Dual Stream Input for Pointing and Scrolling

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ABSTRACT
To find ways to improve users' performance of tasks that involve both scrolling and pointing, we studied three dual-stream input methods, with one stream for pointing and one for scrolling. The results showed that a mouse augmented with a tracking wheel did not outperform the conventional single stream mouse. Two other methods, a mouse with an isometric rate-control joystick and a two handed system significantly improved users' performance.

Keywords Input devices, scrolling, dual-stream input, two-handed Input.

INTRODUCTION
Typical GUI interfaces feature a single stream of input for all interaction tasks. Alternative methods, such as two-handed input, have been proposed and demonstrated to be effective in many tasks [e.g. 1, 2]. These ideas are just beginning to be implemented in mainstream user interfaces. This study investigates user' s performance and preferences with three new dual stream input methods, in a web browsing task.

During browsing, one often needs to alternatively perform scrolling and pointing. With a traditional scroll bar method, there are at least the following two limitations. First, the Fitts' index of difficulty of traveling across the screen to acquire the arrow widget at the end of a scroll bar can be up to 8 bits, which may take 2 seconds to complete. Second, to go to the scroll bar to move a document, even by just one line, takes the perceptual, cognitive and motor resources away from the main task, breaking the work flow.

With dual-stream input methods, one stream can be exclusively used for pointing and the other for scrolling. Two of the dual stream methods we studied were variations of a conventional mouse. One, called WheelMouse in this study, was a mouse augmented with a rolling wheel for scrolling (the Microsoft IntelliMouse™, Fig. 1). The second device, labeled as JSMouse in this study, was a mouse augmented with an isometric joystick (an IBM Trackpoint™) for scrolling (Fig. 2). Both of these devices were manipulated with one hand. The third method, labeled as 2hand condition, used the same sensors as in the second condition, but with a different design: the isometric joystick was in the keyboard and was operated by the user' s non-dominant hand (Fig. 3).

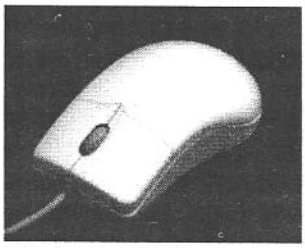

Fig. 1 Mouse with a tracking wheel, the IntelliMouse™

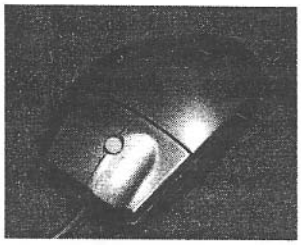

Fig. 2 Mouse with a Joystick (Trackpoint™)

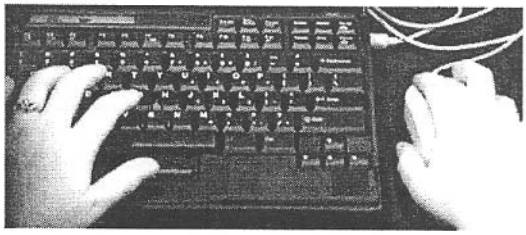

Fig. 3 Two handed system: an in-keyborad isometric joystick and a mouse

THE EXPERIMENT
The goals of the experiment were: 1. Measuring performance and preference of the three dual stream input methods against conventional single stream input; 2. Comparing a rate control isometric joystick with a position control rolling wheel for scrolling tasks; 3. Contrasting the one handed and two handed methods.

The experimental task was to browse 10 web pages: scroll each page, and find and click on the target hyperlink in the page, which led to the next web page.

A total of 12 subjects participated in the experiment, with an order balanced within subject design. With each method, the subjects were first given one practice run which lasted as long as the subjects needed to explore all modes (in the cases of Mouse and WheelMouse). The subjects were then asked to performed two consecutive tests (10 pages each test) as quickly as possible.

Of the 12 subjects, all had extensive experience with using a mouse; five had experience with using the in-keyborad isometric joystick; all but one had no experience with the three dual stream methods. After completing the experiment, subjects were asked to rate each of the four methods.

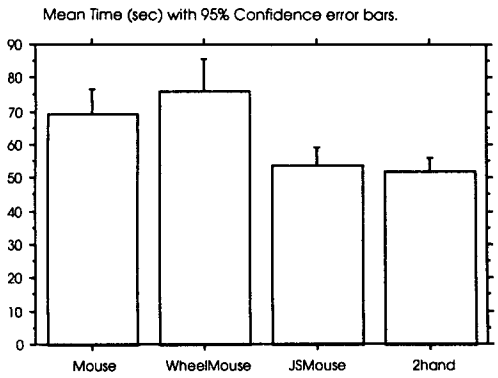

Fig. 4 Mean Completion time of web browsing task

Repeated measure ANOVA analysis on the results showed significantly different completion times among the four techniques ($F_{3,11} = 20.3$, $p < .0001$). As shown in Fig. 4, the JSMouse and 2Hand conditions were 22 and 25 percent faster, but the WheelMouse condition was 8.7 percent *slower* than the conventional single stream mouse. The difference between Mouse and WheelMouse conditions and the difference between JSMouse and 2Hand were not significant. All other pairwise comparisons were significant.

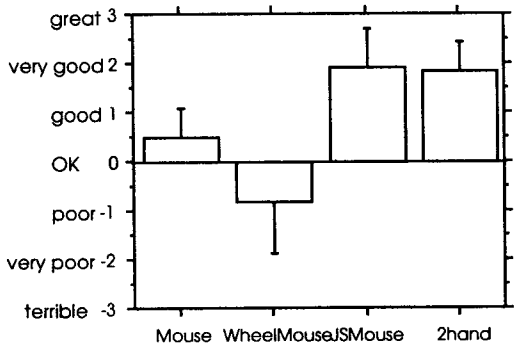

Fig. 5 Mean subjective ratings with 95% confidence error bars

Subjective ratings were similar to the performance measurements (Fig. 5), except that the difference between Mouse and WheelMouse conditions was significant: the WheelMosue received *lower* ratings than the standard mouse.

DISCUSSIONS AND CONCLUSIONS

JSMouse. This device outperformed the standard single stream input by a large magnitude. The isometric joystick in this design is believed to be particularly suitable for scrolling, which requires the user to control not only the final displacement of the document, but also the *speed* of the movement so that he can comfortably scan the document. As shown in our previous studies [4], position control is better conducted with isotonic devices, such as the mouse; and rate control is better conducted with isometric or elastic devices. The key factor to this compatibility is the self-centering effect in isometric or elastic devices. With self centering, rate control can be easily done. Without it, rate control requires conscious effort.

WheelMouse. Although it offered dual-stream input, the WheelMouse did not outperform the conventional single stream mouse. Some subjects commented that it was tedious and tiring to repeatedly roll the wheel, although this was an intuitive mode. The IntelliMouse™ had two additional modes: press (the wheel) and move (the mouse) and click and move, both turned the mouse into rate control mode for scrolling. Although they explored all three modes in the practice phase, only 6 subjects used the two additional rate control modes in the real tests. The lack of self-centering in the isotonic device (mouse) makes it difficult to do effective rate control.

2Hand. Interestingly, no significant performance or rating difference was found between the two handed system and the single handed JSMouse. Nonetheless, the results showed that an asymmetric two handed design, one hand with isometric rate control and the other hand with an isotonic position control, which has not been studied in the literature [e.g. 3], worked well. Questions have been raised whether such a two handed system would work at all, and whether the user would confuse the functions of the two hands. Clearly this was not the case. For more demanding tasks, we have observed more advantage with using two hands. It is extremely difficult, if not impossible, to use the one handed solutions in tasks that require parallel actions, such as scaling, translating, and rotating a 2D geometry object by controlling two vertices.

To conclude, this study indicates that it is time to add multi-stream input into mainstream commercial systems. But, each step of a new design has to be guided by thorough human factors research to avoid very possible mistakes. Further details of this study can be found in [5].

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REFERENCES

[1] Buxton, W. (1986) There is more to interaction than meets the eye: some issues in manual input, in Norman, D.A and Draper, S.W. (Eds) *User Centered System Design*, Lawrence Erlbaum Associates, 319-337.

[2] Buxton, W. and Myers, B. (1986) A study of two-handed input, in *Proc. of CHI86*, 321-326.

[3] Kabbash, P., Buxton, W., Sellen, A. (1994) Two-handed input in a compound task, in *Proc. of CHI94*, 417-423.

[4] Zhai, S. (1995) *Human Performance in Six Degree of Freedom Input Control*, Ph.D. Thesis, U. Toronto. http://vered.rose.toronto.edu/people/shumin_dir/publications.html

[5] Zhai, S., Smith, B.A., Selker, T., Improving browsing performance: a study of four techniques for scrolling and pointing tasks, IBM Research Report RJ10058, Oct, 1996.