Touch-Bookmark: A Lightweight Navigation and Bookmarking Technique for E-Books

Dongwook Yoon
Korea Institute of Science and Technology (KIST)
P.O.BOX 131, Cheongryang, Seoul 130-650, Korea
dwyoon@kist.re.kr

Ji-Hyung Park
Korea Institute of Science and Technology (KIST)
P.O.BOX 131, Cheongryang, Seoul 130-650, Korea
jhpark@kist.re.kr

Yongjun Cho
Korea Institute of Science and Technology (KIST)
P.O.BOX 131, Cheongryang, Seoul 130-650, Korea
yongjuncho@kist.re.kr

Kiwon Yeom
Korea Institute of Science and Technology (KIST)
P.O.BOX 131, Cheongryang, Seoul 130-650, Korea
pragman@kist.re.kr

CHI 2011, May 7–12, 2011, Vancouver, BC, Canada.
ACM 978-1-4503-0268-5/11/05.

Abstract
The navigation function of an e-book significantly influences its usability. In this paper, we introduce Touch-Bookmark (TB), a multitouch navigation technique for e-books. TB enables users to bookmark a page in a casual manner and return to it quickly when required. Moreover, the users can flip between two remote pages by using simple gestures. In a usability test conducted to evaluate our prototype, users found the technique easy to learn, natural to use, and useful for navigation. Analysis of the patterns of interaction gestures helped identify human factors that should be considered when designing touch interfaces for e-books. The factors include navigation strategies, patterns of interaction gestures, types of books, and motor memory.

Keywords
E-books, documents, navigation, bookmark, usability test, gestures, direct manipulation, motor memory

ACM Classification Keywords
H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces (*Input devices and strategies, Interaction styles, Evaluation/methodology*).

General Terms
Design, Experimentation, Human Factors

Introduction

A physical book is a stack of papers fastened together on one side. Owing to the affordances of books, readers seeking specific information navigate by rummaging through the stack. In existing e-book designs (e.g., Kindle and Nook), button-centered navigation is used. This is different from the navigation method used for a paper book, which involves kinesthetic controls [7, 8]. Several studies have attempted to improve navigation interfaces of e-books with kinesthetic cues [3, 8, 9], while others employed gestures similar to physical motions used for reading paper books [11].

Previous researches on reading behaviors for paper books have identified many navigational patterns. Paper-book readers can fold/roll/flip the book [6] or flip/leaf through many pages quickly [8]. Above all, we particularly focused on finger bookmarking behavior observed in previous researches [6, 7, 11]. When using finger bookmarking, a reader inserts a finger between pages to mark a page. He/she can then turn the pages while holding the finger on the marked page and can quickly return to the page. The behavior's uniqueness results from its tangible, lightweight, and casual nature.

In this study, we have developed Touch-Bookmark (TB), a multitouch e-book navigation technique based on the finger bookmarking behavior. TB enables users to use lightweight navigational strategies [6]. We conducted a usability test to evaluate our prototype design and found human factors that should be considered when designing touch interfaces for e-books. The factors include navigation strategies, patterns of interaction gestures, types of books, and motor memory.

Finger Bookmarking as a Lightweight Navigational Behavior

Previous researches have highlighted finger bookmarking as an important navigation method. O'Hara et al. found that their test participants could quickly return to an earlier page by marking the page with one hand [7]. Marshall et al. found that readers frequently use a navigation strategy to turn over many pages and return to a previously marked page [6]. From the results of the researches and our pilot study, we constructed the following functional models (FM) of finger bookmarking behavior.

- **FM1)** When a reader holds a finger on a page and flips through pages, the open page changes while the marked page remains still.
- **FM2)** The reader can quickly return to the marked page by turning the pages stacked on the finger.
- **FM3)** If the finger holding the marked page slides out, the marked page is lost.
- **FM4)** By holding two fingers on two different pages, the reader can quickly move between them.

FM1 and FM2 are identical with the function of legacy bookmarking. FM4 is useful for comparing two relevant pages. All the features are based on the dexterity and efficiency of the finger-holding/page-turning behavior. These factors render the finger bookmarking behavior lightweight and casual.

Few researchers have employed finger bookmarking in e-book interfaces. Watanabe et al. developed Bookisheet [8], a flexible e-book prototype with microswitches near the location of the forefinger. Users could flip through pages while pressing a switch to

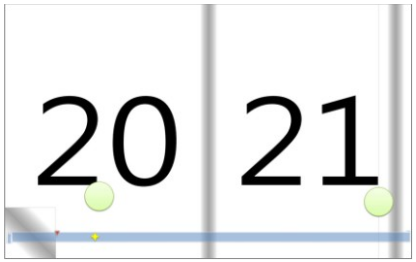


Figure 2. Screenshot taken while using Touch-Bookmark with two touch points. Green circles represent the touch points that hold bookmarks. The left touch and right touch are marking pages 10 and 21, respectively. The fold at the bottom left corner gives the users visual feedback of TB's activation.

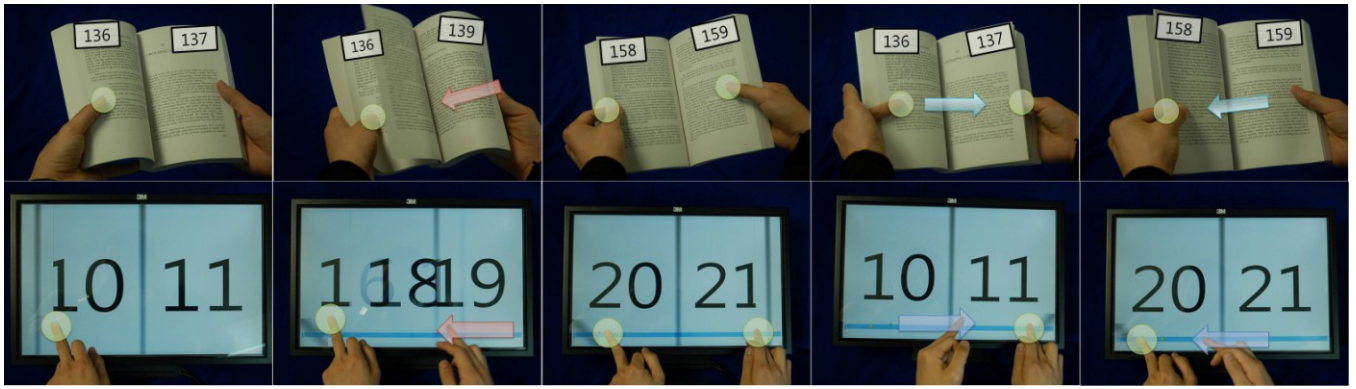


Figure 1. Finger bookmarking behavior for a paper book (top), and Touch-Bookmark function of our E-Book prototype (bottom). White boxes show page numbers. Green circles represent finger positions/touches related to bookmarking. Red arrows indicate the act of turning a page. Blue arrows denote the act of returning to a bookmark by turning multiple pages in one go. In the top panel, a reader turns pages to go to page 159 while holding a finger on page 136, and he turns multiple pages by using the finger to flip between the two pages. Similarly, in our prototype, the user turns multiple pages to flip between pages 10 and 21.

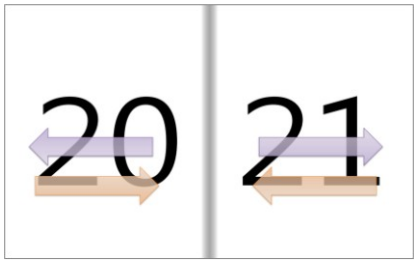


Figure 3. Two types of flicking gestures. Purple and orange arrows depict outward and inward flicking, respectively.

mark a page, and quickly return to the page by releasing the switch. Wightman et al. presented TouchMark, a set of navigation techniques with bendable tabs on each side of the e-book display [9]. TouchMark provides a bookmarking function that gives a tangible feeling by mimicking the thumbing and fingering behaviors. The finger-bookmark function and TouchMark facilitated casual e-book navigation and covered features FM1 and FM2. In comparison, our multitouch gesture interface is more casual and covers features FM 1–4.

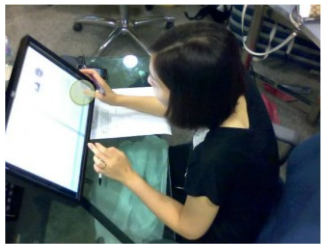
Recently, Hinkley et al. briefly presented a bookmarking technique *Hold Page while Flipping* as a part of their pen+touch input techniques [11]. The technique well covers FM 1–4. However, it is still required that accompanying human factors be investigated in terms of the navigational behavior.

Touch-Bookmark Design and Prototype Implementation

We used a 22″ capacitive-type multitouch LCD display (3M™ C1968PW) for our prototype. The LCD display promptly responds to user inputs and presents pleasant visuals of turning pages. This hardware setting is based on a paper-document metaphor and makes users feel that they are performing direct manipulation.

Types of Page-Turning Gestures

Tapping and flicking are used as the page-turning gestures. We categorize the flicking gesture into two types according to the direction and the page side where the gesture is performed: inward and outward flicking (see Figure 3). While inward flicking resembles the page-turning action for a paper book, there is no such resemblance for the tapping and outward flicking gestures. The advantage of tapping and outward



(a)

(b)

(c)

Figure 4. Various usage patterns of Touch-Bookmark: (a) P4 is reading contents while holding a bookmark on the exercise page; (b) P1 is flipping multiple pages back and forth quickly; (c) P2 is taking an answer on a note while holding a bookmark

flicking lies in the reduced physical effort required for page turning. Tapping requires reduced physical movement. A combination of inward and outward flicking gestures enable users to turn the pages back and forth with only one hand.

Designing Touch-Bookmark Interface

In TB, users can mark a page by holding a touch point (Figure 1). If the users turn pages while holding a touch point, the pages are stacked on the marked page (FM1). Users can return to the marked page by flicking the touch that was holding the page (FM2). If the touch is released, the marked page disappears (FM3). FM4 also can be used by holding and flicking two different touch points on opposite sides of the display alternately (Figure 1). To use this feature, users should hold a touch point on the opposite side of a marked touch point before flicking the previously marked one.

In contrast to the legacy bookmarking, TB is more casual and lightweight. When returning to the marked page, legacy bookmarking presents a bookmark list and let the users to choose one, but TB offers quick returning by a simple gesture. Moreover, TB users can mark a page by simply holding a touch on the page. Therefore TB does not impede the reading flow.

Users should continuously touch the touch points to maintain the bookmarks. This may seem to be rough migration of risky nature (FM3) from paper books to e-books, but the design is based on the following considerations. When people use fingers to mark a page, finger bookmarking helps in recording information about prior reading flow. To reduce the efforts made by the user to maintain the reading flow, we designed the tool such that the user can perceive the reading flow from the position of their finger and does not need to mentally keep track of the flow. In other words, users can off-load their cognitive works to the physical states of their finger and a book [10].

Usability Testing

A qualitative usability test was conducted to evaluate the prototype. Two female (P1, P4) and two male (P2, P3) university students aged between 21 and 26 were recruited. Three types of digitalized books were used as reading materials: a novel, movie magazine, and history textbook. The participants were asked to read the novel and the magazine freely by using the prototype's functions. When reading the textbook, we asked them to solve exercises at the end of a chapter using paper-based notes. This leads the participants into active reading [1].

The test started with an introduction to interface usage, and this was followed by 5 min of training to familiarize the participants with the technique. In the reading sessions the participants read each type of book for 10 min (total 30 min of reading). This was followed by a 20–25 min interview for eliciting the participant's evaluation. Additionally, every gesture command was logged to investigate the gesture usage patterns.

Results and Discussion

Overall Responses

All the participants found TB easy to learn, natural to use, and useful for navigation. They said, "When I use it, it feels like I'm reading real books" (P3) and "Turning pages was similar to the action for real books" (P4). These comments imply the successful transfer of paper document metaphor from paper books to the e-book prototype.

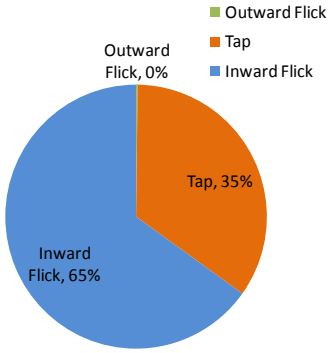


Figure 5. Overall relative frequency of simple page-turning gestures when TB is not used. Outward flicking was used only once in the entire test.

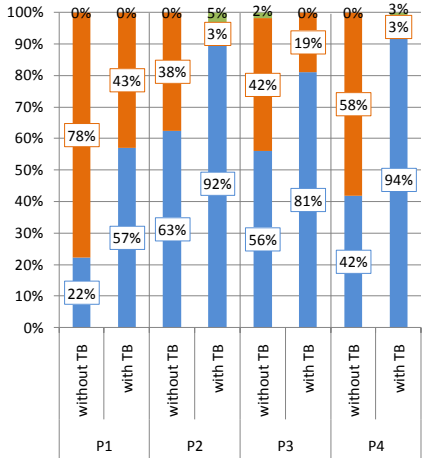


Figure 6. Relative frequency of the page turning gestures with and without TB (combination gestures) logged while reading the textbook. The frequency of the inward flicking was significantly increased with using TB (22–57% for P1, 63–92% for P2, 56–81% for P3, and 42–94% for P4).

Lightweight Navigation Strategies with Touch-Bookmark

We observed two types of navigation strategies. Interestingly, the strategies showed similarities with the lightweight navigation strategies (LNSs) observed by Marshall et al. [6].

- *LNS with TB 1.* Looking ahead in the text to preview or anticipate

This strategy was mainly used when reading the novel and magazine. Although the reason for selecting this strategy varied depending on the context, it was consistently used. The participants instinctively looked up text in later pages and quickly returned to the previous reading flow.

- *LNS with TB 2.* Looking back and forth to seek or re-read targeted contents

The active reading of the textbook involved this type of navigation strategy. To solve an exercise, users frequently referred to relevant contents. Usually, they bookmarked the exercise page and moved backward to the body of the chapter. They then wrote the answer on the note while continuing to bookmark the exercise page (see Figure 4). On average, every participant used TB more than once to solve an exercise (1.29 times for P1, 5.4 for P2, 1.3 for P3, and 1.11 for P4). Thus, TB can be useful for active reading, which involves searching for targeted information for critical thinking and learning [1].

Some Other Findings from the Gesture-Usage Patterns

As shown in Figure 5, the participants obstinately used tapping and inward flicking. From the interviews, we found out that the users felt outward flicking strained because the direction of the gesture is opposite to the turning direction for a paper book. Thus, it appears that the representation of a page widely used in single-sided commodity e-books [2] can hinder the feeling of directness; the discordance arises when users turn a page backward. To ensure the feeling of directness, the slide-type animation or Flipboard™-type animation that folds a page at the middle of the display vertically can be promising.

Tapping was mainly used to turn multiple pages successively, while inward flicking was used to turn each page gradually. While tapping is efficient, it is perceived as somewhat different from the action associated with paper books. In contrast, inward flicking is relatively inefficient, but similar to real-book manipulation. It is possible that such patterns are based on the user's unconscious choice between physical efficiency and intuition to minimize cognitive efforts as discussed by Hollan et al. [4]

When using TB, users should combine the simple page-turning gesture and the holding gesture. For all the users, the relative frequency of inward flicking significantly increased when a combination of gestures was used (Figure 6). When we turn a page by inward flicking, our physical motion becomes more analogous to that associated with finger bookmarking of paper books, compared to the case of turning by tapping or outward flicking. So, it is possible that users have a greater tendency to engage in direct manipulation when they use a combination of gestures instead of single gestures. In that case, we can infer that the user recalls motor memory [5] that has been kinesthetically learned while using finger bookmarking for paper books.

Conclusion and Future Work

We introduced Touch-Bookmark, a multitouch navigation technique for e-books. In the usability test, users found the technique usable and efficient for navigation. The patterns of TB usage indicated that the technique can be useful as a lightweight navigation technique for various types of books.

The results of the usability test provided insights into user behavior. We understood how the bookmarking behavior enables users to use the lightweight navigation strategies and why some types of document representations in e-books can be more convenient. Despite the limited number of users in the study, we found some meaningful variables about e-book reading behavior such as navigation patterns, interaction gestures, types of books, and motor memory. In the future, we plan to conduct a more focused study to evaluate the hypotheses about relationship between the variables.

The major advantage of the real-book metaphor is enabling users to employ previously learned behavioral patterns. On the other hand, a wholesale embracement of the metaphor can result in incongruities with the original functions of an e-book. For example, 'flipping through' is another promising real-book metaphor that can be employed to offer quick skimming/peeping. However, its employment needs to be reconciled with the thumbnail view or text-search function.

Acknowledgments

This research was supported by a grant from the KIST Institutional Program.

References

[1] ADLER, M., AND VAN DOREN, C. How to read a book. Touchston, New York, NY, 1972.

[2] APPLE. iBooks for iPad. http://itunes.apple.com/us/app/ibooks/id364709193.

[3] CHEN, N., GUIMBRETIERE, F., DIXON, M., LEWIS, C., AND AGRAWALA, M. Navigation techniques for dual-display e-book readers. *In Proc. CHI 2008,* ACM Press (2008), 1779–1788.

[4] HOLLAN, J., HUTCHINS, E., AND KIRSH, D. Distributed cognition: Toward a new foundation for human-computer interaction research. ACM Transactions on Computer-Human Interaction (TOCHI) 7, 2 (2000), 196.

[5] KLEMMER, S., HARTMANN, B., AND TAKAYAMA, L. How bodies matter: Five themes for interaction design. *In Proc. DIS 2006*, ACM Press (2006), 140-149.

[6] MARSHALL, C., AND BLY, S. Turning the page on navigation*. In Proc. JCDL 2005*, ACM Press (2005), 225-234.

[7] O'HARA, K., AND SELLEN, A. A comparison of reading paper and on-line documents. *In Proc. CHI 1997,* ACM Press (1997), 335-342.

[8] WATANABE, J., MOCHIZUKI, A., AND HORRY, Y. Bookisheet: Bendable device for browsing content using the metaphor of leafing through the pages. *In Proc. Ubicomp 2008,* ACM Press (2008), 360–369.

[9] WIGHTMAN, D., GINN, T., AND VERTEGAAL, R. TouchMark: Flexible document navigation and bookmarking techniques for e-book readers. In Proceedings of Graphics Interface (2010).

[10] WILSON, M. Six views of embodied cognition. Psychonomic Bulletin & Review 9, 4 (2002), 625.

[11] HINCKLEY, K., YATANI, K., PAHUD, M., CODDINGTON, N., RODENHOUSE, J., WILSON, A., BENKO, H., AND BUXTON, B. Pen + touch = new tools, *In Proc. UIST 2010,* ACM Press(2010), 27-36.