Gaze + Pinch Interaction in Virtual Reality

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Figure 1: Gaze + Pinch interactions unify a user's eye gaze and hand input: look at the target, and manipulate it (a). Virtual reality users can utilise free hand direct manipulation (b) to virtual objects at a distance in intuitive and fluid ways (c).

ABSTRACT

Virtual reality affords experimentation with human abilities beyond what's possible in the real world, toward novel senses of interaction. In many interactions, the eyes naturally point at objects of interest while the hands skilfully manipulate in 3D space. We explore a particular combination for virtual reality, the *Gaze + Pinch* interaction technique. It integrates eye gaze to select targets, and indirect freehand gestures to manipulate them. This keeps the gesture use intuitive like direct physical manipulation, but the gesture's effect can be applied to any object the user looks at — whether located near or far. In this paper, we describe novel interaction concepts and an experimental system prototype that bring together interaction technique variants, menu interfaces, and applications into one unified virtual experience. Proof-of-concept application examples were developed and informally tested, such as 3D manipulation, scene navigation, and image zooming, illustrating a range of advanced interaction capabilities on targets at any distance, without relying on extra controller devices.

KEYWORDS

Gaze; pinch; freehand gesture; interaction technique; multimodal interface; menu; eye tracking; virtual reality.

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1 INTRODUCTION

Current advances in virtual reality (VR) technology afford new explorations of experimental user interfaces in the pursuit to *"identify natural forms of interaction and extend them in ways not possible in the real world"* [23]. A natural form of interaction is the use of free virtual hands, enabling direct control of objects based on analogies from the real world [12, 18, 33]. Using the eyes for control, however, is not possible in the real world, although considered as efficient, convenient, and natural input for computer interfaces [15, 39, 52**?**]. We are interested in the combination of both modalities, to explore how the eyes can advance freehand interactions.

We propose the *Gaze + Pinch* technique that combines the eyes and freehand input for 3D interaction in VR (Figure 1). The basic idea is to bring direct manipulation gestures, such as pinch-to-select or two-handed scaling, to any target that the user looks at. This is based on a particular division of labour that takes the natural roles of each modality into account: the eyes select (by visual indication of the object of interest), and the hands manipulate (perform physical action). This resembles a familiar way of interaction: looking to find and inspect an object, while the hands do the hard work. What's new in the formula is that the hands are not required to co-locate in the same space as the manipulated object, affording fluid free-handed 3D interaction in ways not possible before. In particular:

- Compared to the virtual hand, users can interact with objects at a distance — enhancing the effective interaction space and allowing users to take full advantage of the large space offered by the virtual environment.
- Compared to controller devices, users are freed from holding a device and can issue hand gesture operations on remote objects as if interacting through direct manipulation. This renders the interface highly intuitive, as spatial gestures are inherently ingrained in human manipulation skill [12].

Although prior work examined extending hand input in VR [2, 32], and gaze + gesture combinations on 2D screens [7, 45], only little