Tangible devices for two handed 3D interaction

Robert van Liere, Jurriaan D. Mulder
Department of Information Systems
Center for Mathematics and Computer Science
Amsterdam, the Netherlands
{robertl,mullie}@cwi.nl

Abstract

Tangible devices, two handed interaction and co-location are well known concepts in the 3D user interface community. Many researchers believe that these concepts can improve the quality of interaction and enhance the sensation of presence in a virtual environment.

In this workshop contribution we show how we have integrated these concepts in the Personal Space Station (PSS), a near field desktop VR/AR environment. We review the governing principles and enabling technology of these concepts, and discuss our observations of interaction styles in the PSS.

1 Introduction

The Personal Space Station (PSS), is a near field desktop VR/AR environment, [1]. It was our desire to design and create an interactive 3D workspace which provides the user with a strong sense of presence and evoke participation with the 3D world.

We employ the PSS primarily as a tool for interactive scientific visualization. Consider figure 1: a comfortably seated, head tracked user has a stereoscopic outside-to-inside view of a three-dimensional structure. Co-located, two-handed interaction is realized by reaching under the (possibly semi-transparent) mirror to interact with the structure.

1.1 Governing Principles of PSS Interaction

There are three principles that have guided our design:

1. Co-location

   Alignment of the interaction space with the visual space is an important aspect, which exploits proprioception and hand-eye coordination.

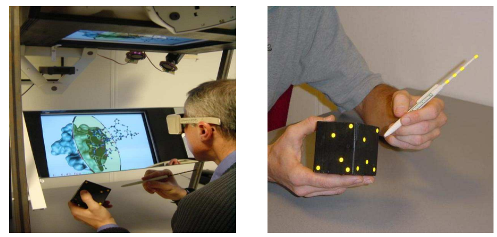

Figure 1. Left: The Personal Space Station. Right: A pen and cube device.

2. Tangible devices as a basis for object manipulation.

   The goal of using tangible devices is to mimic virtual objects with physical representations. The world-in-hand metaphor is very natural when the center of rotation corresponds to the reference frame of the device. Furthermore, we feel that passive tactile feedback from the physical surface of the device may enhance user performance for tasks such as sketching and tracing.

3. Two handed interaction.

   In theory, two handed interaction allows relative positions of hands to be used as kinesthetic reference frames. The non-dominant hand can be used in global positioning tasks whereas the dominant hand can be used in local precision tasks.

4. Ease of use.

   Users must be comfortably seated with their elbows rested on the desktop, reducing fatigue when performing interaction for an extended period of time. Devices should be non-intrusive, wireless, and easy to handle. The PSS should provide a highly transparent layer between the user and the 3D workspace.

These principles are certainly not novel; others researchers have explored them in isolation, [2, 3, 4, 5]. However, we believe that their combination can be used to im-

Figure 2. Examples of specific devices : A thimble for probing the object, a cutting plane device for cutting plane orientation, a ruler for distance measurements.

plement direct and intuitive interfaces and result in new interface styles.

1.2 Enabling Technology

Optical tracking is used to track input devices. Two progressive scan CCD-cameras are mounted on the PSS chassis. The interaction volume is illuminated by rings of IR LEDs mounted around the camera lenses. Input devices can be constructed by pasting retro-reflective markers on the device in unique patterns that can are recognized by the tracker.This allows for easy construction, application, and evaluation of different (generic or task specific) devices. Figure 1 shows a cube device consisting of 6 patterns of 5 coplanar markers and a pen device consists of 4 collinear markers. The tracking system is responsive. The optical tracker tracks the devices at approximately 55 Hz. Typical end-to-end latencies are around 25 ms.

Figure 1 and 2 show example of devices that have been used in the PSS.

2 Observations

The PSS is currently being used in six Dutch academic institutes for various applications, including medical visualization and cell biology. Furthermore, we have had many users in the PSS during various fares and exhibitions. The PSS was received with much enthusiasm, and we often observed spontaneous, active participation with the 3D world. We believe that the following factors have contributed to the success of PSS interaction styles:

- Direct, co-located, interaction provide users with a strong sense of presence and control over the virtual world. These factors stimulate exploration and user participation.

- Passive tactile feedback is beneficial for many interaction tasks, ranging from system control to sketching on cutting planes, [6]. We hypothesize that tangible devices provide a natural means to constrain degrees of freedom in interaction.

- We acknowledge the findings that two hands are not always better than one, [7]. However, we feel that for many interactive tasks it can enhance the interface. For instance, we found the "world-in-one-hand, probe-in-the-other-hand" metaphor to result in a natural and intuitive interface for scientific visualization.

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