Bezel-Flipper: Design of a Light-weight Flipping Interface for E-Book

Sangtae Kim
Institute for IT Convergence, KAIST
291 Daehak-ro, Yuseong-gu,
Daejeon 305-701, Korea
expanne@gmail.com

Jaejeung Kim
Institute for IT Convergence, KAIST
291 Daehak-ro, Yuseong-gu,
Daejeon 305-701, Korea
jjkim@itc.kaist.ac.kr

Soobin Lee
Institute for IT Convergence, KAIST
291 Daehak-ro, Yuseong-gu,
Daejeon 305-701, Korea
soobinlee@itc.kaist.ac.kr

CHI 2013 Extended Abstracts, April 27–May 2, 2013, Paris, France.
ACM 978-1-4503-1952-2/13/04.

Abstract
In this paper, we have designed a novel touchscreen interaction technique for light-weight navigation: Bezel-Flipper. The design specifics and initial prototype application are developed with user evaluation. We received overall positive feedback from our initial user study in terms of engagement and enjoyment.

Author Keywords
Multi-touch; e-book; paper-book; page; bi-manual

ACM Classification Keywords
H.5.2. Information interfaces and presentation: User interfaces-Graphic user interfaces.

General Terms
Design, Human Factors

Introduction
Among portable devices, multi-touch tablets are promising as e-book readers. Such devices are light, widespread in the market, and equipped with high quality multi-touch panels that enable direct manipulation of contents. However, they are associated with limited navigational functionalities compared to paper books despite their manifold advantages.

With the inherent advantages of flexible and bi-manual manipulation of paper, navigation with paper books is normally quick and light; users can freely move back and forth among multiple pages using both hands [2, 3]. However, the software buttons and scroll bar that are provided by a tablet as substitutes do not fulfill the skimming and scanning functionality. Moreover, such functions also tend to require screen space that occludes the book contents, or an additional step for displaying and hiding these functions.

To overcome these limitations, previous studies [1, 5, 7, 8] have identified several reading functionalities for e-books. Among these fuctionalities, page flipping for quick scanning of the book by bending the remaining stack of the book, and finger-bookmarking for the cross-referencing of distant pages using both hands are identified as representative quick and light reading patterns of paper books. However, such approaches as these require additional sensors or equipment, such as bend sensors [5, 7], dual screens [1], or dedicated hardware buttons [5].

In this paper, we introduce a novel navigation technique called Bezel-Flipper that allows lightweight page flipping on a multi-touch tablet. In the designing process we conveyed flipping functionality using the paper-book metaphor and integrated this with page folding and finger bookmarking functionalities to see how the new system would work alongside existing functionality.

The Design of Bezel Flipper

We use a bezel gesture [4] to initiate the page flipping mode. The bezel gesture is a touch event initiated from outside of the screen; this motion passes through a thin activation area on the inner boundary of the screen. Using the bezel gesture has several advantages. First, it is less distracting than buttons, which occlude the contents space. And, it is also easily reachable from various positions when holding the tablet [6], allowing users to enter the flipping mode readily when they need to do so.

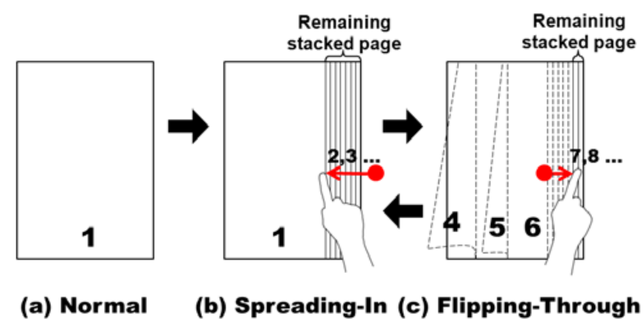

Figure 1. Three States of Bezel Flipping.

Once users have entered the flipping mode using the bezel gesture, Bezel-Flipper can be used in one of two states depending on the direction of the continuous touch gesture: spreading-in (Figure 1-b) for extending the flipping control area, and flipping-through (Figure 1-c) for manipulating the page-flipping operation.

The spreading-in state is initiated by a bezel gesture from the bezel area to the inner area of the touchscreen. This gesture drags out the user interface rendered with the remaining stacked pages. Meanwhile, the quantity of the spread-in area pushes the same quantity of the current page out of the screen. The deeper the gesture is, the wider the control area that is revealed, enabling relatively precise flipping control. The shorter the gesture is, the smaller the amount of control area that is revealed, leading to quick page flipping control. Each stacked page acts as a control unit in the ensuing flipping-through state. The spreading-in state can be initiated on both the left and right sides, for the previous pages and the remaining pages, respectively.

When a user changes the gesture direction from inward (spreading-in) to outward, the flipping-through state is activated. As the gesture passes through each control unit generated by the spreading-in state, the continuous turning of the pages (page flipping) occurs in the corresponding order. Similar to the bending and spreading behavior of the side stack of a paper book, if the gesture moves inward again, the spreading-in state is activated again for the resizing of the control area.

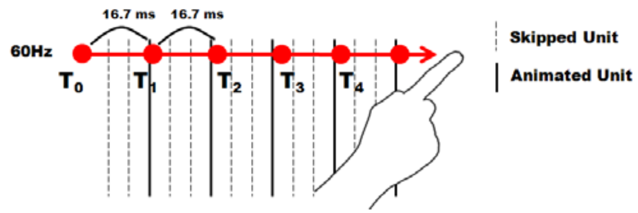

Figure 2. Animation frequency control

Bezel-Flipper enables a series of page-turning animations during page flipping. However, enabling the animation for every control unit raises a performance issue. Also, too many page-turning animations can cause occlusions among the flipped pages, disturbing the efficient scanning functionality. For these reasons, we limited the number of page-turning animations depending on the update frequency of the touch event. For instance, if the update frequency is set to 60 Hz, the control unit near the touch events that occur every 16.7 ms is animated and the other units are skipped (Figure 2). In addition, we also minimized occlusions among animations by turning the pages gradually transparent as animation proceeds, except for newly generated pages. For instance, P1 and P2 in Figure 3 are removed from the screen earlier, at the time that P6 is generated, increasing the chances of revealing P3, P4, P5, and P6.

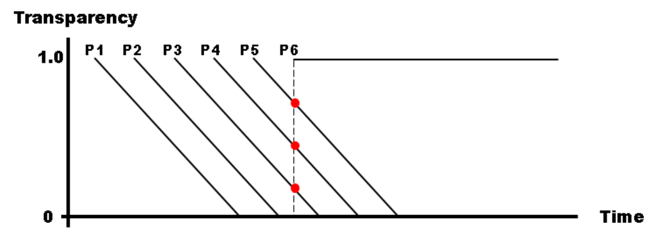

Figure 3. Animation transparency control

Since the available screen area for the flipping control is relatively narrow, a gesture occasionally makes many more pages flip than the user intended. To address this problem, we slightly reconfigured the alignments of the stack. Rather than maintain an equal distance between the stacked pages on the side interface (Linear alignment, Figure 4a), we placed the pages sparsely on the inner side of the side interface and densely on the outer side (Gradual alignment, Figure 4b). This alignment allows a user to navigate near pages precisely and to turn to distant pages quickly.

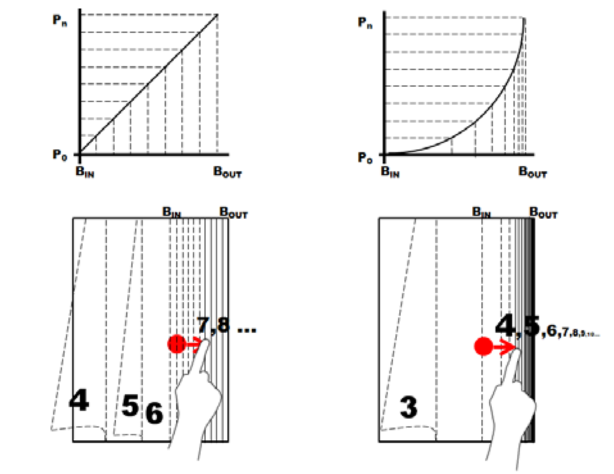

Figure 4. Two types of stack alignment

Integration with existing interface

To see how Bezel-Flipper works with existing user interfaces we integrated two representative functionalities: page folding for single page movement and finger-bookmarking [3, 8] for temporal bookmarking between distant pages.

A page folding event is started by a touch event on the screen, except for the bezel gesture event; users can turn to the next or previous page by releasing the touch. And we combine finger-bookmarking with page flipping and page folding instead of having it to be a unique process. For example, if an extra touch event is found on a page before a flipping or folding event, the page is automatically bookmarked and the extra touch event acts as a finger bookmarking handler.

The Finite State Machine (FSM) shown in Figure 5 identifies six states: idle, ready for bookmark, page flipping, page flipping with bookmark, folding, and folding with bookmark. Each state represents the functionality described above and the combination of functionalities, as finger-bookmarking works with other functionalities.

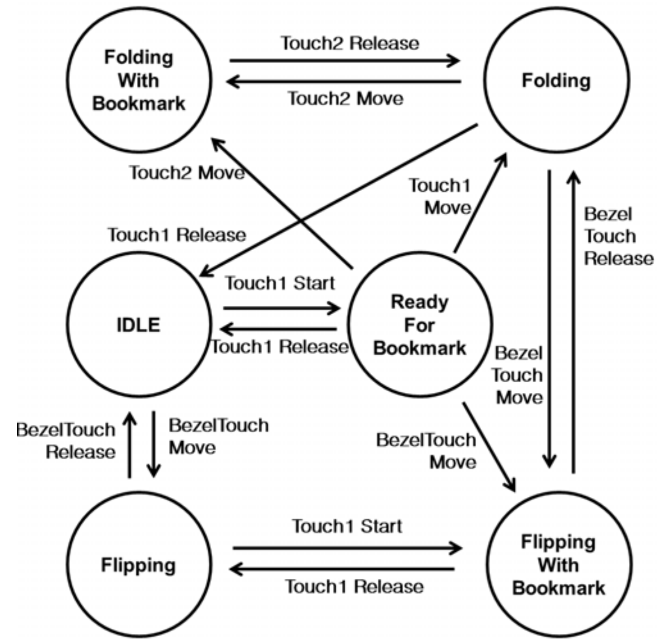

Figure 5. Finite State Machine of Bezel-Flipper

Initial Evaluation

In the pilot evaluation, we aimed to gain insight into how users react to Bezel-Flipper and to obtain feedback regarding specific design elements.

Recruiting

Six participants were recruited for a user study (two females, average age: 27.7). All participants were graduate students in the Culture Technology Department at KAIST and all had experience with e-books on touch-screen devices.

Apparatus and Material

We fully prototyped Bezel-Flipper designs on a tablet device (iPad2) with a 10” display (1024 x 768 pixels). Two types of application were prepared for the evaluation: Gradual alignment mode and linear alignment mode (Figure 2). We selected the Korean edition of Lonely Planet magazine as the experimental content to determine the active scanning behavior; these travel guides are normally composed of a number of short sections.

Procedure

After a short introduction to Bezel-Flipper, the participants were asked to read more than 10 sections of the travel guidebook that interested them. Participants were required to use both alignment mode in the beginning, then allowed to read contents using the preferred mode. Because we wanted to determine how the users naturally reacted, we minimized the instruction session and allowed participants to use Bezel-Flipper freely.

Evaluation Results

All participants gave positive feedback about the design of Bezel-Flipper. In this section, we describe selected findings regarding the design of Bezel-Flipper.

Selected Findings

- Before the short instruction, none of the participants discovered the bezel gesture. However, once the participants were instructed in the proper use of the device, they appeared to use it naturally.
- Continued and repeated state-switching between the spreading-in state and the flipping-through state rarely occurred. Instead, participants tended to re-initiate the page-flipping mode using bezel gestures.
- Two participants did not realize that their thumb was moving out of the screen at times, expecting the flipping-through state to last. When asked why they did not realize this, they reported that their focus was on the contents and that there was no tactile feedback between the screen and the bezel.
- All participants preferred the gradual alignment of the page stack to the linear alignment of the page stack. One participant noted that it was more convenient for controlling navigation and that it also resembled the counterpart shape of a paper book.
- For finger bookmarking, participants rarely moved their non-dominant hand to manipulate a bookmarked page. Some participants reported that the non-dominant hand was not free because they were holding the tablet and that the 10” display was too heavy to allow active movement.
- All of the participants reported that finger-bookmarking with one hand is useful and efficient for

quick paper navigation; they liked the idea of the "picking and page turning" gesture.

Discussion

Once users became accustomed to using Bezel-Flipper, they managed to manipulate it easily. However, all the participants seemed to find it difficult to make use of the functionalities without instruction, as none of the Bezel-Flipper functionalities have visual cues before initiating themselves and rely on the paper-book metaphor only. Some participants suggested that having a tutorial menu would help lower the learning curve. Another suggestion for handling those problems was to design visual cues to provide hints for the current and next states.

Future Work and Conclusion

In this paper, we designed a lightweight navigational interface for handheld e-book devices. We received overall positive feedback from our initial user study in terms of engagement and enjoyment. Users especially enjoyed the point that the paper-book metaphor was applied to an e-reader. Our future work will include refinements following the initial user feedback, such as adding visual cues and designing a tutorial, and detailed user study to evaluate how Bezel Flipper design increase the efficiency of reading.

Acknowledgements

This study was partially supported by the Korea Communications Commission, under grant number 11912-03001.

References

[1] Chen, N., Guimbretiere, F., Dixon, M., Lewis, C., and Agrawala, M. Navigation techniques for dual-display e-book readers. In Proc. CHI2008, ACM Press (2008), 1779-1788.

[2] Marshall, C., and Bly, S. Turning the page on navigation. In Proc. JCDL 2005. ACM Press (2005), 225-234.

[3] O'hara, K. and Sellen, A. A comparison of reading paper and on-line documents. In Proc. CHI 1997, ACM Press (1997), 335-342

[4] Roth, V., and Turner, T. Bezel swipe: conflict-free scrolling and multiple selection on mobile touch screen devices. In Proc. CHI2009, ACM Press (2009), 1523-1526.

[5] Tajika, T., Yonezawa, T., and Mitsunaga, N. Intuitive page-turning interface of e-books on flexible e-paper based on user studies. In Proc. MM 2008, ACM Press (2008), 793-796.

[6] Wanger, J., Huot, S., and Mackay, W. BiTouch and BiPad: designing bimanual interaction for hand-held tablets. In Proc. CHI2012, ACM Press (2012), 2317-2326.

[7] 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.

[8] Yoon, D., Cho, Y., Yeom, K., and Park, J. Touch-Bookmark: A Lightweight Navigation and Bookmarking Technique for E-Books. In Proc. CHI2011, ACM Press (2011), 1189-1194.