Cybathlon Symposium, SWISS Arena, October 6, 2016

Personalized Brain-Computer Interfaces for Non-Laboratory Environments

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Abstract

Brain-computer interfaces (BCI) based on Electroencephalography (EEG) have to meet a range of requirements. Besides dealing with general problems like variations across subjects, sessions and paradigms, usage in non-laboratory conditions induce additional problems to deal with noise, calibration and setup. In this work, we study recent developments to create a BCI for non-laboratory environments tailored to individual subjects. We first investigate different paradigms based on mental tasks, motor imagery and more, to get a discriminative collection of neural activity patterns. A customized set of paradigms is then composed depending on task enjoyment [1] and modulation abilities. Thereafter, state-of-the-art artifact reduction techniques are examined to enhance the signal to noise ratio for the decoding tasks. Band-power features extracted from the preprocessed signals ranging from usage of explicit expert knowledge of the paradigms to advanced spatial filters and recent EEG structure exploitation [2] are used to create different feature spaces for BCI classifiers. Different classification models including recent transfer learning extensions to cope with subject-specific variations are trained on offline data to obtain a combination of high performing classifiers and feature spaces. Finally, we compare three real-time decoding architectures based on hierarchical combinations of the classifiers and error correcting codes. Exploitation of temporal correlation of incoming signals enable custom trade-offs between sensitivity to noise and certainty of predicted brain conditions. First results suggest that different subjects have various strength across different paradigms, so that initial transfer learning approaches show promising results in subject-specific classifier adaptation.

References

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Short Biography

Tamara is a 24 years old B.Sc. Computer-Science student at the Technische Universität Darmstadt. She joined the Athena-Minerva Team in March 2016. In her curiosity about the human brain, its structure and how thoughts can be measured and processed, she evaluates new customized paradigms for individual subjects. Tamara further participates with the Brain-Computer Interface Group of the Max Planck Institute for Intelligent Systems (Tübingen) in the development of a low-cost BCI System to enable encouraging neurofeedback training of brain rhythms at home.

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