 DOI: 10.3217/978-3-85125-962-9-218

Adaptive task designer for optimized training of a motor ECoG-based Brain-Computer Interface: toward unassisted closed loop BCI training.

Félix Martel[1], Charlotte Quellec[1], Romain Guy[1], Guillaume Charvet[1], Stephan Chabardes[1,2], Tetiana Aksenova[1]
[1]Univ. Grenoble Alpes, CEA, LETI, Clinatec, Grenoble, France; [2]Univ. Grenoble Alpes, Grenoble University Hospital, Grenoble, France

*CEA, 17 rue des Martyrs, 38054 Grenoble Cedex 9. E-mail: felix.martel@cea.fr

Introduction: Motor Brain-Computer Interfaces (BCI) are now showing impressive performances in the laboratory. However, there are still some challenges to be addressed before functional neuroprostheses can be used for daily-life applications. Online closed loop decoder adaptation (CLDA) is known to be efficient procedure for BCI decoders training, allowing to take into account the day-to-day variability of the brain signals as well as the neuronal feedback, when controlling an effector. These calibration procedures are often based on supervised learning techniques, thus require a clinician to cue the patient with target movements. For a home-use application, decoder calibration is required to be unassisted by trained staff. In this context, we developed an automated task designer, which supervises the calibration phases by giving target movements that are both optimal for the decoding model training and for the patient commitment. In a daily-life application of BCI neuroprostheses, task designers would allow to have model evolving, able to cope with day-to-day variability and patient improvement.

Materials, methods and Results: The automatic task designer consists in multiple parts. First, a performance measurement system has been specifically designed to assess the efficiency of the different parts of our decoding model for each task [1,2]. The convergence of each part of the model and across the multiple calibration steps is also evaluated. Additionally, patient related criteria have been added to take into account task repetitions and exploration to improve the patient commitment in the training process. Finally, multiple strategies merge these criteria to define in an online manner the sequence of tasks proposed to the patient.

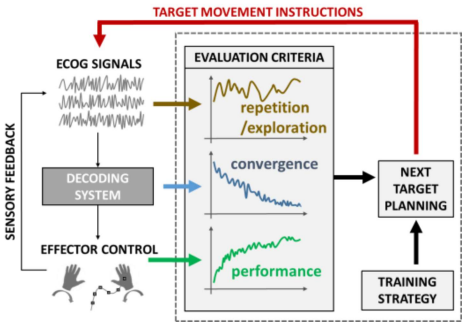

Figure 1. Schematic of the task designer principle

The different strategies for task designer have been tested on pre-recorded data from the "BCI and Tetraplegia" clinical trial (NCT02550522, ClinicalTrials.gov). The data recorded come from 8-dimensional alternative control of both arms (3D translation and 1D rotation of each hand). The dataset has been segmented in trials, corresponding each time a new target movement has been asked to the patient. New decoding models have been calibrated as it would have been trained in online experiments by picking trials through the different training strategies. These models have been evaluated by testing on a fixed test dataset. The strategies tested so far are limited to random picking (as a baseline comparison), worst performance movement first, and combined ranking according to all criteria.

Discussion and perspectives: Other strategies combining performance, convergence and patient related criteria should be tested. Tuning of the decision hyperparameters as well as testing of the most promising strategies in online experiment are to be carried out.

References

[1] Moly A, et al. An adaptive closed-loop ECoG decoder for long-term and stable bimanual control of an exoskeleton by a tetraplegic. J Neural Eng. 2022 Mar 30;19(2). doi: 10.1088/1741-2552/ac59a0. PMID: 35234665.
[2] F. Martel, et al. Evaluation criteria for closed-loop adaptive dynamic discrete-continuous brain-computer interfaces: clinical study case with tetraplegic patient, 2020 International Joint Conference on Neural Networks (IJCNN), Glasgow, UK, 2020, pp. 1-10, doi: 10.1109/IJCNN48605.2020.9207243.