

AR Pad: An Interface for Face-to-Face AR Collaboration

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ABSTRACT

The AR Pad is a handheld display with a Spaceball and a camera, which can be used to view and interact with Augmented Reality models in collaborative setting.

Keywords

Augmented Reality, CSCW, object manipulation

INTRODUCTION

Although Augmented Reality (AR) applications provide a very intuitive interface for viewing virtual content, there is still a lot of research that needs to be done on how to interact with AR content. The AR Pad explores how a handheld display can be used to view and interact with Augmented Reality models in collaborative setting.

AR Pad builds on the earlier work of Transvision [1], NaviCam [2] and more recent mPARD work [3] in which handheld displays are used for viewing AR content. Although these projects show the value of using a handheld display for viewing AR scenes, they provided little support for interaction with the virtual images. The AR Pad allows users to both view and interact with AR content using a combination of camera, button and trackball input.

THE ARPAD INTERFACE

The AR Pad consists of three main components: a Spaceball input device attached to a handheld LCD panel and a camera mounted on the back of the display (figure 1). This is connected to a desktop or laptop computer that is used for virtual image generation. The video image from the camera is fed to the computer and then backs to the LCD panel. When the camera sees square tracking markers in the real world, image processing software (based on the ARToolKit library [4]) is used to calculate the camera position in real time and overlay graphics onto the video view (figure 2). So the ARPad provides support for video-see through Augmented Reality.

In addition to displaying AR content, the AR Pad is also the primary tool for interaction with the AR environment. Once a virtual model is seen on the tracking marker it can be selected by positioning a virtual cross hair over it and



Figure 1: AR Pad Hardware

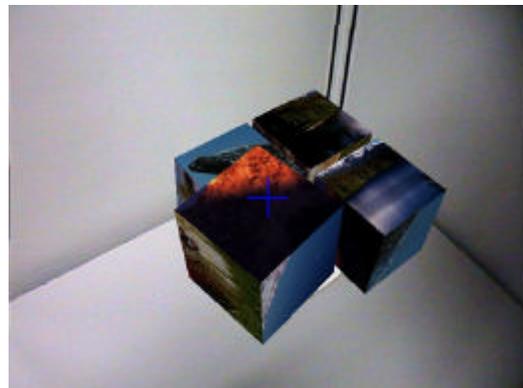


Figure 2: Selecting a virtual block



Figure 3: Using AR Pad as a video see-through display

clicking a selector button on the controller (figure 3). When selected, the object is attached to the camera viewpoint and appears to stay in a fixed position relative to the display; the virtual model is switched from a marker coordinate frame to a camera coordinate frame. This means that users



Figure 4: Using AR Pad for face-to-face collaboration.



Figure 5: Viewing frustum of the partner.

can move and position virtual objects in space simply by moving the handheld display. In addition, objects can be rotated and translated using the Spaceball [5] as well as scaled using other buttons on the controller. So unlike most other handheld AR displays the AR Pad is both a viewing and interaction device.

The AR Pad can also be used as a tool for supporting face-to-face collaborative AR. Several users can sit around a common workspace each with an AR Pad display to look at the same real tracking markers. Any user can select and attach a virtual object to his camera viewpoint, however with the addition of a tracking marker mounted on the back of the AR Pad screen, the other users can also see the object relative to their own handheld displays. Therefore, when a user captures a virtual model, his collaborators can also see it by pointing their displays at the marker on the back of the user's AR Pad. Unlike most head-mounted AR displays, the AR Pad is unencumbering, allowing users to see each other's eye gaze and facial expressions (figure 4). Thus AR Pad does not obstruct the non-verbal cues commonly used in face-to-face collaboration. Users of AR Pad can also see partners' viewing frustum by which they can easily understand their relative spatial relationship (figure 5).

USER FEEDBACK

Through an informal observation of more than 30 pairs, we found many users felt it quite intuitive to interact with objects. No user had any trouble with using the interface. Also, not a few users mentioned it good you don't have to put anything on. Some said AR Pad is an interesting device in that it contains 3D tracker, display and interaction device, all in one. As a negative feedback, some said the device is not compact and rather heavy, which we should improve in the future.

APPLICATIONS

There are many potential applications for this platform, including:

- *Augmented Reading*: The AR Pad could show virtual scenes overlaid on normal book pages.
- *Mobile, Augmented Reality teleconferencing*: Looking at a tracking marker could trigger a connection to a remote collaborator who could be shown as a live video texture on the marker.
- *Technical support*: The AR Pad could be used to show AR annotations on real equipment for training and technical help.
- *Special effects "previsualizations"*: Devices such as the AR Pad could be used in the film industry to provide simplified visualizations of special effects while filming.
- *Computing Gaming*

CONCLUSIONS AND FUTURE WORK

In the future the interaction technique developed for the AR Pad could be used in a Web Pad based Magic Window: The Magic Window could be prototyped on a high performance web pad from Microsoft or Hitachi when they are available on the market. A PDA based Magic Window is another possibility: Once these devices develop the necessary 3D graphics capabilities, a micro Magic Window could be created.

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