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Raphaël Grasset, Jean-Dominique Gascuel

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MARE : Multiuser Augmented Reality Environment on table setup

Raphaël Grasset, Jean-Dominique Gascuel *
iMAGIS-GRAVIR, INRIA Rhône-Alpes
655 Avenue de l'Europe, 38330 Montbonnot, France
http://www-imagis.imag.fr

1 Introduction

Using augmented reality (AR) in collaborative situations is appealing: it combines the use of natural metaphors of communication (gesture, voice, expression), with the power of virtual ones (simulation, animation, persistent data). But few 3D AR collaborative systems are devoted to keep human's ability (like grasping, writing). The motivation of this research is to mix together virtual reality techniques ([Schmalstieg et al. 2000]) and computer human interaction techniques ([Fjeld et al. 2002]), so to have the best of both worlds.

Two users with the system.

A user's vision.

2 A testbed for interaction techniques

We present a completely open architecture (XML config files, openGL Performer), dedicated to the evaluation of different new interactives techniques. The system reproduces the configuration of a round-the-table meeting: it allows collaborators to keep contact with the real environment, while interacting with virtual objects. We decompose the table space in two parts: first, the personal area where the user put his private real objects (pen, PDA, laptop, cup) and virtual ones (private menu). The second part is the shared area, communication and common interactive space. In this space the user can:

- interact with virtual and real objects,
- add, remove virtual objects,
- register real objects to the system can account for them.

We present our system and some innovative solutions for these three tasks.

We introduce the concept of **least intrusive devices**: each user is equipped with devices, that try to keep all liberty of movement for the task in which the user is involved : navigation and interaction with virtual objects, perception and interaction with the real world. We use stereo optical see-through Head Mounted Display attached with magnetic or optical trackers. We also developed a **"mixed-pen" metaphor**: a pen you can write with, but also tracked so that you can use it to interact with virtual objects. We use a **wacom tablet** to realize annotation, gesture recognition, or manipulate electronic documents. We also define intuitive methods, in the spirit of "plug'n play", for an easy and **simple calibration** of the different tools and objects allowing to rapidly start and stop the sessions. Navigation is natural, thanks to **tracked HMD**. But we also use the **Dive-in-the-model** metaphor to switch between AR and VR modes.

We developed different techniques of interaction based on what we call **"low haptic feedback"** (contact with the table, and preservation of gravity). The procedure to move an object is inspired by two metaphors: **dragging** an object on surface or **lifting** an object above an obstacle. We also developed a hand-attached device that can replace the "mixed-pen". Real and virtual objects are moved using the forefinger with the same drag/lift metaphor.

For adding virtual objects, we propose three methods: hierarchical virtual menus (in the private area of the user), gesture recognition (unistroke approach) and the catalogue metaphor (similar to VOMAR[Kato et al. 2000]).

Adding real objects can be used to mix them with virtual mockup, to use them for game surroundings, or as "tangible user interface". We propose two methods: if we have a CAO model, we ask the user to **superpose** a virtual representation of the real object to find its position. If not, we ask the user to **digitalize** the real object by inserting some simple geometric primitives (cube, cylinder, sphere, plane).

For **multiuser sessions**, we have realized an **access control manager**, to control personal view information (each user can have a different representation of the same object), to set permission to move or modify objects etc.

We integrated basic editing tools (move, rotate, scale, copy, delete) with a replay event manager and an help, information and annotation service (audio, video, image and wacom input). Our system can be easily used in **any domain of application** (users just have to customize interface and domain objects). We show some example applications: scientific application, engineering, architecture, urban planning, and game.

3 Future Works

To encompass the limited accuracy of magnetic trackers, a new high precision tracking system (*optotrak*) will be used and even less intrusive tracking methods, based on computer vision, will be tested. In complement, video can be used to develop new kinds of HMD (hybrid video/optical see-through) and to enhance the user vision (creating shadow/lighting effects).

In a similar manner to virtual reality, usability of augmented reality in collaborative application will be studied, during a cooperation with CHI specialists. Better interaction techniques are needed: "tangible user interface" and new 3D interaction wireless devices seem promising.

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*e-mail: {Raphael.Grasset /Jean-Dominique.Gascuel}@imag.fr