A Transparent Personal Interaction Panel for the Virtual Table

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German Abstract

Augmented Reality kombiniert computergenerierte Bilder mit der realen Welt, statt diese zu ersetzen. Diese neuartige Mensch-Maschine-Schnittstelle ist Inhalt einer Forschungskooperation zwischen dem Fraunhofer Center for Research in Computer Graphics (CRCG) in Providence, USA, und dem Institut für Computergraphik der Technischen Universität Wien. Diese Kooperation, ermöglicht durch CRCGs Ausstauschprogramm für Studenten und Wissenschaftler, ergänzt die Aktivitäten des INI-GraphicsNet Virtual Table Konsortiums (cf. CG Topics 03/98).
Am CRCG wurde eine neue Art von Arbeitsumgebung realisiert, welche auf dem Virtual Table und der *Studierstube* [1] basiert, einem an der TU-Wien entwickelten Software-Framework für 3D Interaktion und Visualisierung. Zu diesem Zweck wurden transparente Tablett- und Stift-Werkzeuge eingeführt, eine Variante des in der Studierstube verwendeten Personal Interaction Panel (PIP) [2]. Die daraus entstehenden neuen Interaktionstechniken werden im vorliegenden Artikel überblicksartig beschrieben.

Introduction

Virtual reality techniques that completely lock out the human user from the real world have recently been complemented by less obtrusive technology based on *Augmented Reality*, which combine computer-generated images with the perception of the real world rather than replacing it.
The presented development is the result of a research cooperation between the Fraunhofer Center for Research in Computer Graphics (CRCG) in Providence, USA, and the Computer Graphics Group at the Vienna University of Technology (TUV), Austria. This research cooperation has been supported by CRCG's Student and Scholar Exchange Program and extends the activities of the INI-GraphicsNet Virtual Table consortium (cf. CG Topics 03/98).
At CRCG, a new kind of work environment has been created based on a combination of the *Virtual Table* hardware platform and the *Studierstube* [1] software framework for 3D interaction developed at TUV. For this purpose, we introduced transparent pen and pad props to use with the Virtual Table, an adaptation of the *Personal Interaction Panel* (PIP) [2] developed for Studierstube.

Studierstube and the Personal Interaction Panel

Studierstube is an augmented reality environment capable of visualizing three-dimensional data for multiple simultaneous viewers within one room. In the original Studierstube architecture which has been used for scientific visualization, users wear see-through head-mounted displays showing stereoscopic real-time images. Users can freely walk around to observe the augmented environment from different viewpoints. Interaction with the augmented part of the scenery is maintained using high-level interaction metaphors and tools, like the *Personal Interaction Panel* (PIP), a pen-and-pad style interface. This new two-handed input device supports a multitude of interaction styles and is particularly well suited for augmented reality applications. It unifies general control functions of Studierstube and generic 3D

Figure 1: The two-handed input device - pen and pad - for the Virtual Table

manipulation tasks with application-specific interaction methods. The PIP is composed of a lightweight notebook-sized hand-held panel and a pen equipped with position and orientation tracking, allowing instant augmented elements for interaction.

Bringing Studierstube to the Virtual Table

Table-like devices such as the Virtual Table are designed to serve for applications that are traditionally performed with or on workbenches, tables or presentation surfaces. Through the presentation of computer-generated or real scenes on a horizontal or vertically-tilted output surface, the usual dialog concept for man-machine communication is put into an application-oriented form that is tailored to the particular working situation. Stereoscopic graphics are enabled by the use of LCD shutter glasses.

Unlike a head-mounted display, the Virtual Table does not allow for overlaying images onto physical objects such as a wooden pad. For this reason, a different solution had to be found for creating a PIP that works with the Virtual Table.

We have created transparent pen and pad props made of Plexiglas (Figure 1), that allows for the display of stereoscopic 3D graphics that the user perceives as coincident with the physical position of the devices. The transparent non-reflecting surface of the pad virtually disappears when the table graphics are switched on. The user then sees computer-generated images while the physical properties of pen and pad are retained. In particular, pen and pad allow force feedback and users intuitively understand and can easily

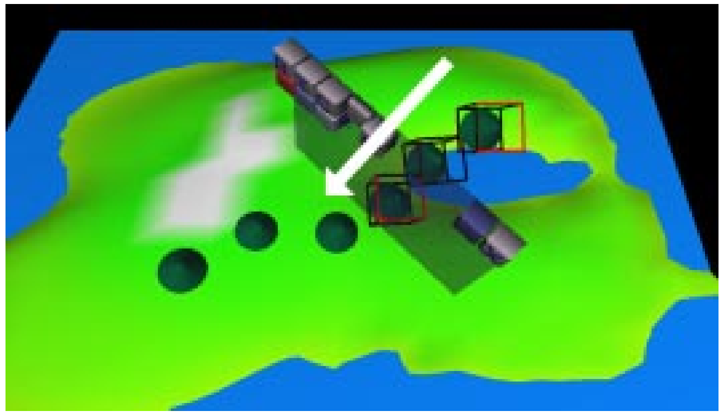

Figure 2: Using the PIP for 'Fishnet'-interaction at the Virtual Table (Note: Sweeping is performed in direction of the marked arrow).

exploit the relative position and orientation of pen, pad, and table surface.

Objects can be aligned with the surface of the pad, and also appear floating above or below the pad. The pad essentially becomes a hand-held palette that may carry all kinds of 2D and 3D user-interface elements (e. g., buttons, sliders, dials) as well as three-dimensional objects. The pen is equipped with a single button that triggers various actions depending on the context in which it is used.

Uses of the transparent PIP

The transparent PIP allows for various uses, some of which have been ported from the original (opaque) PIP, but several have been enabled by the props' transparency:

- The pad is a context-sensitive container for control elements. Traditional 2D widgets such as buttons or sliders find their natural place on the pad. Furthermore, small 3D objects can be placed on the PIP while they are being worked on with the pen, whereas unused objects rest on the table. The user may easily drag and drop objects between pad and table.
- The pad can not only be used as a hand-held control panel, but also as a 'fishnet' by being swept through the scene to rapidly select from a large number of 3D objects (Figure 2).
- The pad is two-sided, so it can carry elements on either side simultaneously. Users can select different applications or contexts by turning the pad over.
- The pad can be used as a see-through tool. It carries context-sensitive control elements depending on what can be seen through the pad, similar to context-sensitive toolbars, which are widely used in popular desktop applications.
- A similar use of see-through functionality as provided by "magic lenses" (e.g. [3]). A different information view can be overlaid (Figure 3) on the pad. By using the pen *under* the pad rather than above it, objects only visible through the magic lens can be manipulated.
- Pan and pad are natural surfaces for sketching. Gestural input can then be used for either 2D or 3D creation and manipulation

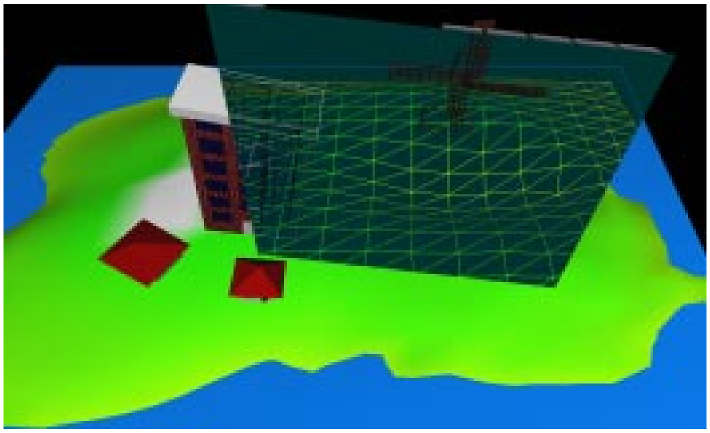

Figure 3: Using the backside of the PIP as 'Magic Lens' on the Virtual Table.

of objects, or possibly even for handwriting.

Application scenario: Virtual Landscaping

To study our interaction design and to perform user testing, we developed a simple landscaping application which allows us to populate an island with houses, trees, plants and similar objects. The application is based on using the pad as a palette carrying a selection of 3D objects grouped into various categories as well as a control element to copy and delete objects, color them and so forth. Objects may be dragged and dropped into the scene and further manipulated. Various selection mechanisms include regular picking, as well as sweeping (see Figure 2) and see-through-the-pad selection. Our test users were rapidly able to use the various interaction forms and generally found them natural and appealing.

Conclusions

The presented user interface consisting of a new two-handed interaction paradigm for the Virtual Table based on transparent pen and pad props, considerably simplifies the control of a complex 3D application by drawing from a user's proficiency with the interaction devices' real-world counterparts. The physically transparent nature of the interface allows for several surprising and efficient interaction designs.

References

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