The Flexible Pointer: An Interaction Technique for Selection in Augmented and Virtual Reality

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ABSTRACT

We present a virtual flexible pointer that allows a user in a 3D environment to point more easily to fully or partially obscured objects, and to indicate objects to other users more clearly. The flexible pointer can also reduce the need for disambiguation and can make it possible for the user to point to more objects than currently possible with existing egocentric techniques.

KEYWORDS: interaction techniques, augmented reality, virtual reality.

1 INTRODUCTION

There are many interaction techniques for selection in immersive environments. Poupyrev et al. [7] classify interaction techniques as egocentric or exocentric. *Egocentric* techniques include virtual hand (e.g., "classical virtual hand" [3] and "go-go" [6]) and virtual pointer (e.g., ray-casting [3], "flashlight" [4], and aperture-based and image-plane–based selection [2,5]). *Exocentric* techniques include World-In-Miniature [8]. Each of these interaction techniques has its advantages and disadvantages, as discussed in previous work [1,3,7]. One problem that the virtual pointer techniques share is that they typically need some way to disambiguate the object to which the user is pointing when many objects are close to each other, or when the target is obscured by other objects. Most of these techniques also obstruct the user's view of the scene with the pointer or the user's hand. (Pierce et al. [5] suggest the use of transparent rendering of the user's hand to address this problem, but this does not help in optical see-through augmented reality.) While pointing in a World-In-Miniature potentially avoids the disambiguation problem (since the user can choose a viewpoint that makes it easier to select the target), it can make obscuring the view even more problematic because of the denser rendering of the scene. Aperture-based selection [2] and image-plane–based interaction [5] do not apply well to pointing out objects to other users in collaborative environments who do not share the pointing user's line-of-sight.

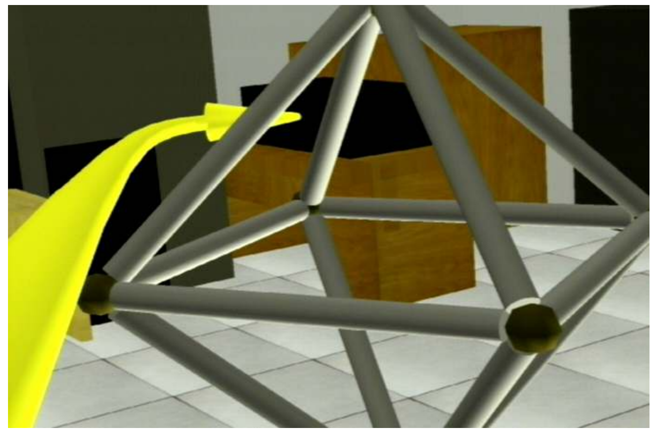

Figure 1. The flexible pointer selecting a partially obscured object, without visually interfering with the occluding object. The pointer also gains access to a larger selectable area than is visible to the user.

2 THE FLEXIBLE POINTER

To address these problems, we have developed an interaction technique that extends existing ray-casting selection techniques [2,4,5,6]. The flexible pointer allows the user to point around objects with a curved arrow, to select fully or partially obscured objects, and to point out objects of interest more clearly to other users in a collaborative environment. The flexible pointer reduces ambiguity by avoiding obscuring objects, which could have been selected with traditional ray-casting techniques, as shown in Figure 1. The flexible pointer also has a visual advantage of not obstructing other objects of interest, such as the large structure in the foreground of Figure 1, while still providing a continuous line from the user to the target.

The advantages provided by the flexible pointer can be summarized as:

- Expands the set of objects to which a user can point.
- Makes it easier to point to some objects by exploiting surfaces that are not directly exposed.
- Reduces the need for disambiguation.
- Clarifies indicative pointing in multi-user environments.
- Avoids obstruction of the user's view.
- Helps selection through visual cues.

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Target Disambiguation in Human Pointing

Our informal observations show that users do not always point along a straight line when indicating an object of interest. This is especially evident when we want to point out an object to another person. When pointing to something that is not currently visible (e.g., behind a corner), we have noticed that people often curve the pointing gesture to make it easier to understand. The curved gesture is often combined with movement to further clarify the intention. Curved pointing is also commonly used when there are many objects close to each other; for example, we might point sideways, from the direction with most free space. People also seem to point along a curve when it is difficult to point straight at an object because its visible surface is relatively small; for example, when pointing to the leftmost object in a cluster of objects, people tend to point from the left and inwards, avoiding the other objects.

Controlling the Pointer

Inspired by these observations, we track hand position and orientation to control the length and curvature of our flexible pointer. Hand orientation determines the amount of curvature, and position is mapped to length. For increased precision and comfort, our current implementation uses two-handed control of the pointer, where the vector formed by the hands determines the pointer's length and orientation, and the relative orientation determines the curvature, as shown in Figure 2.

Implementation

The flexible pointer is implemented as a quadratic Bézier spline, where position, length, and curvature are controlled by three points (position, end point, and control point) in 3D space. In our current version of the interaction technique, each hand is tracked by a 6DOF tracker. The vector between the hands forms the *axis* of the pointer.

The pointer uses five parameters:

- position 1 (hand position)
- position 2 (hand position)
- pointer scale factor (a constant that determines how much the axis is scaled, allowing scaled pointing at a distance)
- amount of curvature (control point distance from axis)
- relative position of curvature (location of control point projection onto axis)

We map the relative position of curvature to the orientation deviation of the two sensors from the pointer's axis, and the amount of curvature to the total amount of deviation of the two sensors. In other words, the bending of the hands controls how much and in which direction the pointer curves, as shown in Figure 2.

3 CONCLUSIONS AND FUTURE WORK

The flexible pointer has worked well in our informal experiments and we plan to try other control approaches (e.g., one-handed control, using hand, wrist, and handheld trackers). We have already begun to explore improved versions and expect to perform a user study comparing the flexible pointer with other selection mechanisms.

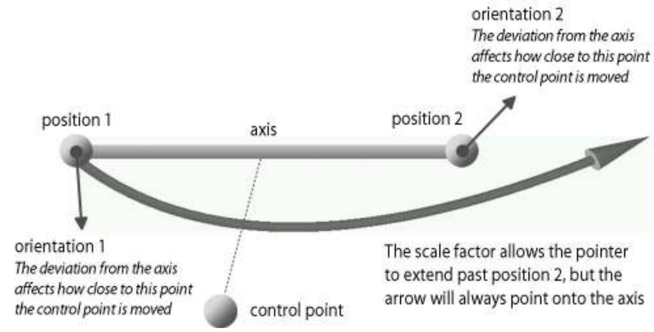

Figure 2. Control parameters for the flexible pointer.

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