MagicBook: Transitioning between Reality and Virtuality

Mark Billinghurst
HIT Laboratory
University of Washington
Box 352-142, Seattle
WA 98195, USA
grof@hitl.washington.edu

Hirokazu Kato[1]
Faculty of Information Sciences
Hiroshima City University
3-4-1, Ozaka-higashi, Asaminami-ku
Hiroshima 731-3194, JAPAN
kato@sys.im.hiroshima-cu.ac.jp

Ivan Poupyrev[1]
Interaction Lab
Sony CSL
3-14-13 Higashi-Gotanda
Tokyo 141-0022, JAPAN
poup@csl.sony.co.jp

ABSTRACT
The MagicBook explores how interfaces can be developed that allow for seamless transition between Physical Reality, Augmented Reality (AR), and immersive Virtual Reality (VR) in a collaborative setting. The MagicBook is a normal book and can be read without any additional technology. However, when book pages are viewed through a handheld display three-dimensional virtual images appear overlaid on them. Readers can view these AR scenes from any perspective and can also fly into the scenes and experience them as an immersive VR world. VR users can see other VR users represented as life-sized virtual avatars, while AR users will see VR users as miniature avatars in the scene.

Keywords
Augmented Reality, Collaboration, CSCW.

INTRODUCTION
Many computer interfaces have been developed which explore collaboration in a purely physical setting, in an AR setting, or an immersive VR environment. Milgram's taxonomy places these interfaces along a Reality-Virtuality continuum [1]. Moving from left to right the amount of virtual imagery increases and the connection with reality weakens. However, collaborative interfaces typically do not allow people to move easily along this continuum.

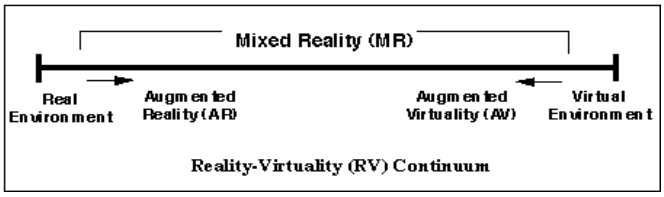

Fig 1: Milgram's Reality-Virtuality Continuum

VR and AR are complimentary and the best type of collaborative interface depends on the nature of the task [2]. If collaborators want to experience a virtual scene from different scales then immersive VR may be ideal, but if they want to have a face-to-face discussion while viewing a virtual model an AR interface may be best. So an interesting question is how to support seamless transitions along the Reality-Virtuality continuum.

THE MAGICBOOK
The MagicBook project explores transitional interfaces and how a physical object can be used to seamlessly transport users along the Reality-Virtuality continuum. We use a real book, so people can turn the pages, look at the pictures, and read the text without any additional technology. If they look at the pages through an AR display they see three-dimensional virtual models appearing out of the pages (fig. 2). The models appear attached to the real page so users can see the scene from any perspective simply by moving themselves or the book. Finally, readers can fly into the virtual scene and experience the story immersively (fig. 3).

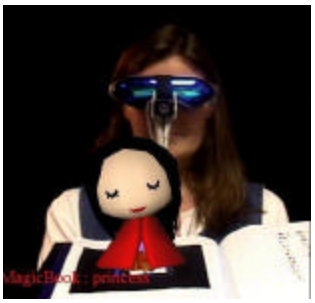

Fig 2: AR Scene

Fig 3: Immersive VR Scene

The MagicBook supports collaboration on three levels:

As a Physical Object: Similar to using a normal book, multiple users can read together.

As an AR Object: Users with AR displays can see virtual objects appearing on the pages of the book.

As an Immersive Virtual Space: Users can fly into the virtual space together and see each other represented as virtual avatars in the story space (figure 3).

[1] Also affiliated with ATR MIC Labs, 2-2 Hikaridai, Seika-cho, Soraku-gun, Kyoto 619-0288, Japan

Several users can read the book together and see the virtual images from their own viewpoint. More interestingly, if one user is viewing the book in an AR mode while another is experiencing it in immersive VR, the AR user will see an exocentric view of the avatar of the immersive user in the virtual world (figure 4).

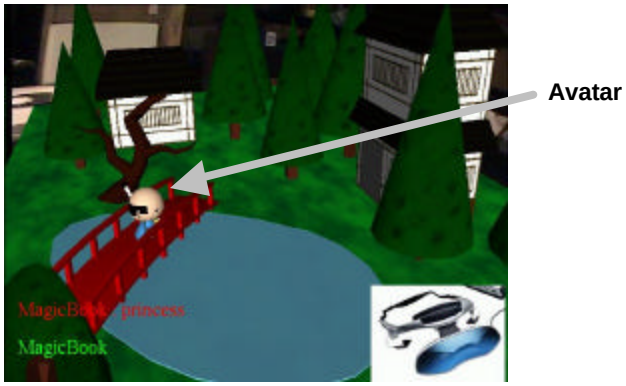

Fig 4: Avatar in an exocentric AR view

MAGICBOOK TECHNOLOGY

The current MagicBook interface has two components; one or more a handheld displays (HHD) and the physical book. The HHD is a handle with a Sony Glasstron display mounted at the top, an InterSense InterTrax inertial tracker at the bottom, a small camera on the front of the Glasstron display and a switch and pressure pad (figure 5). The Sony Glasstron is a bioccular color display with two LCD panels of 265x235 pixel resolution. The camera output is connected to a desktop computer and the video-out of the computer is connected back into the HHD. So by looking through the HHD users experience a video-mediated reality.

Fig 5: The MagicBook Handheld Display

The books used in the MagicBook interface are normal books with text and pictures on each page. Certain pictures have thick black borders surrounding them. When the reader looks at these pictures through the HHD, computer vision techniques are used to precisely calculate the camera position and orientation relative to the picture [3]. The computer then generates virtual images that appear precisely registered with the real pages.

Users each have their own displays, so if two or more are looking at the same page, they will see the same virtual model attached to the page from their individual viewpoints. Since they can see each other at the same time they can use natural communication cues to enhance the collaboration.

When the user sees an AR scene they wish to explore, flicking the switch on the handle will fly them into an immersive VR environment. Head tracking is changed from the computer vision module to the InterTrax inertial orientation tracker so readers can look around the scene in any direction. By pushing the pressure pad on the handle they can fly in the direction they're looking. The harder they push the faster they fly. To return to the real world users simply need to flick the switch again.

When users are immersed in the virtual environment or are viewing the AR scenes their position and orientation is broadcast to the other users. This is used to place virtual avatars of people that are viewing the same scene, so users can collaboratively explore the virtual content.

The MagicBook software incoporates a complete VRML 97 parser making it easy for content developers to produce their own books. Nearly a dozen books have been created, including books for architecture, scientific visualization, education and entertainment. Users can dynamically load different book content simply by looking at the title pages.

CONCLUSIONS

The MagicBook interface demonstrates how a physical object (a book) can be used as a transport mechanism to seamlessly move users between Reality and Virtuality. In the future we intend exploring futher how tangible interface metaphors can be combined with AR and VR techniques to support face to face and remote collaboration. We will also conduct formal user studies to compare collaboration in transitional interfaces to more traditional systems.

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REFERENCES

1. Milgram, P., Kishino, F. A Taxonomy of Mixed Reality Visual Displays. *IECE Trans. on Information and Systems* (Special Issue on Networked Reality), vol. E77-D, no. 12, pp.1321-1329, 1994.
2. Kiyokawa, K., Iwasa, H., Takemura, H., Yokoya, N. Collaborative Immersive Workspace through a Shared Augmented Environment, In *Proceedings of the International Society for Optical Engineering '98 (SPIE '98)*, Vol.3517, pp.2-13, Boston, 1998.
3. Kato, H., Billinghurst, M. Marker Tracking and HMD Calibration for a Video-Based AR Conferencing System. In *Proceedings of IWAR 99*, October, 1999, San-Francisco, USA.