
The Mixed Reality Book: A New Multimedia Reading Experience

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Abstract

We are introducing a new type of digitally enhanced book which symbiotically merges different type of media in a seamless approach. By keeping the traditional book (and its affordance) and enhancing it visually and aurally, we provide a highly efficient combination of the physical and digital world. Our solution utilizes recent developments in computer vision tracking, advanced GPU technology and spatial sound rendering. The systems' collaboration capabilities also allow other users to be part of the story.

Keywords

Interactive Book, Augmented Reality, Mediated Reality.

ACM Classification Keywords

H5.2. User Interface

Introduction

From Weiser's vision of Ubiquitous computing [8] and Wellner's Digital Desk [9], the merging of digital information and physical properties of paper has been explored. In recent years research has been conducted on different approaches to digitally enhancing real books. Some projects have directly integrated physical components in the book like RFID tags or other physical interactive components ([7]). Others, like Leapfrog's

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LeapPad [4] have enhanced the book surroundings, permitting pen interaction with the book. There has been work exploring sound integration with traditional books, providing a new modality to enhance seamless immersion and interactivity [1]. Finally, researchers have been interested in visually augmenting books by showing complementary information on a screen [5], projecting information next to the book [3], or providing a new type of 3D popup book using augmented reality [2],[6].

In this project, we introduce an interface with a seamless integration of different modalities, while keeping the high intrinsic value of the physical properties of the book. Contrary to the previous research mentioned, we are not enhancing the content by linking it digitally with content on another surface, but we are fully augmenting the real content. The approach is based on spatially visual and aural augmentation, and our focus is on illustrated children's story books.

Proposed Solution

The experience with an augmented book can be defined in terms of the spatial properties of books. As figure 1 below shows there are four elements, which can be explored for the reading experience:

1. Inside: augmenting the material in the book pages
2. Outside: augmenting the space around the pages
3. Outside to the Inside: interacting from the space around to the content of the book
4. Inside to the Outside: extracting content from the book

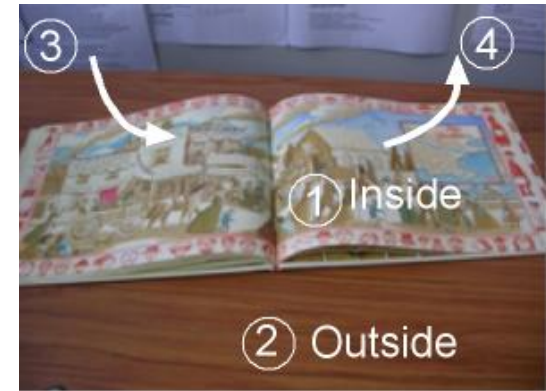


figure 1. Spaces elements for an enhanced reading experience

The content of the book (*Inside*) can be augmented with different media (2D graphics, video, 3D animations, etc.), but the surroundings of the book (*Outside*) is a particular interesting space to enhance the reading experience. One can imagine recreating an ambiance scene around a book, for example displaying a semi-transparent virtual sea during reading a book on fish.

We experimented with augmenting books using two dimensional virtual images (static or dynamic) to provide a better sense of integration with the media (same dimensionality). Using spatial audio will provide a new experience following works done in [1]. Users can move their head closer or further away from the book to experience spatial modulation of sounds (movement of a ship, fire, etc.). When they move around the page sounds will change according to the associated content.

Another aspect is the collaborative experience of the book. Users can view the content alone or in groups. It is also possible for users to become part of the story as live video characters. We envision support for remote collaborative techniques like expert agents in educational material for medical surgery.



figure 2. User launching a virtual boat; a virtual sea surrounds the user, with the sound of the ocean in the background.

Prototype

Our prototype consists of the book, standard desktop computer hardware, a multimodal handheld device, tangible interaction devices (cube, paddles), and an additional green screen.

Using a handheld device the user can naturally get immersed into the mixed-reality book. This device provides visual (screen+camera) and aural (headphones) feedback. We chose a book called "The House that Jack Built", which has a lot of pictorial elements about New Zealand history and the relationship of Maori and European settlers.

The book has been slightly modified to integrate different markers for recognizing which page a user is actually looking at. Beyond this, natural features of the book pages are used to register the users' viewpoint.

The prototype has several key features:

- Background music, narrator's voice over, etc.
- Spatially registered 3D sounds on a page matching with the pictorial content (e.g. picture of a fire with sound of fire men, picture of a horse with the sound of his gallop).
- Spatially registered 2D content, like the movement a boat along the page, a video, 2D annotations, etc.
- 3D spatial content (e.g. a 3D House) displayed above its 2D pictorial representation.
- Augmentation of the surrounding: e.g. a virtual sea appearing around the book and getting rougher the longer the user stays on a page.
- Interaction with the book: using a paddle to trigger animations in a sequence, e.g. moving the video of your image around etc.
- Interaction out of the book: using a tangible cube the user can pick content with and move it out of the page (e.g. 3D house, 3D cow, etc).
- Another user located in front of a green-screen can appear on specific pages in the book and become part of the story. This provides a new type of multi-space collaborative activity.

The User Experience

Using the handheld display the user sees a live video feed of the scene in front of him with the superimposed digital content and hears augmented and spatialized sound. Using gaze based interaction visual content like 3D models can change their detail depending on the angle. Users can experience the spatial sound changing according to their position and the actual content on the page.



figure 3. A user experiencing the Augmented Book with a handheld display. The computer screen in the back shows what the user sees through the handheld display.

While flipping through the pages the book conveys a new meaning due to full registration of the digital content with the real content presented on the pages. Spatial sound can for instance guide the user through the page and highlight important content. Additionally the user can interact with the digital content (e.g. launching a boat with the use of a tangible cube, which replicates a bookmark) and transition his/her viewpoint seamlessly into the model. This change from an AR-

view into VR (i.e. the user zoom into a house that is first represented as a 3D model on a book page) again is adding more information to the book.

Audience, Relevance and Context

This particular prototype was developed in continuing collaboration with a local childrens' book author. The aim of the book is to tell and illustrate history of New Zealand. Reading and interacting with the book provides the user with a multi-sensory experience which is hard to achieve with other technologies. Thus, this book may not only be used for entertainment but may be a good tool for educational purposes. Providing a broad set of input channels, students with different learning styles may equally benefit from such learning materials. Augmenting books with dynamic and interactive visual and auditory content may not only be used for interactive story telling but also to explain complex phenomena or processes.

A mixed reality book allows us to present multi-sensory content by keeping the physical book. Hence, it seamlessly combines a traditional medium with new media and technologies. In the future we will also provide an authoring tool that will enable teachers to create a mixed reality book on their own. This will empower educators to create new curriculum material to be used in schools.

Apart from education, mixed reality books also may be used by artists or museums to create novel and interactive installations. It is suitable for a broad range of users who like to experience new types of entertainment and learning technologies.

Commercial Status

Following the initial development of the MagicBook project, the HIT Lab NZ generated various publications and a patent application for a user interface tailored to the Mixed Reality Book. MR books can potentially become an omnipresent technology because they can technically extend any physical book. In future this provides authors and publishers alike with the opportunity to provide added value. Authors search for novel ideas to extend and improve a publication. In order to prove the feasibility of this approach we are working on a project extending various existing publications with MR content.

With our prototype we are able to provide a comprehensive digital extension to physical books which enhances an existing interaction paradigm. Therefore the Mixed Reality Book is an accessible technology usable by most users.

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