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Filteryedping: a dwell-free eye typing technique

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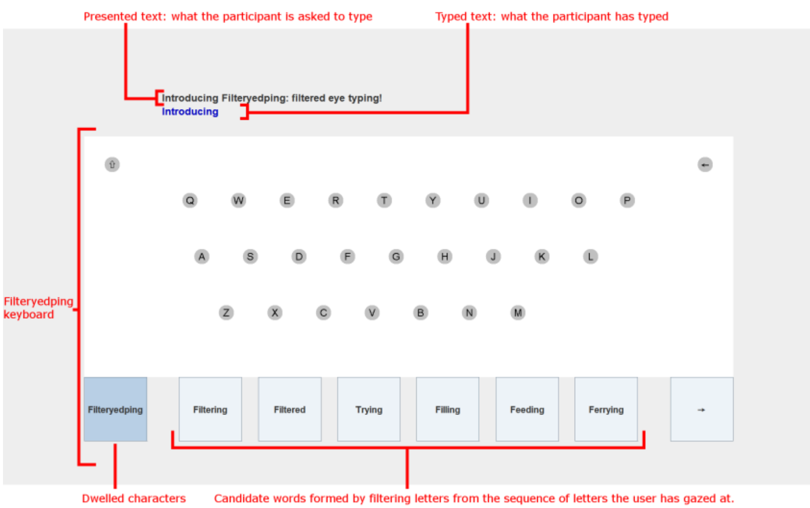

Figure 1. Study software with the Filteryedping interface after user looks at the sequence "filteryedping".

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Abstract
The ability to type using eye gaze only is extremely important for individuals with a severe motor disability. To eye type, the user currently must sequentially gaze at letters in a virtual keyboard and dwell on each desired letter for a specific amount of time to input that key. Dwell-based eye typing has two possible drawbacks: unwanted input if the dwell threshold is too short or slow typing rates if the threshold is long. We demonstrate an eye typing technique, which does not require the user to dwell on the letters that she wants to input. Our method automatically filters out unwanted letters from the sequence of letters gazed at while typing a word. It ranks candidate words based on their length and frequency and presents them to the user for confirmation. Spell correction and support for typing words not in the corpus are also included.

Author Keywords
Gaze; text entry; eye typing; dwell-free; motor disability.

ACM Classification Keywords
H.5.2. [Information interfaces and presentation]: User Interfaces – Input devices and strategies; H.5.2. [Information interfaces and presentation]: User Interfaces – Interaction styles

Dwell-free text entry techniques

A dwell-free text entry technique does not require the user to *dwell* over a key for a specific amount of time to detect the user's intention for inputting that letter. Some of the possible approaches include:

- the use of eye-gestures for writing individual letters [1][2][5][14]
- context switching eye-typing [9], and
- visually navigating nested boxes of letters [12][13].

Although these previous works offer alternatives to dwell-based eye-typing, the user must learn a new way to write a letter with each. Eye-gestures for writing words [4] might be a good alternative, but it still suffers from some not yet explored drawbacks.

Introduction

People affected by motor neuron diseases and disorders that cause muscle degeneration, such as Amyotrophic Lateral Sclerosis (ALS) and Duchenne Muscular Dystrophy (DMD), often rely on eye trackers—devices that determine where on the screen the user looks at—to communicate with others. In particular, eye trackers enable users with motor problems to type by allowing them to simply gaze at the letters that they want to input in a virtual keyboard shown on the screen.

Currently, the most common method of eye typing requires the user to dwell at a letter for a specific amount of time, which can be as short as 400 ms [8][11]. Dwell-based eye typing has two possible drawbacks. When a short dwell time is used, the user gaze may accidentally input unwanted letters. Alternatively, a long dwell time can impede the user's desire to quickly enter text.

Through an experiment, Kristensson and Vertanen [6] learned that users were able to reach a mean entry rate of 46 words per minute (WPM) using a system, which simulates a perfect recognizer for a dwell-free eye typing. Their results demonstrate that dwell-free eye typing can be theoretically much faster than existing eye-based text entry techniques.

In this paper, we describe Filteryedping—a *key filtering–based* approach for supporting dwell-free eye typing. Filteryedping recognizes the intended word by performing a lookup in a word frequency list for possible words that it can form after discarding none or some of the letters that the user has looked at. The system sorts the candidate words based on their length and frequency and presents them to the user for confirmation. Details about the algorithm and implementation can be found in [10]. The name of the technique describes and demonstrates the idea of the technique: filtered eye typing. "Filteryedping" is an example of a stream of letters that our technique can process to produce: "filtered", "eye", and "typing".

Interface

Figure 1 shows the interface of our study software with the Filteryedping keyboard. To write a word using this technique, the user only needs to look at each letter in the word. Unlike with a dwell-based input technique, the user do not have to dwell over a letter to select it. The only requirement is that the user must look at all the letters in the intended word in the same order. It does not matter if the user accidentally looks at extra letters in between the intended letters. To show the user where the system recognizes her current gaze position to be on the screen, Filteryedping simply displays the key looked at by the user in a different color (see character '-' in Fig. 5).

After typing the last letter of a word, the user must look at the bottom part of the interface, where a space bar would normally be. The system then displays the candidate words given the sequence of letters that the user looked at. The user must then identify the intended word, as shown in Figure 2. Arrow buttons at the left and the right extremes of the interface allow the user to view additional candidate words. To accept a candidate word, the user must look at it in the candidate list to select it, and then look to the target / typed text area or back to the keyboard to type the next word. This allows the user either to confirm that she has entered the correct word or to continue to type if she does not feel the need to check. If the user does not find the intended word in the candidate list, she can

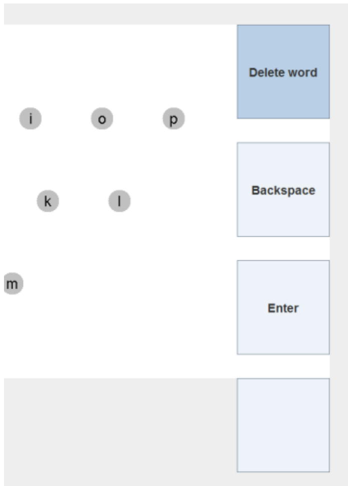

Figure 3. Right view while user looks at "Delete word" button.

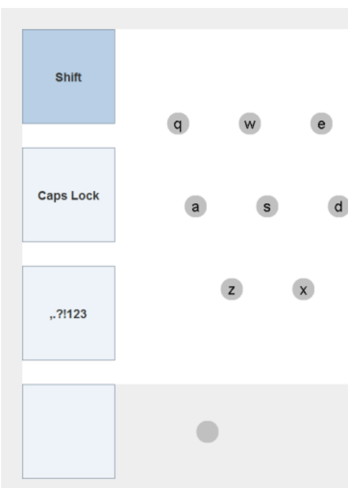

Figure 4. Left view while user looks at "Shift" button.

try to type that word again by looking back to the keyboard while one of the arrow buttons is selected.

Figure 2. Candidate words that best match the sequence of letters looked by the user.

If the user looks at the top right key ("←"), the interface shows a menu with four options: Delete word, Backspace, Enter, and Cancel. The menu works exactly like the candidate list: the user confirms the selection of the functionality by looking back to the keyboard or to the text area. The Cancel button works as a dismiss button in case the user activated the menu by mistake (Fig. 3). If the user looks at the top left key ("⇧"), similarly the interface shows a menu with four options: Shift, Caps Lock, Alternate Layout, and Cancel (Fig. 4). Figure 5 shows the alternate layout displayed after the user looks back to the keyboard.

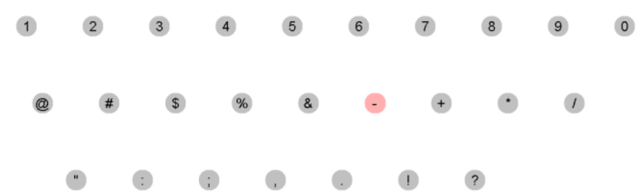

Figure 5. The alternate keyboard layout while the user looks at character '-'.

The system also uses the FreeTTS speech synthesizer library to provide auditory feedback so that the user does not need to visually inspect their typing. The prototype speaks each written word or command name ("deleted", "backspaced", "shift", "caps lock", and "lower case") after the user inputs them.

Word frequency list & out-of-list words

We created the word frequency list used in Filteryedping by first starting with words from the Corpus of Contemporary American English (COCA) [3]. We then reduced it to omit words that contained non-alphabetical characters and those that are not found in *dictionary.com*. Finally, we added the British spelling for 2 words that were in the Mackenzie and Soukoreff [7] phrase set used in the experiments. The result was a list of 133,223 words with their associated frequencies of occurrence.

In Filteryedping, if the user skips gazing at a letter in the intended word or switches the order of some letters, she will not find it in the candidate list. To handle such typo errors, we have added the common misspellings listed in two public online available lists[1] to our word frequency list.

Finally, the interface also allows the user to type words out of the list, such as passwords, by dwelling about 1 second over each desired key. The user then looks at the left-most button in the candidate list, which shows the word composed by the dwelled keys.

Final remarks

We present an implementation of a dwell-free eye typing technique for the QWERTY keyboard layout. Filteryedping allows the user to type without being slowed down by needing to dwell over each key. Kristensson and Vertanen [2012] showed that with a

[1] "Wikipedia:Lists of common misspellings/For machines" (http://en.wikipedia.org/wiki/Wikipedia:Lists_of_common_misspellings/For_machines, accessed 06/Mar/2014) and "Common misspellings" (http://www.oxforddictionaries.com/words/common-misspellings, accessed 06/Mar/2014)

perfect recognizer and error free input, users would be able to reach 46 WPM. In practice, however, a real system needs to handle issues such as extra letters being gazed at by the user. Our approach processes the stream of letters gazed at by the user and creates a list of possible candidates words by filtering out extra letters not part of the intended text. The user, then, selects the desired word from this list.

Previous work have reported the mean typing rate achieved by users with a dwell-based typing interface to be 7.0 WPM [12]. As a point of comparison, when typing text taken from the Mackenzie and Soukoreff phrase set [7] for slightly more than 6 minutes, the first author was able to reach a rate of 19.8 WPM. At the same time, the uncorrected error rate was 1.03%. This illustrates that the method potentially offers faster performance without comprising accuracy for speed.

Acknowledgements

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References

[1] Bee, N. and André, E. Writing with Your Eye: A Dwell Time Free Writing System Adapted to the Nature of Human Eye Gaze. In *Proc. PIT 2008*, Springer (2008), 111–122.

[2] Chakraborty, T., Sarcar, S., and Samanta, D. Design and evaluation of a dwell-free eye typing technique. In *Ext. Abstracts CHI 2014*, ACM Press (2014), 1573–1578.

[3] Davies, M. The corpus of contemporary American English (COCA): 450 million words, 1990-2012. http://www.americancorpus.org (2008).

[4] Hoppe, S., Löchtefeld, M., and Daiber, F. Eype – Using Eye-Traces for Eye-Typing. In *Workshop on Grand Challenges in Text Entry (CHI 2013)*.

[5] Isokoski, P. Text input methods for eye trackers using off-screen targets. In *Proc. ETRA 2000*, ACM Press (2000), 15–21.

[6] Kristensson, P.O. and Vertanen, K. The potential of dwell-free eye-typing for fast assistive gaze communication. In Proc. ETRA 2012, ACM Press (2012) 241–244.

[7] MacKenzie, I.S. and Soukoreff, R.W. Phrase sets for evaluating text entry techniques. In *Ext. Abstracts CHI 2003*, ACM Press (2003), 754–755.

[8] Majaranta, P., Ahola, U.K., and Špakov, O. Fast gaze typing with an adjustable dwell time. In *Proc. CHI 2009*, ACM Press (2009), 357–360.

[9] Morimoto, C.H. and Amir, A. Context switching for fast key selection in text entry applications. In *Proc. ETRA 2010*, ACM Press (2010), 271–274.

[10] Pedrosa, D., Pimentel, M.G., Wright, A., and Truong, K.N. 2015. Filteryedping: Design challenges and user performance of dwell-free eye typing. TO APPEAR in TACCESS. 39 pages.

[11] Räihä, K.J. and Ovaska, S. An exploratory study of eye typing fundamentals: dwell time, text entry rate, errors, and workload. In *Proc. CHI 2012*, ACM Press (2012), 3001–3010.

[12] Rough, D., Vertanen, K., and Kristensson, P.O. An evaluation of Dasher with a high-performance language model as a gaze communication method. In *Proc. AVI 2014*, ACM Press (2014), 169–176.

[13] Ward, D.J., Blackwell, A.F., and MacKay, D.J.C. Dasher – a data entry interface using continuous gestures and language models. In *Proc. UIST 2000*, ACM Press (2000), 129–137.

[14] Wobbrock, J.O., Rubinstein, J., Sawyer, M.W., and Duchowski, A.T. Longitudinal evaluation of discrete consecutive gaze gestures for text entry. In *Proc. ETRA 2008*, ACM Press (2008), 11–18.