WikiTUI: Leaving Digital Traces in Physical Books

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ABSTRACT
This article describes the design of WikiTUI, a tangible user interface system that allows readers to manipulate multimedia information tied to page-level locations in common books. This system will also facilitate the exchange of information with other readers using wiki technology. While other projects have coupled the dual worlds of atoms and bits, few have combined the idea of collaborative and distributed authoring with tangible interfaces. WikiTUI not only bridges the real and digital worlds, but facilitates multiple contributions to a reference base spanning across these worlds. The goal of our work is to apply the paradigm of coupling atoms and bits in order to extend the collaborative annotation and authoring possibilities of wiki media.

Categories and Subject Descriptors
H.5.2 [**Information Interfaces and Presentation**]: User Interfaces---*input devices and strategies, interaction styles*

General Terms
Design, Human Factors

Keywords
Tangible interface, annotation, augmented books, CSCW.

1. INTRODUCTION
Even though the electronic media nowadays provides a number of advantages over paper, it has not eliminated paper from our daily lives. The WikiTUI prototype explores the affordances of projecting multimedia information onto real books. The novel aspect here is the addition of collaborative distributed annotation using online wikis. The information projected on books can be in any digital format, retrieved from a wiki server. A camera on top of the book captures user gestures, such as the manipulation of projected multimedia content with fingertips.

2. RELATED WORK
Our idea extends the vision of Ishii et al. [4] by emphasizing the use of familiar physical objects in a non-destructive way, rather than creating new or exotic interfaces and interaction metaphors to connect the two realms. Work such as the Digital Desk [7] has tried to merge the physical desktop and documents with their virtual counterparts by using digital projections on the desk surface and computer vision to capture user actions. Instead of projecting on a desktop and paper, WikiTUI uses books as the projection screen. Moreover, WikiTUI connects to the Internet and makes use of the

self-maintaining wiki community. Another related project is the Enhanced Desk [5], which uses IR cameras to capture user motion as input. The researchers have also developed a method for real-time finger tracking [6]. In contrast to our work, their emphasis is on real-time interaction between the user and the desk. More recently, Escritoire [1] has demonstrated positive results in user studies, showing that users can adapt themselves to the system without extra training.

3. WIKITUI DESIGN
The WikiTUI system with full functionality is envisioned to sit on a specially instrumented desk that provides overhead projection onto the book and desktop surface (see Figure 1).
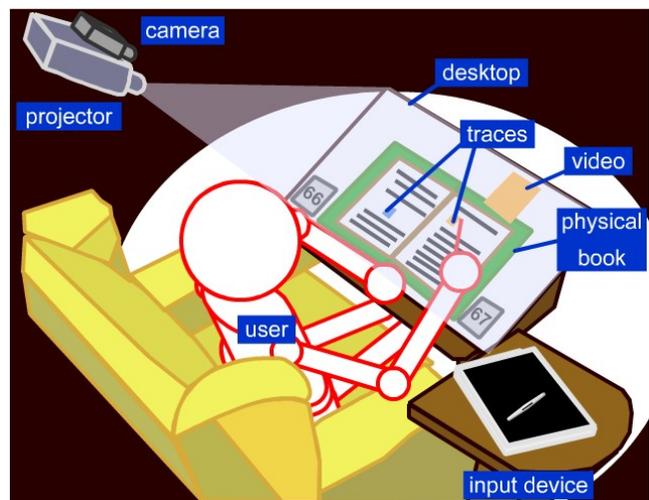

Figure 1. A user is working with WikiTUI. In the figure, a tablet computer is used as the input device.

The WikiTUI system is currently under development as a physical desk or tabletop application. An overhead camera captures images of the book pages and the movement of users' fingers. A projector displays visual cues and media elements retrieved from the wiki server onto the pages of the book. Accordingly, all multimedia elements can be added to the wiki server. Annotations are retrieved through gesture-based interaction on the book's pages. The input device is needed only when the user wants to create an annotation to share with others.

We use a camera to capture the user's hand movement. We adopt methods proposed by Hardenberg et al. [3] to separate the hand shapes from the background and to detect fingertips. WikiTUI requires each user's identity for data entry, which could be accomplished by scanning the user's ID card with an RFID or bar code reader. Currently, the identities are entered manually. To determine the page numbers of a physical book, our current solution is to move the fingertip onto a projected page number block to turn

pages. The next step would be to have the computer recognize the book's page number (see Figure 2).
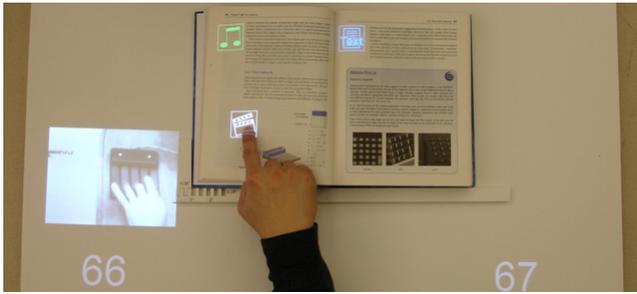

Figure 2. A user moves her fingertip to a projected trace on, which triggers an associated video at the left.

The user can interact with content in the current WikiTUI prototype using gestured-based interactions as illustrated by the state transition diagram depicted in Figure 3.
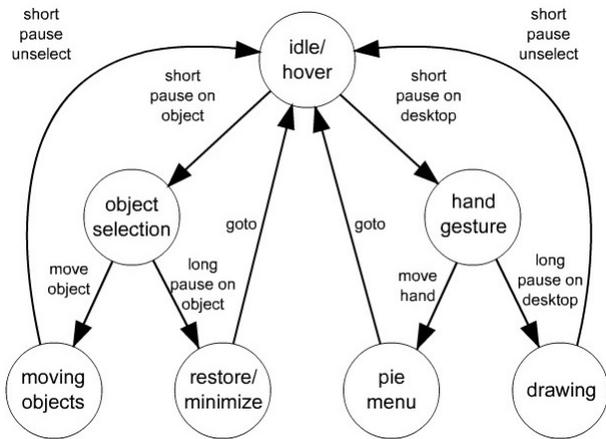

Figure 3. The WikiTUI state transition diagram. The circles represent the states and the edges are transitions.

Based on early observations and the fact that many annotations might be online media URLs or long text comments, laptop and tablet computers meet our needs of quick data entering quite well. We expect that users could carry their personal devices to WikiTUI. These devices would be used to create annotations in the online wiki page, which overlay the book through projection.

4. EVALUATION AND CONCLUSIONS

We observed readers in the Georgia Tech library and found that the function of this particular library seemed to be more like a computer center than a typical library. Most people were using computers, and using books only as references. Some were holding group discussions. Others were studying or writing. Only few of them were the readers that we expected to see. This discovery has made us believe that the audience of WikiTUI should be groups of readers that regularly use tools or technology to support the reading of physical books they are reading in common (e.g. study group, book club), rather than those who primarily read online materials such as journal papers.

Based on our initial observations, we believe that reading behaviors change when the type of book changes. In other words, when reading a novel, a reader only reads; for a history book, he/she annotates or marks passages a lot; and when studying calculus, the reader may spend most of the time calculating. We are currently conducting a follow-up study focusing on reading behaviors, in groups where reading occupies a large portion of time, and where readers annotate or work collaboratively when needed. Although we have not as yet conducted a user study with the WikiTUI system, we have been doing informal testing in our lab over the course of our prototyping and development. Based on preliminary user feedback, we have thus chosen to use a laptop or tablet PCs for input. We hypothesize that the input space equipped with fast text entering should be separated from the reading space.

Although our current prototype is not a fully functional system yet, we believe that WikiTUI might have impacts on certain communities or groups of users. We have introduced traces that are created by readers. It is also possible that writers or publishers might want to create some permanent traces associated with their printed books. For example, a magazine might add a trace of a video clip and embed it in the content.. Consequently, magazine contents could be more than just text and figures, and contents from online articles could be linked to the printed versions. Similar applications may affect the use of textbooks as well. Using WikiTUI, supplementary information could be projected directly onto the book.

We have proposed the WikiTUI infrastructure to realize the goal of bridging real and virtual realms seamlessly within the scope of reading. In our initial design and development, we have found that research in computer vision and image recognition still presents problems for creating a truly robust system. Yet the technology is not the main focus of this research. Our purpose is to extend the concept of coupled atoms and bits using a non-destructive method, and by so doing extend the use of paper books into new realms. Once we complete the next round of developments and have a sufficiently mature system, we plan to conduct a qualitative evaluation to test out the prototype.

5. REFERENCES

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