

FlashType™: A Context Aware, Language Independent, Typing System using c-VEP or Eye Tracking

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Introduction: Communications have been one of the main motivations behind brain computer interfaces (BCIs). Different brain responses have been utilized towards building typing applications. Event Related Potentials (ERPs) and more specifically P300 responses have been used in different paradigms such as matrix or rapid serial visual presentation. In addition, Visually Evoked Potentials (VEPs) and its variations Steady State Visually Evoked Potentials (SSVEPs) and code Visually Evoked Potentials (c-VEPs) also have been utilized towards typing applications. While some methods have shown positive results, still the accuracy and robustness are big concerns. In these methods, characters are playing a role as part of the stimuli, which in turn makes factors such as the font and the size of the characters important. For example, similarly looking letters such as ‘O’ and ‘Q’ produce a weaker P300 response and letter ‘I’ produces a much weaker VEP response comparing to ‘B’.

Method: Taking advantage of our four stimuli c-VEP based system; we designed a cursor based typing interface. One of the key advantages in our design is the separation of the stimuli and the keyboard. Using a checkerboard based stimuli makes the system completely independent from the alphabet letters used in the keyboard. Stimuli consist of 4 reversed pattern checkerboards. Four different m-sequences of length 63 bit are used to control the flickering pattern at a bit presentation rate of 110 Hz. This translates to average decision time of less than a second. The probabilistic classifier will gather more trials if the confidence doesn’t reach a predefined ratio [1].

Keyboard consists of three parts, *Static Keyboard*, *Character Suggestions* and *Predicted Words*. In the default setting, the *Static Keyboard* consists of the 28 English alphabet letters and space and backspace symbols. A language model is used to estimate the probability of every letter while selecting the next character. These probabilities are marginalized towards the four commands based on the location of the cursor. The graphical model used to make the selections is described in a concurrently submitted journal paper [2]. Language model is put to two other uses as well, suggesting a few characters (~7) with the highest probability and predicting 3 or 4 highest probable words.

The stimuli provide the user with four simultaneous options, *Select*, *Horizontal*, *Vertical*, and *Reverse* to make a selection, make a horizontal or vertical movement in the active direction and reverse the active direction respectively. For every selection, cursor starts from the most probable character. Figure 1 shows a screen shot of the FlashType™ where PW stands for *Predicted Words*, and CS stands for *Character Suggestion*. CS1 is the default start point of the cursor. The vertical and horizontal movement is circular so the users can use the *Reverse* option to reach to their target on the opposite side of the grid faster. FlashType™, using an auto-scroll mode, can operate using only a single stimulus.

Results: Figure 2 shows the usage of different parts of the keyboard by three participants while typing 10 different words. *Character Suggestions* have been the most favorite part of the keyboard. Novice users have been able to achieve an average of 6 seconds per character.

Significance: FlashType™, provides a fast, reliable and language independent typing interface, using a single EEG electrode or alternatively an eye tracker. Typing quality is improved using the *Character Suggestions*, *Predicted Words* and by incorporating the EEG from all the movements towards making a selection.

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References

- [1] Nezamfar, H., Orhan, U., Purwar, S., Hild, K., Oken, B., & Erdogmus, D. (2011). Decoding of multichannel EEG activity from the visual cortex in response to pseudorandom binary sequences of visual stimuli. *International Journal of Imaging Systems and Technology*, 21(2), 139-147.
- [2] Nezamfar H, Salehi S, Moghadamfalahi M, and Erdogmus D. FlashType™: A Context Aware c-VEP based BCI Typing Interface using EEG signals. Submitted in: *IEEE Journal of Selected Topics in Signal Processing*, September 2015.

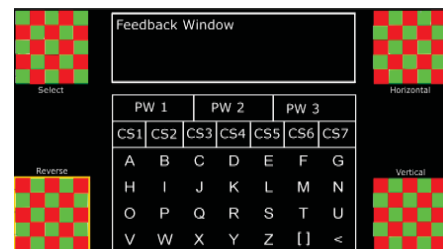


Figure 1: FlashType™ screen shot, first row Predicted Words (PW), second row, Character Suggestions (CS), third part is the Static Keyboard.

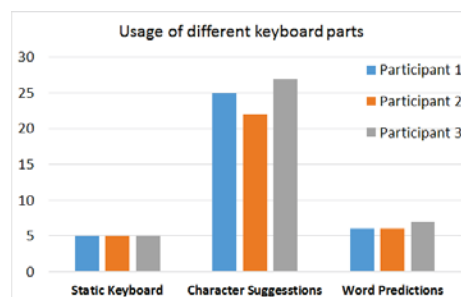


Figure 2: Usage of different keyboard parts by three participants while typing 10 different words.