EyeSeeThrough: Unifying Tool Selection and Application in Virtual Environments

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Abstract

In 2D interfaces, actions are often represented by fixed tools arranged in menus, palettes, or dedicated parts of a screen, whereas 3D interfaces afford their arrangement at different depths relative to the user and the user can move them relative to each other. In this paper we introduce EyeSeeThrough as a novel interaction technique that utilises eye-tracking in VR. The user can apply an action to an intended object by visually aligning the object with the tool at the line-of-sight, and then issue a confirmation command. The underlying idea is to merge the two-step process of 1) selection of a mode in a menu and 2) applying it to a target, into one unified interaction. We present a user study where we compare the method to the baseline two-step selection. The results of our user study showed that our technique outperforms the two step selection in terms of speed and comfort. We further developed a prototype of a virtual living room to demonstrate the practicality of the proposed technique.

Index Terms: Human-centered computing—Human-centered-computing—Gestural input;

1 Introduction

3D virtual environment afford direct operation of objects using their body and hand movements. Interfaces can be designed in relation to the body to exploit the user's sense of proprioception [30]. Handheld palettes [9,27,43] and cockpit menus [13] are examples of such user interfaces in which the menu items are fixed to the user's body, enabling users to remain aware of, and interact with, both the menu interface and the background objects in the scene at any time.

The application of a tool's effect to an intended target is based on a two-step process. Target objects and menus are typically presented at distinct locations in the scene. As a result, the interaction is two-fold: First, the user points at the tool in the menu and confirms the selection. Second, the user points at the object, and confirm the application of the tool. This can also be done by first pointing at and selecting the object, and secondly, pointing at the tool and confirming its application to the object. At times such as when the user's task involves frequent switching between different tools and targets, it can become a tedious and inconvenient operation. For this reason, this research explores how the two-step process can be unified into one interaction.

We introduce *EyeSeeThrough*, an interaction technique for VR that leverages eye-tracking to streamline the two-step operation by utilizing the ability to align the object and tool relative to each other in 3D. In particular, users apply a tool by visually aligning it with a target, followed by a confirmation (Figure 1). The alignment is based on explicit movement of the tool displayed on a semi-transparent layer in the view relative to the target in the background, inspired by Bier et al.'s Toolglass technique for 2D desktop UIs [5]. The user simply looks at the target while positioning the tool over it. When the user confirms the alignment (e.g., by click), the 3D gaze ray determines both the tool and the target, and the action is executed in the virtual scene. Therefore, two successive selections are unified into one interaction, analogous to a shooting task where the user aligns the gun's crosshair with the target and triggers the action.

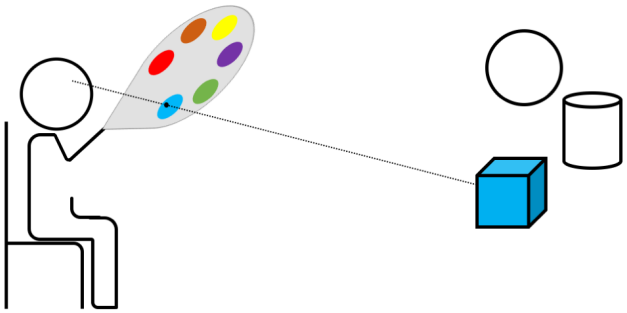

Figure 1: The EyeSeeThrough technique unifies tool selection and application: the user visually aligns the menu's tool with the target in line of sight. Here the user applies the blue color to the cube object.

The eyes play an important role in visual alignment task. The technique infers the alignment of the tool and the object by examining the intersection of the user's gaze ray with the object and the tool in 3D. Therefore, gaze is used implicitly for the interaction. Although gaze is employed similar to a pointing mechanism, the technique doesn't require users to move their eyes between the object and the tool, but allows them to retain their visual attention on the desired object while aligning the tool with it. In other words, gaze is used for pointing towards two targets at once which we believe offloads the extra pointing step to other modalities such as hand to bring the tool towards line-of-sight.

In this paper, our goal is to better understand the underlying interaction process of EyeSeeThrough from a design and a user perspective. We first describe two variations of the technique: one where the tool palette is attached to the user's hands, and one where the menu is attached to the user's head like a cockpit interface. We then present a user study that compares the baseline two-step to our approach, to understand the effect of unifying the steps. Our study shows promising results on EyeSeeThrough. In the tested color-matching task, the user's performance improves over the baseline two-step approach, and users also preferred the technique.

Based on the findings, we explore the design space of the technique through application examples to demonstrate how the technique can be used in realistic environments. For instance, users can leverage the cockpit interface to control smart objects such as a lamp or a TV through EyeSeeThrough. Lastly, by considering the

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