Initial design of a communication device with non-invasive brain-computer interface (BCI), adaptive language modeling and Rapid Serial Visual Presentation (RSVP)

Abstract

We are designing a portable communication device that relies on a non-invasive brain-computer interface (BCI) with optimized language modeling for literate individuals who are functionally locked-in.

We use single trial P3 detection for binary selection of single characters in a rapid serial visual presentation (RSVP).

The innovative BCI has three essential, unique features:

1) Linguistic components ranging from letters to words to phrases that are presented on a computer screen one at a time in rapid succession;
2) A detection mechanism that employs multichannel electroencephalography (EEG) and/or other suitable response mechanisms that can reliably indicate the binary intent of the user and adapt based on individualized neurophysiologic data of the user; and
3) An open-vocabulary natural language model with a capability for accurate predictions of upcoming text.

The collaborative nature of the proposed translational research is expected to yield new knowledge for both BCI development and clinical augmentative communication use.

Anticipated System

Typical System for Portable RSVP Device

- Quad-core, 2.53 GHz laptop
- Code written in Labview, Matlab (Psychophysics Toolbox), C
- 24-bit, 16-channel amplifier from Guger Technologies (gTec Austria)
- 30 symbols
  - 26 uppercase letters, comma, period, space, backspace
- Symbols shown using RSVP
- Support vector machine (Gaussian kernel) used to detect P3

Language Model Comparison

Row/column scanning
(uses optimized grid frequency layout)

Huffman scanning
(uses an 8-gram language model and a Hoffman code)

RSVP (Rapid Serial Visual Presentation)
(uses an 8-gram language model and Displays in rank order)

(Models trained using NYT data)

A locked-in subject/collaborator and his personal assistant

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