Transition Times for Manipulation Tasks in Hybrid Interfaces

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1. INTRODUCTION

In 3D modeling environments, such as Autodesk Maya, users most frequently use 2D input devices, typically the mouse and keyboard, to manipulate objects. While it seems more appropriate to use 3D input for these tasks, previous research on 3D input devices has pointed out several weaknesses, specifically fatigue, lower accuracy, and in some cases a slower interaction speed [3]. Fatigue also becomes a problem when users have to keep their arm suspended in the air for an extended time. Not only is this a problem for the in-air interaction as a main interaction paradigm, the fatigue induced may also cause users to relax the poses needed for gestures, increasing the chances of interpretation errors [3] and decreasing pointing precision [1]. One way to address this is to build hybrid user interfaces that combine the expressiveness of in-air interactions for select operations with the precision achievable by 2D input devices for other interactions.

We investigate a three-device hybrid setup using a keyboard and mouse in combination with the Leap Motion for in-air interactions. We examine the costs associated with transitioning between these interaction devices, and performing 2D manipulation tasks using mouse and Leap Motion.

2. METHODS

The study had 31 voluntary participants (five female), with 18 trials per participant (2 devices x 3 manipulation tasks x 3 difficulty levels). The two devices consisted of the Leap Motion and the mouse. For the tasks, they had to rotate, scale or translate an object. In order to perform each manipulation, the participant had to press a key on the keyboard with one hand (typically the non-dominant one) to activate the tool, and then depending on the task, use the mouse or perform a gesture using the Leap Motion with the other (dominant) hand. The main dependent variables in the experiment were the completion time of the primary tasks, and the transition times between the main devices and the alternate devices, including the travel time to and from the devices. We introduced simple alternate tasks in between the core tasks to create situations where participants had to transition between input devices; this ensured that we measured transition time consistently. For the alternate tasks, we used transitions to the keyboard and mouse. The measurements are only for transitions of a single hand; we enforced this by having the users activate a keyboard clutch with the other hand while interacting. There were two types of alternate tasks, one requiring the user to transition to the mouse and the other requiring a transition to the keyboard.

3. DISCUSSION

We found that there was a significantly higher transition cost for the in-air device compared to the cost of transitions between keyboard and mouse. Transitions between the Leap Motion and the mouse took 1.26 seconds longer (47% increase), while transitions between the keyboard and the Leap Motion took only an additional 0.48 seconds (16.38% increase). This means that the average transition cost to *and* from the Leap Motion is only 0.87 seconds extra (32% increase). The transitions between keyboard and mouse were comparable to the homing times reported in Card et al.'s work [2]. They found a transition time of 0.4 seconds when transitioning from the keyboard to the mouse or vice versa. In the direct comparison with the mouse, the Leap Motion is slower. However, it is still worthwhile to investigate the kind of role an in-air device can play in a hybrid setup, as the Leap Motion can be used for tasks that are more difficult to perform with the mouse, such as 3D rotations. The findings indicate that the Leap Motion could be used together with the mouse without introducing an overly large transition cost between devices. Thus, for hybrid interfaces the Leap Motion may be an appropriate tool for performing large-scale interactions in the air, while precise fine-tuning is better performed with the mouse. This way few transitions are needed and the impact of longer transition times would be lessened, which also reduces the amount of fatigue arising from prolonged use of in-air interaction devices.

4. REFERENCES

[1] Brown, M. A., Stuerzlinger, W., and Filho, E. J. M. 2014. The performance of un-instrumented in-air pointing. In *Proceedings of the 2014 Graphics Interface Conference*, pp. 59-66. ISBN=978-1-4822-6003-8.

[2] Card, S. K., Moran, T. P., and Newell, A. 1980. The Keystroke-level Model for User Performance Time with Interactive Systems. Communications of the ACM, 23 (7), pp. 396-410. DOI= http://doi.acm.org/10.1145/358886.358895.

[3] Sambrooks, L., and Wilkinson, B. 2012. Comparison of gestural, touch, and mouse interaction with Fitts' law. *OzCHI'13*, pp. 119-122. DOI= http://doi.acm.org/10.1145/2541016.2541066.

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