Effects of Stereo and Head Tracking in 3D Selection Tasks

Bartosz Bajer
York University
bartb@cse.yorku.ca

Robert J. Teather
York University
rteather@cse.yorku.ca

Wolfgang Stuerzlinger
York University
wolfgang@cse.yorku.ca

ABSTRACT
We report a 3D selection study comparing stereo and head-tracking with both mouse and pen pointing. Results indicate stereo was primarily beneficial to the pen mode, but slightly hindered mouse speed. Head tracking had fewer noticeable effects.

Categories and Subject Descriptors
H.5.2 [Information Interfaces and Presentation]: User Interfaces – input devices, interaction styles.

Keywords
Pointing; Fitts' law; ISO 9241-9; virtual reality

1. INTRODUCTION
Stereoscopy and head tracking are commonly used in virtual reality systems to improve immersion, but results indicating the value of these in selection tasks are somewhat mixed [1, 2, 4]. We present a study evaluating these technologies for a ray-casting, and a mouse-based pointing. One might expect that mouse pointing would not benefit from these additional depth cues, as it is predominantly 2D. However, it is an example of "projected" pointing [5], i.e., 3D screen-plane selection via target projections. Both the cursor and targets are affected by stereo and head tracking, which may improve pointing, even with a mouse. Our study investigates this.

2. EXPERIMENT
Thirteen participants volunteered for the study, a 3D version of the ISO 9241-9 [3] reciprocal tapping task. We used a stereo-capable PC with a NaturalPoint *OptiTrack* system to track the head and pen. The software displayed 3D interpretation of the ISO 9241-9 reciprocal tapping task, (Figure 1, right) set in a 10 cm deep box matching the 22" display size. Participants were instructed to select the highlighted target using the current pointing technique. Target height relative to the screen varied from +8 cm to 0 cm in 1 cm increments. The first target in the circle (the top-most highlighted target in Figure 1, right) was the highest (+8 cm), and the opposite target was the lowest (0 cm). All other targets had a height between these two extremes. Mouse pointing used a mono cursor, while the pen used ray-casting. Participants completed all combinations of pointing technique (mouse/ray), stereo (on/off), and head tracking (on/off).

SUI'13, July 20-21, 2013, Los Angeles, California, USA.

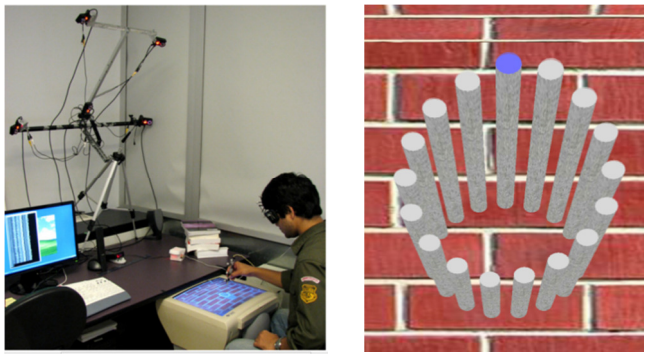

Figure 1. (Left) Apparatus. (Right) 3D version of ISO 9241-9 [3] task used, requiring depth with each motion.

3. RESULTS
Stereo significantly increased pen movement time $(F_{1,11} = 106.36, p < .001)$, by 30% with mono display. There was a significant interaction between head tracking and target height for pen movement time $(F_{15,165} = 3.11, p < .005)$, larger height differences were slower with head-tracking. This same effect was present for stereo as well $(F_{15,165} = 3.31, p < .001)$. Surprisingly, stereo slightly *increased* mouse movement time by about 5% $(F_{1,11} = 10.51, p < .01)$.

4. CONCLUSIONS
Overall, the effect of stereo display was stronger in our study than that of head-tracking. Surprisingly, stereo negatively affected the mouse, yielding slower target acquisition times. Head-tracking also yielded worse completion times with larger height differences. This may be because participants required extra head-motion to properly view the scene in these cases.

5. REFERENCES
1. Arsenault, R. and Ware, C., Eye-hand co-ordination with force feedback, in *Proceedings of the ACM Conference on Human Factors in Computing Systems - CHI 2000*, 408-414.
2. Boritz, J. and Booth, K. S., A study of interactive 3D point location in a computer simulated virtual environment, in *Proceedings of the ACM Symposium on Virtual Reality Software and Technology - VRST 1997*, 181-187.
3. ISO 9241-9 Ergonomic requirements for office work with visual display terminals (VDTs) - Part 9: Requirements for non-keyboard input devices. International Standard, International Organization for Standardization, 2000.
4. Teather, R. J. and Stuerzlinger, W., Guidelines for 3D positioning techniques, in *Proceedings of the ACM Conference on FuturePlay 2007*, 61-68.
5. Teather, R. J. and Stuerzlinger, W., Pointing at 3D target projections using one-eyed and stereo cursors, in *ACM Conference on Human Factors in Computing Systems - CHI 2013*, 159-168.