Development of a Brain-Computer Interface using Code-Modulated Visual Evoked Potentials and Beamforming

Research Group: Computational Neuroscience
Promotor: Prof. Marc van Hullle
Daily supervisor: Benjamin Wittevrongel
Information: benjamin.wittevrongel@kuleuven.be

Context
Brain-Computer Interfaces (BCIs) aim to establish a direct communication pathway between the brain and an external device. They have raised great hopes for people suffering from severe motor- and communication disorders (ALS, spinal cord injury, stroke, etc.). At this moment, the best performing BCIs are based on Visual Evoked Potentials (VEP), in which visual stimuli (i.e., flashes) are used to elicit well-known brain responses. In code-modulated VEP (c-VEP), a unique sequence of illuminated and dark frames ('code') is assigned to each target (letter, figure, ...). Brain activity, measured non-invasively through electroencephalography (EEG), is then analyzed for the codes, and machine learning algorithms are used for classification of a trial (i.e., the selection of a target).

Typical c-VEP analysis is based on template matching techniques. Recently, a spatiotemporal extension of the beamforming principle has successfully been applied towards estimating the contribution of a signal-of-interest (i.e., a template) to the measured EEG signal. More specifically, we have shown that spatiotemporal beamforming outperforms the competition for Steady-State Visual Evoked Potentials (SSVEP), another type of VEP. This project will investigate whether this approach can also outperform traditional methods for c-VEP detection.

Objective
Develop a BCI based on c-VEP, and investigate whether beamforming can compete with state-of-the-art c-VEP approaches.

Approach
The student will start with a literature study to become familiar with the characteristics of c-VEP and its implementations in previous BCI studies.

An EEG experiment will be implemented and several recordings will be performed to collect data for analysis. During the analysis, the student will assess whether the beamforming approach can be employed towards reliable classification of the EEG responses.

If time allows, the method will be implemented in an online experiment.

Profile
The student should have an interest in brain-computer interfacing and machine learning, and have some programming experience.

This project provides an unique opportunity to work with EEG and gain insights in the interdisciplinary field of neuroscience.

Example of c-VEP BCI
Video: c-VEP Brain-Computer Interface [http://youtu.be/te00PxGwpM]
References


