Tangible Books – Virtual Library Interfaces

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Abstract. Future hybrid library concepts require new media technology to attract customers for visiting physical libraries. This paper presents a novel tangible interface for virtual libraries using physical books in real space to interact with digital books in the virtual space. The proposed approach uses RFID sensors, cameras and OCR technology to realize a smart interactive workspace for library users. In a pervasive table-top setting with an augmented reality video projection, books are identified per RFID. The systems recognizes, when book pages are turned and detects the currenty open page using grabbed video frames. The system allows for using well-known usage patterns on books to interact with augmented virtual information in e-books.

1 Introduction

Traditional libraries suffer from a decreasing number of visitors. Especially in the scientific and academic environment, digital libraries are becoming dominant. The availability of potentially unlimited information collections in the Internet have diminished the reasons to visit conventional libraries. Libraries have also always been the place to implement newest technology trends for information access, from egyptian papyrus and medieval codices to printed books and e-books, combined with the expert knowledge of trained librarians.

In the McLuhan Documentation Center library at the ISNM – International School of New Media, (http://www.isnm.de/mcluhan) we try to reiterate this tradition by developing newest library technologies which bridge the gap between the physical and the virtual library to build the future hybrid library, which we call the hybrary. By integrating pervasive services in our library, we make the library attractive again for students and researchers as the place to be for exploring the knowledge space. In this context we have developed several projects within our ubiquitous computing research initiative, including guidance systems on mobile devices, librarian avatars [1], self-book stations using RFID, automatic pre-view and pre-listen stations for audio-visual media collections, tangible libraries, context-aware information systems, and augmented reality table-top library desks.

The following project is proposed as a novel interface for processing e-books in order to support library users with typical scientific tasks in the library.

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2 The Tangible Book

Books are without doubt one of the greatest inventions ever made by humans, since they provide a very flexible and convenient interface for printed information. Some recent research projects have investigated the book metaphor in different approaches of human computer interfaces. For example, in [6] and [3], touch screens are used to browse books with a three-dimensional look supporting smooth turning of pages. The Librovision project uses gesture recognition via cameras to turn pages on a virtual book [5]. Sony Inc. created a reader device for e-books based on electronic ink (Librie, [8]). All of these approaches try to emulate the behavior of real books in either virtual or electronic ways.

In this paper we propose to use real books as a tangible interface to the virtual counterparts. Our proposed system does not need any technology inside the book (except one RFID label, which will be anyhow part of any printed book soon). Therefore, any existing book collection is supported without changing the infrastructure and without adding any additional cost for books to libraries.

Virtual books have not raised our attention in the way traditional books do. Critics state that it was hard and uncomfortable to read on screen and there is not much advantage over physical books. However, research shows that people are more willing to accept e-books if they show some characteristics of its physical equivalent [10]. For example, it should be possible to open a particular page of an e-books just as easily as it is with physical books. Our approach will show how physical books can be featured with additional services to combine the advantages of these two media i.e. to provide the user with search and reproduction functions on the virtual site, while keeping the comfort of handling physical books.

2.1 Concept

We implement our project using the interactive table-top setup developed at the ISNM [7]. The table uses augmented video projection from the ceiling, is equipped with a grid of RFID readers and provides an embedded camera. Users are automatically identified with their RFID library card and can place books on a glass plate embedded in the table in order to allow line of sight between the camera and the book. The system recognizes the book and the opened page automatically, presents the e-book version on the table and offers an interactive interface using tangible objects (i.e., objects with embedded RFID labels). Bookmarks in e-books can be used to personalize books in a public library without harming the real book. The text for those bookmarks is stored in a database and appears in an animation whenever the reader opens the corresponding page. Another interesting service is the extraction of bibliographic information. Scientists can copy text from books to own documents with automatic creation of bibliographic information in bibtex entry format (fig. 2), easing the burden of manual typing. Images can be extracted as well for seminar presentations, etc. The idea is not to support plagiarism, but to guide novices how to cite correctly.

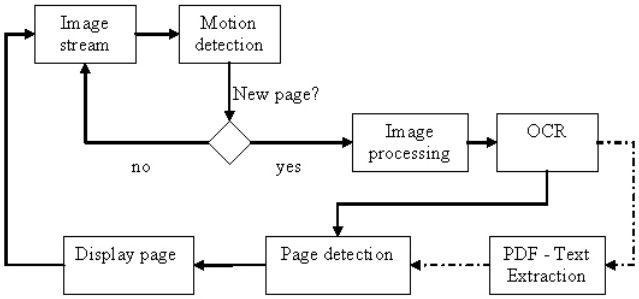

Fig. 1. Setup demonstration of the interactive library desk.

2.2 Technology

While it is easy to identify books with attached RFID labels, book page identification needs approaches that are more complex. A research group at XEROX PARC used RFID tags attached to every book page [2]. This solution may be feasible for smaller amounts of books, but it is physically almost impossible to furnish every book page in a larger library with RFID labels. Our solution is an optical page identification component, which is independent from technical prerequisites in the book itself. A multi-frame motion detection modul checks whether the page turning activity has already been finished and triggers the OCR process, which recognizes parts of the text based on the image frames. The page is then identified by a fast string pattern matching algorithm (avg. 100ms for a book with 850.000 characters) with the text in the virtual book. This mechanism is much faster than using a conventional scanner system, which would not support real-time interaction. The algorithm also discarts spelling errors from OCR so no further processing like dictionary corrections [9] or fuzzy string pattern matching [4] is needed.

Fig. 2. Scientist working on the interactive desk.

2.3 Results

An experiment with the German book "Jetzt lerne ich C++" was used to test accuracy and performance of the OCR page identification component. This book offered the possibility to check the application behavior with images, drawings and source code on a page where we expected the results to be significantly lower than with normal text. A total sample of N=103 pages were randomly chosen from the book and identified by the application. The identification algorithm showed an accuracy of 97,2% for book pages with merely text. A second algorithm, which takes only the three longest recognized words to identify that page was also implemented to investigate the impact of phrase formation and dynamic searching on accuracy.

Table 1. Page identification rate by iteration step and algorithm in cumulated percentage values (IR = Identification Rate).

Iterations	1	2	3	4	5	N.I.
IR Dynamic Algorithm	55,56%	75,0%	83,33%	94,44%	97,22%	2,78%
IR Static Algorithm	20,0%	68,0%	84,0%	–	–	16,0%

It turned out that the static algorithm performed worse (accuracy of 84% for text) than the dynamic algorithm with phrase formation, but this means at the same time that 84% of all pages in a text book can be identified by just having the three longest words recognized by OCR. Table 1 shows the performance of both algorithms.

Our results outline that phrase extraction significantly increases the number of recognized pages after the first iteration step (56,56% compared to 20%). The iteration value "N.I." indicates that the page could not be identified.

One major problem, which we encountered with source code was very thin fonts for code examples. OCR showed problems in recognizing the words, and even if words were detected it couldn't be mapped to a unique page, because code is highly redundant and the words detected by OCR occur on more than one page.

3 Conclusions

Our research demonstrates a new pervasive interface to enhance the reader's and learner's experience in modern libraries. It closes the gab between scientific demand for high quality, browsable, easy access information and the traditional book. This is the first step towards the complete integration of the library in an academic learning process. The augmented reality library desk enables users to intuitively compile documents on the fly and the personalization of public books with augmented reality bookmarks.

References

1. Abdul Ahad. Neva: A Conversational Agent Based Interface for Library Information Systems. Master's thesis, University of Lübeck, June 2005.
2. Maribeth J. Back and Jonathan Cohen. Page Detection using Embedded tags. In *UIST '00: Proceedings of the 13th annual ACM Symposium on User Interface Software and Technology*, pages 159–160, New York, NY, USA, 2000. ACM Press.
3. Yi-Chun Chu, David Bainbridge, Matt Jones, and Ian H. Witten. Realistic Books: a bizarre Homage to an obsolete Medium? In *JCDL '04: Proceedings of the 4th ACM/IEEE-CS Joint Conference on Digital Libraries*, pages 78–86, New York, NY, USA, 2004. ACM Press.
4. Kevyn Collins-Thompson, Charles Schweizer, and Susan Dumais. Improved String Matching under Noisy Channel Conditions. In *CIKM '01: Proceedings of the tenth International Conference on Information and Knowledge Management*, pages 357–364, New York, NY, USA, 2001. ACM Press.
5. Horst Hörtner, Christian Naglhofer, and Robert Praxmarer. Librovision, Installation. http://www.aec.at/de/center/project.asp?iProjectID=12779, 2004.
6. British Library. Turning The Pages. http://www.bl.uk/onlinegallery/ttp/digitisation.html, 2005.
7. Andreas Schrader, Abdul Ahad, Darren Carlson, Brian Egan, Jörg Kaminski, and Juliane Moser. Das begreifbare Museum - Ein interaktives Informationssystem. In *Mensch und Computer 2005 Conference of the GI and the German Chapter of the ACM*, pages 160–161, September 4-7 2005.
8. Sony Corporation. Librie EBR-1000EP. http://www.sony.jp/products/Consumer/LIBRIE/, 2004.
9. Kazem Taghva and Eric Stofsky. OCRSpell: An Interactive Spelling Correction System for OCR Errors in Text. *Intl. Journal on Document Analysis and Recognition*, 3(3), March 2001.
10. Ruth Wilson and Monica Landoni. Evaluating the Usability of Portable Electronic Books. In *SAC '03: Proceedings of the 2003 ACM Symposium on Applied computing*, pages 564–568, New York, NY, USA, 2003. ACM Press.