Abstract

Patients with quadriplegia or amyotrophic lateral sclerosis (ALS), often find conventional keyboard interfaces difficult if not impossible to use. After researching the methods that existing assistive technologies used to create gaze based typing interfaces, we developed two interfaces: a model of a conventional keyboard and a model of what we believed to be an efficient replacement. Our interface design requires a less accurate eye tracker, decreasing cost while increasing flexibility.

Prior Art

Over the last two decades, many gaze based typing interfaces have been made. The gaze based keyboards below were helpful in creating a design for our own.

Dasher: Dasher is a zooming interface. You point where you want to go, and the display zooms in wherever you point. The more you zoom in, the longer the piece of text you have written. You choose what you write by choosing where to zoom. Dasher is one of the fastest with a reported speed of over 17 wpm for trained users.

Eye-Sistant: Developed in the Netherlands, the Eye-Sistant is an older version of assistive technologies. The Eye-Sistant uses the glasses shown above the actual device. The user focuses on the letters, which are arranged in order of frequency, and they are typed.

ERICA: A more recent, and conventional method of a eye-tracker based keyboard, the ERICA is another assistive technology that allows users to type with their eyes. It is modeled after the conventional keyboard people use today, and is compatible with MS Word and has some speech recognition software, allowing users to "talk" with the words they see. It is commercially available.

Eye tracking Technology

Eye trackers are used in the study of eye movements in the area of active vision and visual attention. Because of the speed and precision of eye movements, they also show promise as a human-computer interface in specialized situations (such as when the hands are not free). The need to calibrate and difficulty in determining gaze position accuracy are limitations to these applications but the technology is improving.

During our research, we used the SR-Research EyeLink 1000®. The SR-Research EyeLink 1000® is a hi-speed, video-camera-based eye tracker. An algorithm detects the corneal reflection and pupil location and uses this to determine gaze location.

Methods:

The diagram above illustrates how both keyboards select letters. The user looks in a desired box and the interface begins to calculate the standard deviation of those points from the center of any given box. If the points are under a certain standard deviation, the letter prints on the screen, otherwise it continues to collect samples. The process repeats until the user is done. In the diagram above, the points that the user looks at on the screen are generally within the "1" box, so the interface would print the number "1" in the space above.

Results

After ten trials with our interface, we produced the results shown on the two graphs. To test our keyboard interface, we timed the time it took to type the sentence. "The quick brown fox jumps over the lazy dog." In the first graph, the amount of errors is directly related to the amount of time it took to write the sentence. An exception would be trial 8, which had the shortest Dwell Time. Dwell time, the amount of time a person looks at the keyboard, was measured in milliseconds. The Dwell Time is also related to the errors. As the User goes on, he adjusted to the dwell time. However, in Trial 8, the Dwell time was too fast, resulting in the most errors made. On average, it took 165 seconds to finish writing the sentence, with an average of 5 errors per trial and average dwell time of 222 milliseconds. Attempts to use the conventional layout were not as successful. Because of difficulties in selecting keys near the corners, the subject could only type the sentence once out of six attempts.

Conclusion

After the trials between the conventional key layout and our own, we concluded that our keyboard is superior in some respects. Because there are only 9 keys at a time, there is higher tolerance to errors and bad calibration. The conventional layout may be faster to learn since it draws on a familiar layout, but even with only 1 session, the subject was typing at 5 wpm. The conventional layout may also be faster since it has all the letters on one screen. However, if the eye tracking is not precise enough, the time and frustration it takes to fix errors and recalibrate may not be worth it. Our layout is well suited for applications where precision is a limitation, such as small or very large displays or for a more affordable at-home assistive technology.

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