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Ambiguous Text Input for Brain-Computer Interfaces

Chirag Panchakshari[1], Betts Peters[2], Mackenzie Miller[1], & Dylan Gaines[1*] on behalf of the Consortium for Accessible Multimodal Brain-Body Interfaces (CAMBI)
[1]*Michigan Technological University, Houghton, MI, USA*
[2]*Oregon Health & Science University, Portland, OR, USA*
[*]1400 Townsend Dr., Houghton, MI 49931, USA. E-mail: dcgaines@mtu.edu

Introduction: One of the main driving forces of current BCI research is robust and consistent results with a high information transfer rate (ITR). Code-modulated Visual Evoked Potentials (c-VEP) have been shown to provide high ITR in target-related applications [1]. Our research aims to explore the effect of using an ambiguous text entry method [2] on our system's accuracy and ITR, and its overall efficacy as a communication BCI. We design a system that allows users to input text by selecting a sequence of ambiguous character groups instead of requiring individual character selections.

Material, Methods and Results: Our user interface consists of eight target boxes (Figure 1). Boxes 1–4 in the top row contain ambiguous groups of letters, while boxes 5–8 in the bottom row contain a mode switch, two word suggestions, and backspace. To enter text, a user selects the target box for each letter in their desired word. For example, to type "WORLD", the user would select boxes in the sequence 43321. After each selection, the word suggestion boxes are updated with the most likely words that match the selected group sequence. Users can select their intended word if it appears, or select mode switch to choose specific letters if the system is not able to predict their word. This would replace the existing ambiguous targets with the individual letters from each selected group in turn.

During selection, each target box is replaced by a checkerboard pattern that flickers in a pseudo-random sequence specific to that target. We place electrodes at O1, Oz, and O2 (by the international 10-20 system) to detect the c-VEP produced in response to the attended stimulus. We amplify the EEG signals using the OpenBCI Cyton Board and transmit them to Lab Streaming Layer (LSL) software on a desktop computer. Using Canonical Correlation Analysis (CCA) [3], we compare the recorded signals with the templates produced for each target sequence during calibration to discern the user's target.

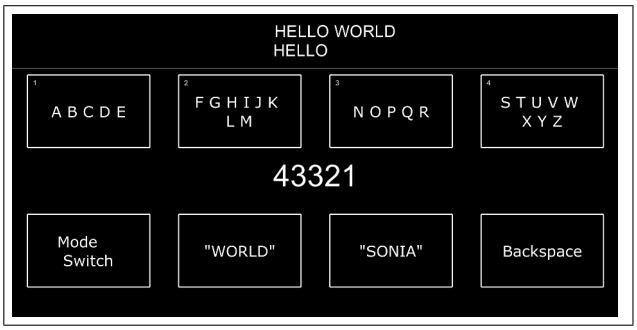

Figure 1: *The user interface for our system. The target and currently typed text are displayed at the top. The selected character groups in the current word are shown in the middle of the screen, surrounded by the eight target boxes.*

To determine the most likely matching words, we leverage a large language model domain-adapted on conversational text [4]. Given the text the user has typed so far, we use the model to evaluate the likelihood of all text that matches the selected letter groups. The two most likely predictions are displayed to the user in boxes 6 and 7. In future work, we seek to extend this algorithm to enable the model to predict words that start with the entered group sequence, allowing it to finish the user's word.

Conclusion: We have designed a preliminary system for ambiguous text input using a c-VEP brain-computer interface. We will validate the efficacy of our system with quantitative data and qualitative feedback from BCI users in the next phase of this project.

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