Technische Universität München

Neurowissenschaftliche Systemtheorie

Engineering Practical Project

Correcting Katana Robotic Arm Mistakes based on Error-Related Potentials Detection

25-09-2017

Problem description:

Brain-computer interface (BCI) is a great hope for thousands of patients affected by the most various motor impairments, notably paralysis as it can provide those disabled people with new tools for control and communication. Patients fitted with such equipment can control artificial limbs such as neuroprosthetics through electrodes connected to their brains [1]. Recent studies show the ability to recognize errors that can be used to correct or adapt BCI decoders using both invasive and non-invasive recordings during complex tasks [2]. These errors are called error-related potentials (ErrPs) and they are evoked by actions that the user considers wrong and do not match his/her expectations. According to BCI researchers, ErrPs decoding approaches will become a key element of the next generation of brain-computer interfaces.

The main objective of this project is to implement and test the algorithm proposed recently in [2,3] for online detection of ErrPs. A specific experimental paradigm for ErrPs recording has been already designed and tested at our lab NST. Therefore, the ErrPs recorded data are available and can be used by the student for his project. Additionally, in order to be able to test his ErrPs detector online, the student will also have access to our recently developed algorithm for EEG motor imagery decoding [4].

Tasks:

This practical project requires the student to:

- Implement and test the proposed algorithm in [3] for ErrPs online detection.
- Use our EEG-motor imagery decoder [4] and his developed algorithm to control and correct our Katana robot arm mistakes in an online scenario.

Bibliography:

[1] Chavarriaga, Sobolewski, Millán Jdel, "*Errare machinale est: the use of error-related potentials in brain-machine interfaces*" Front Neurosci. 8, pp 5-7. 2014.

[2] Iñaki Iturrate, Ricardo Chavarriaga, Luis Montesano, Javier Minguez, José del R. Millán, "*Teaching brain-machine interfaces as an alternative paradigm to neuroprosthetics control*", **Scientific Report (Nature)** 5, 2015.

[3] Andres F. Salazar-Gomez, Joseph DelPreto, Stephanie Gil, Frank H. Guenther, and Daniela Rus. "*Correcting Robot Mistakes in Real Time Using EEG Signals"*, IEEE International Conference on Robotics and Automation **(ICRA),** 2017

[4] Zied Tayeb, Emeç Erçelik, and Jörg Conradt, "*Decoding of Motor Imagery Movements from EEG Signals using SpiNNaker Neuromorphic Hardware"*, 8th IEEE International Conference on Neural Engineering (IEEE EMBS), 2017

Supervisor: Dipl.-Ing. Zied Tayeb

(Jörg Conradt)
Professor