in Grenoble and at EPFL / CHUV in Lausanne. The BCI&Tetralegia clinical trial in Grenoble explores the solutions for tetraplegic patient functional compensation by controlling an exoskeleton. High-dimensional control of upper limbs is achieved [1] [2]. In the Brain-Spine interface (BSI) project (STIMO-BSI clinical trial EPFL / CHUV, Lausanne) the implantable spinal cord stimulator is used as an effector. The BSI project explores the solutions for functional compensation and/or rehabilitation to restore walking in paraplegic suffering from complete or partial spinal cord injury [3] [4]. The PhD candidate will contribute to the next ambitious scientific breakthroughs addressing the medical needs of efficient, unassisted and easy use embedded neuroprosthetics.

Mission

Within a multidisciplinary team, the PhD candidate (M/W) will work in the field of machine learning / neural signal processing to improve efficiency and usability of neuroprosthetics in para / tetraplegics combining different effectors.

To achieve the objectives

- Strategies for BMI decoder real-time update from weakly labeled / noisy labels data will be explored.
- Perspectives of (partial) transfer learning between BMI paradigms will be studded.
- Exploration of BMI for realistic real life scenarios will be a topics of a project.
- The developed algorithms will be evaluated and tested offline using recorded databases.
- Finally, the BMI will be tested in real-time in ongoing clinical trials.

The PhD student will be integrated into the signal processing team of CLINATEC. Participating in highly interdisciplinary project, she/he will interact with software and electrical engineers, biologists and medical doctors: contributing to clinical trials at Clinatec and EPFL / CHUV.

[1] Moly, A., Costecalde, T., Martel, F., Martin, M., Larzabal, C., Karakas, S., ... & Aksenova, T. (2022). An adaptive closed-loop ECoG decoder for long-term and stable bimanual control of an exoskeleton by a tetraplegic. Journal of Neural Engineering, 19(2), 026021.
[2] Benabid, A. L., Costecalde, T., Eliseyev, A., Charvet, G., Verney, A., Karakas, S., ... & Chabardes, S. (2019). An exoskeleton controlled by an epidural wireless brain–machine interface in a tetraplegic patient: a proof-of-concept demonstration. The Lancet Neurology, 18(12), 1112-1122.
[3] Rowald, A., Komi, S., Demesmaeker, R., Baaklini, E., Hernandez-Charpak, S. D., Paoles, E., ... & Courtine, G. (2022). Activity-dependent spinal cord neuromodulation rapidly restores trunk and leg motor functions after complete paralysis. Nature Medicine, 1-12.
[4] Lorach, H., Charvet, G., Bloch, J., & Courtine, G. (2022). Brain-spine interfaces to reverse paralysis. National Science Review.

Applicant's profile :

CLINATEC is looking for a PhD candidate specializing in machine learning. The skills in adaptive / incremental learning, real-time processing of large data flows, as well as, the knowledge in deep learning will be appreciated. Programming skills in MATLAB and Python is essential. Experience in neural signal processing (EEG-ECoG-MEG) and strong interest in neuroscience and biomedical fields will be an advantage.

Date to start: preferable starting date is December 2022 - January 2023.

Application : CV, motivational letter and contact information for at least two referent scientists should be sent to Tetiana Aksenova, tetiana.aksenova@cea.fr and CHARVET Guillaume, guillaume.charvet@cea.fr.