A System for Evaluating 3D Pointing Techniques

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ABSTRACT

This demo presents a desktop VR system for evaluating human performance in 3D pointing tasks. The system supports different input devices (e.g., mouse and 6DOF remote pointer), pointing techniques (e.g., screen-plane and depth cursors), and cursor visualization styles (e.g., one-eyed and stereo 3D cursors). The objective is to comprehensively compare all combinations of these conditions. We especially focus in on fair and direct comparisons between 2D and 3D pointing tasks. Finally, our system includes a new pointing technique that outperforms standard ray pointing.

Keywords

3D pointing; cursors; selection; Fitts' law.

1. INTRODUCTION

Three-dimensional pointing in VR systems is analogous to 2D pointing commonly used with a mouse on desktop systems. While 2D pointing tasks are well-studied and well-understood [1], 3D pointing is relatively less well understood and direct comparisons between 2D and 3D pointing are rare. Hence we developed a system to both evaluate 3D pointing tasks, and to permit direct comparison between 2D and 3D pointing tasks under a variety of test conditions. Our main objective is to identify better methods for evaluating 3D pointing techniques using methodology commonly employed in the evaluation of 2D techniques.

2. The System

Our system runs on a 3 GHz PC, with an Nvidia Quadro 4400, and a 24" 120Hz stereo LCD. Stereo graphics are enabled using NVidia 3DVision Pro shutter glasses. Five NaturalPoint Optitrack S250e cameras are used for 3D tracking. Alternatively other 3D trackers can also be used. The system can display the scene in both stereo and mono. It can also render the cursor only in stereo or mono, see e.g., Ware's work on one-eyed cursors [5].

The system uses a 3D extension of the ISO 9241-9 standard for evaluating computer pointing devices [2], based on Fitts' law [1]. The scene is a 30 cm deep box matching the display size, see Figure 1a. Textures and cylinders are used to facilitate spatial perception of the 3D scene. Target spheres are centered on top of cylinders arranged in a circle. The active target highlights blue and targets highlight red when selected. The cursor is a small 3D crosshair, either at the screen plane or in the 3D scene, depending on the current condition. In one-eyed mode, the cursor is displayed only to the viewer's dominant eye. In ray mode, the 3D device ray is also displayed. While the 2D experimental paradigm varies only target size and distance, our system supports any combination of target size, distance, and depth within the limitations of the geometry imposed by the screen, tracking volume, and input device characteristics.

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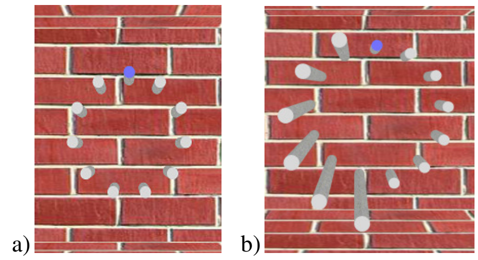

Figure 1 (a). A target circle at constant (flat) -20 cm depth. (b) Mixed depth targets – those on the right are farther.

3. Pointing Techniques

We currently support two different cursor modes with each of the mouse and remote pointing devices. The first mode employs a screen plane cursor and the second a sliding cursor. All four cursor/device combinations are depicted in Figure 2.

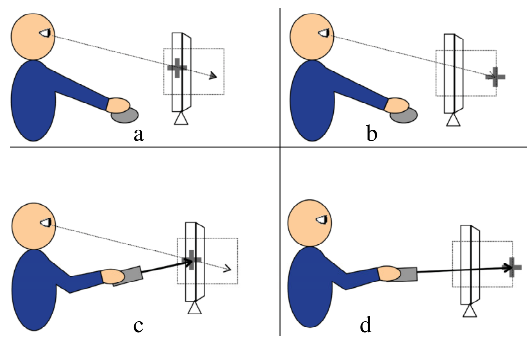

Figure 2. The pointing techniques supported by the system.

The mouse technique (Figure 2a) uses a screen cursor. The sliding mouse cursor (Figure 2b) instead displays the cursor at the ray/scene intersection*,* so the cursor slides across geometry. Our novel "ray-screen" technique (Figure 2c) displays a screen cursor where the device ray intersects the screen, and uses the eye-to-cursor ray for selection. The final technique (Figure 2d) is standard ray pointing. Our evaluations [3, 4] show the mouse is best, but also that ray-screen outperformed ray pointing.

4. REFERENCES

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