IMPLEMENTATION OF SMR BASED BRAIN PAINTING

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Introduction

Current brain-computer interface (BCI) systems are mostly used for communication with patients with severe motor impairment. These systems offer only restricted possibilities to their users to express themselves creatively. Nonetheless, many patients consider artistic activity to be a valuable aspect of their lives.

We previously extended our P300 BCI for communication used by amyotrophic lateral sclerosis (ALS) patients, to enable them to use a painting application. This was achieved by mapping the individual fields of the control matrix to painting functions [1]. These can be used for e.g., cursor control and placing various figures on the virtual canvas used for painting. When using a P300 BCI though, the user is restricted to predefined (discrete) step intervals when moving a cursor or changing the size of objects on the canvas. This limitation was overcome by designing a new painting application that is controllable with a sensorimotor rhythm (SMR) BCI based on the detection of event-related desynchronization and synchronization (ERD/SD) of those rhythms during motor imagery.

Aims of project

The aims of the project were to
1. create a menu structure suitable for SMR controlled painting, and
2. provide a connection to existing BCI systems (Graz BCI, BCI2000)
3. verify that EEG based control is possible

Menu design

The menu was modeled after the established hex-o-spell typewriter system developed by the Berlin BCI group [2]. This model offers six sub-menus placed in hexagons that are arranged in a circular fashion around a central hexagon (see below). This hierarchical structure is needed due to the restriction to two classes using a conventional SMR BCI system.

Selection in a hexagon based menu was realized by controlling the arrow in the center which, depending on the configuration, can be elongated with one class (e.g., foot movement imagination) and shortened or rotated with another class (e.g. hand movement imagination). Shortening the arrow with the second class is advantageous for correction of wrong selections without an additional menu point to select. However, the arrow is then rotating clockwise automatically and the speed cannot be influenced by the user. Additional commands can be added by increasing the number of submenus.

BCI interaction

The application can be adapted to receive commands from any BCI system that sends out classification results over a network socket. Currently it has been tested using the Graz BCI software with actual EEG control, but will be extended to the BCI2000 software in a next step. So far the connection to BCI2000 has been tested using a signal generator.

Canvas

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References


Brain painting menu

Figure 1: Hexagon menu used for command selection.

Figure 2: Brainpainting canvas