IPT-EGVE Symposium (2007)
B. Fröhlich, R. Blach, and R. van Liere (Editors)

Visual Consistency in Rotational Manipulation Tasks in Sheared-Perceived Virtual Environments

Michal Koutek, René Molenaar, Gerwin de Haan and Frits H. Post

Delft University of Technology, The Netherlands

Abstract

Sharing one large screen projection display, such as the Virtual Workbench, with multiple users can cause distortions in viewing and interaction, as the users perceive a sheared and moving space. Generally, object rotation in non-orthogonal, sheared coordinate spaces is something that should be avoided as it consequently invalidates homogeneous geometric object transformations. Although this problem seems to be artificial, in shared multiple-user VR this issue gets a real, substantial flavor. It is typically a problem for the "secondary" users viewing and interacting with a VR system. Due to rendering the scene from a different viewpoint, they perceive several distortions in the stereo image, one of which is that the VE appears to be sheared. This is also the case in our affordable approach to a multiple user VR Workbench. In this paper we describe technical aspects of our novel viewpoint compensation method to make the object selection, translation, and rotation consistent with the (secondary) user's view of the scene. We focus on description of object rotation inside sheared VE's. We demonstrate that our techniques ensure a sense of interaction consistency despite the view distortions.

Categories and Subject Descriptors (according to ACM CCS): I.3.7 [Computing Methodologies]: Computer GraphicsVirtual Reality;

1. Introduction

Virtual Reality Workbenches have the potential to be used for direct collaboration by a small group of people, and for interactive VR demonstration. To make a Workbench suitable for these scenarios, two major issues need to be resolved: a suitable stereo display and view consistent interaction for the users. When the typical (single-user) Workbench is employed for this situation without any adjustments, the usability is be rather limited.

One solution would be to provide a robust, multi-user stereo display system. Every user would be headtracked and able to correctly interact in 3D with the system. Obviously, this is difficult and expensive to implement. The hardest part for the Workbench system proves to be multi-user stereo display. We have developed an approach and a set of guidelines that make an "ordinary" single-user Workbench suitable for multi-user viewing and interaction in a rather affordable fashion [dHMKP07]. In our approach we can share the screen in a number of ways to provide a good stereo display for certain application/collaboration scenarios [Mol07]. In this paper we use one of the viewing modes, where multiple users share the whole display with only one stereo delivery system.

By applying certain constraints and following our guidelines, we can minimize the adverse effects when one stereo display is being shared. The most challenging part however is to make the interaction of all the users consistent with their visual perception of the 3D scene. The reason is that the main part of the scene is rendered from one viewpoint, while only user-specific parts of the scene can be displayed correctly for their individual viewpoints. This typically leads to a situation where the "secondary" users manipulate objects in a visually distorted VE. In this paper we limit our explanation to the direct and remote (ray-casting) interaction techniques. For the VR effect to work, it is important to retain the consistency between the interaction (scene) space and the visual space. When the visual space of the VE is distorted by shearing, the interaction becomes difficult and often confusing, according to novice users. For example moving an object straight up in the visual/perceived space gets interpreted as moving in a slanted direction relative to the screen plane. Another example is that without compensation, it will not be clear around which axis is an object actually rotating.