Book-Like Reader: Mirroring Book Design and Navigation in an E-Book Reader

Yuto Kotajima(✉) and Jiro Tanaka

University of Tsukuba, Tsukuba, Japan
{kotajima,jiro}@iplab.cs.tsukuba.ac.jp

Abstract. This paper describes our design of the Book-Like Reader, an e-book reader interface that mirrors paper books. This study focuses on the characteristics of flexibility and lightweight navigation in paper books. We consider the important requirements for navigation to be the control method, the behavior of paper pages, and lightweight bookmarking. By satisfying these requirements, the user can handle an e-book intuitively like a paper book. Our reader is capable of the same user-friendly navigation as a paper book.

We have developed a prototype (as an Android application) with an Android tablet, two force sensitive resistors, and a microcomputer board. The touch display and the resistors are sufficient to detect the input. The application visualizes e-books (consisting of image files) like paper books using an OpenGL ES. Our Book-Like Reader has the aforementioned characteristics of paper books.

Keywords: Electronic book · Mobile device · User interface · Android application

1 Introduction

As portable devices (such as tablets) become increasingly widespread, electronic books are becoming increasingly popular. However, these kinds of books do not offer the same advantages as paper books, such as flexible navigation and viewing multiple documents placed side by side. These functions have an important role in reading books. This study focuses on flexibility and lightweight navigation as two of the most important characteristics of paper books. By reproducing behaviors such as flipping, lightweight bookmarking, and tactile/acoustic feedback, we aim to obtain the same user-friendly navigation of a paper book on an e-book.

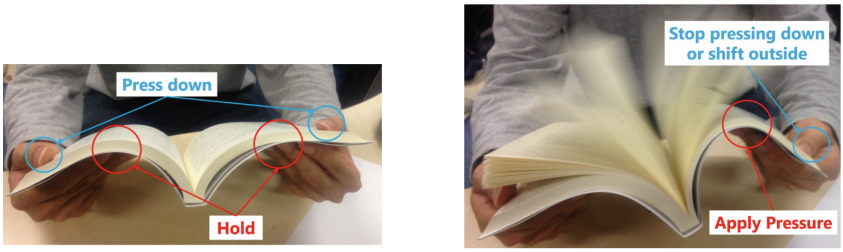
2 System Design

2.1 Requirements for the User-Friendly Navigation

We believe that the factors contributing to a user-friendly navigation in paper books are the following.

M. Kurosu (Ed.): HCI 2016, Part II, LNCS 9732, pp. 192–200, 2016.
DOI: 10.1007/978-3-319-39516-6_18

Control Method. When reading a paper book, the reader commonly holds a book with both hands: pressing down the front of the book with the thumbs and holding the back of the book with the other fingers (Fig. 1(a)). Then, the reader flips through the book by bending it: applying pressure to the back of the book and shifting the thumb outside to the front of the book (Fig. 1(b)). The reader can control the flipping speed and the number of pages flexibly and precisely by adjusting the pressure applied and the movement of the thumb.



(a) Holding the Book (b) Flipping the Book

Fig. 1. Control method of paper book

Behavior of Pages and Feedback. A lot of information can be obtained from the pages of a paper book. Flipping is accompanied by a sound as well as visual cues and sensory ones (touching/grazing the pages). The reader knows how many pages are turned judging by the thickness. Furthermore, using the same thickness, it is easy to tell how much of the book has already been read and how much is left (Fig. 2(a)). The thickness of the closed book is used as a criterion of reopening as a rule of thumb (Fig. 2(b)). All these pieces of information support flexible navigation.

Lightweight Bookmarking. A paper book can be bookmarked by putting a marker between the leaves of the book. The reader can use a variety of things as a marker, even his/her own finger (Fig. 3(a)). In addition, bookmarking and turning to a bookmarked page are very easy to achieve (Fig. 3(b)).

2.2 Design of the Book-Like Reader

We propose the Book-Like Reader as a design of an e-book reader device and application, which has the aforementioned functions for mirroring the user-friendly navigation of a paper book. We chose tablet devices as the platform because of their sufficiently large size and the many built-in sensors for reproducing a paper book. Moreover, they use stripped-down sensors that allow maintaining the characteristics of e-books, e.g., the ease of carrying many books.

(a) Thickness of Side Pages

(b) Thickness of Closed Book

Fig. 2. Thickness of pages

(a) Finger Bookmark

(b) Turning to Bookmark

Fig. 3. Lightweight bookmarking

Built-in or attached sensors are capable of detecting the input: both thumbs are shifted to the front of the device, and pressure is applied from other fingers (Fig. 4). A Book-Like Reader application loads the e-book data, then it handles the e-book through the input detected by the sensors (Fig. 5).

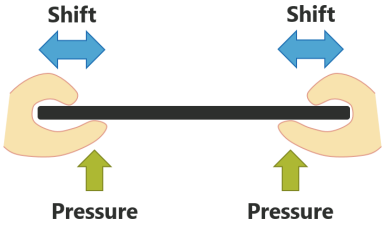


Fig. 4. Detecting input

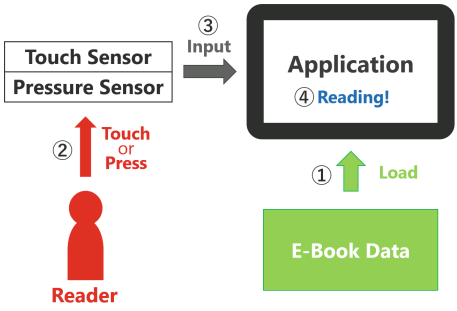


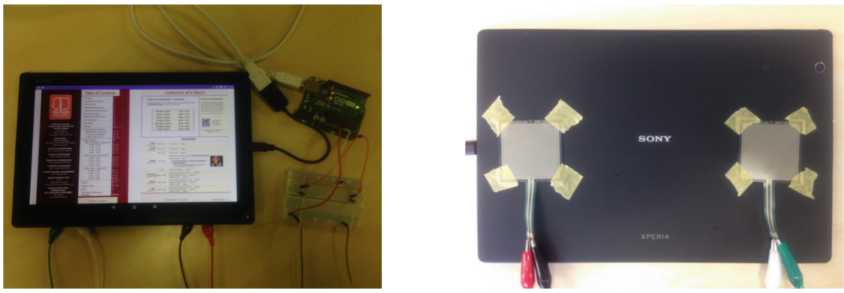
Fig. 5. System flow

3 Implementation Prototype

3.1 Prototype Device and Application

The prototype of the Book-Like Reader device is shown in Fig. 6. As previously stated, as much as possible, the prototype is not equipped with additional sensors. Only two force sensitive resistors are attached to the back of the device. The sensors convey the detected values to the device through the Arduino board with a USB OTG host cable.

The prototype of the Book-Like Reader software is implemented as an Android application; the detected data are processed using this application. In this prototype, the e-book data format loaded by the application is restricted to a set of image files compressed into a zip file.



(a) Device Connected to Arduino

(b) Back of Device, Equipped with Two Force Sensitive Resistors

Fig. 6. Prototype device

3.2 Detecting Input Method

Just like when bending a paper book, the Book-Like Reader is controlled by shifting both thumbs to the front of the device and by applying pressure with other fingers. The input from the front of the device can be detected using the touch display to detect these actions with the tablet. The input from the back is detected by two force sensitive resistors (because the tablet does not have pressure sensors on the back) (Fig. 7). The e-book reader is controlled according to these detected values.

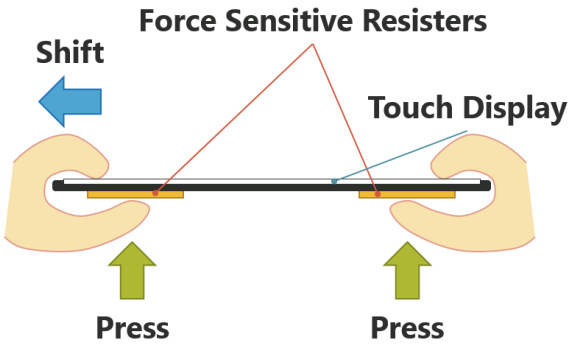


Fig. 7. Detecting input

An example of the relationship between the values measured by these force sensitive resistors and the user's behavior is shown in Fig. 8. The value measured by both sensors is clearly different, depending on whether the user performs no action, holds the device, or presses the back of the device. These states can be differentiated according to whether the sensor values are higher or lower than the threshold: 50 or 400. In addition, when the user taps the sensor twice, the values repeat the transition from high to low values.

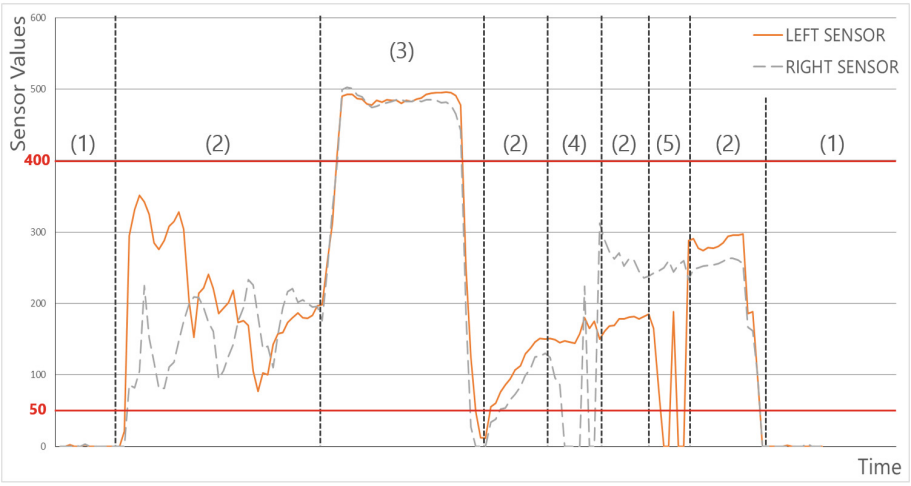
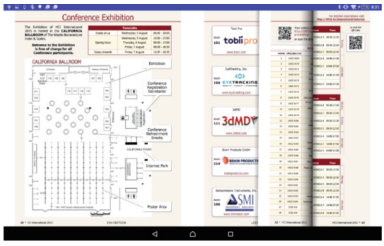


Fig. 8. Pressure values and related action

3.3 Visualizing Similar to a Paper Book

On the assumption that the user handles the tablet device with horizontal orientation, the Book-Like Reader displays two pages at once, like an opened paper book (Fig. 9). This e-book is rendered by using an open source application, android_page_curl [1], which creates a page curl and flip effect using OpenGL ES [2]. The page images are loaded before being shown. Due to the issue of the device's memory capacity, the application keeps some nearby pages, which are resized to fit into the display.

(a) Displaying Two Pages

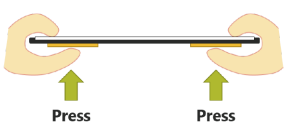


(b) Curl Effect

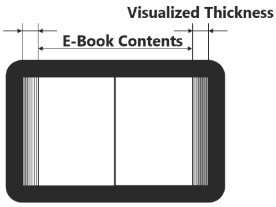
Fig. 9. Application screenshot

Visualizing the Book Thickness. We developed a function to visualize the thickness of the e-book, similar to a paper book. When both sensors on the back of the device are pressed over a specified value (Fig. 10(a)), the contents area becomes narrow, and the thickness of the e-book is visualized on both sides on the display (Fig. 10(b)). This thickness is drawn at a fixed width to leave enough space to show the contents. The number of pages is indicated by the depth of gradation in the background and by the number of drawn vertical lines in the visualized thickness area.

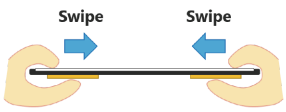
When both thumbs are swiped towards the center of the display (Fig. 10(c)), the thickness of the closed e-book is visualized (Fig. 10(d)). It is possible to turn to the selected page by tapping the thickness.



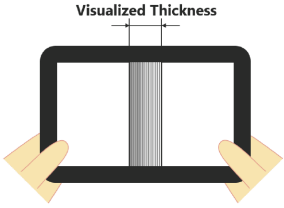
(a) Showing Thickness of Opened Book



(b) Visualizing Thickness of Opened Book



(c) Showing Thickness of Closed Book



(d) Visualizing Thickness of Closed Book

Fig. 10. Visualizing E-book thickness

Continuous Flipping Animation and Feedback. The Book-Like Reader performs flipping animation and gives feedback to the user when the two sensors are pressed over a given threshold and when one of the thumbs is swiped towards the outside of the display (Fig. 11(a)). The user is given feedback through vibration of the device and sound (Fig. 11(b)). Keeping the state that the thumb was shifted, the user can continue flipping. The flipping speed and the number of pages correspond to the detected sensor values.

However, the application can render animation for only one page; thus, it cannot turn pages as fast as those of a paper book.

(a) Performing Flipping (b) Draw and Feedback Flipping

Fig. 11. Flipping pages like those in paper books

3.4 Lightweight Bookmarking

Similar to a paper book, the Book-Like Reader can bookmark and enable turning to the bookmarked page with a simple action. The user can bookmark by tapping either force sensitive resistor twice. Moreover, the user can return to the bookmarked page by releasing the finger that tapped the sensor. As shown in Fig. 8, when the user taps the sensor twice, the values measured by either of the force sensitive resistors changes from a low value to a high value twice successively. The application remembers the page where this transition of the values was detected. Then, it returns to the page by using the decrease in the values as a trigger.

4 Related Work

4.1 Natural Interaction with a Physical Object Like Paper

Some studies obtained natural interaction like paper books using a physical object as an interface of digital content. The Listen Reader and Sequence Book consist of a paper book with RFID tags embedded in each page [3,4]. Watanabe et al. developed an interface consisting of two thin plastic sheets for browsing content [5]. Fujita et al. proposed a novel book-shaped device for flipbooks, embodying some physical features and e-book interactivity [6]. These studies can give users a natural interface and can offer the advantages of paper books. However, many books cannot be carried as easily as portable devices can.

4.2 Obtaining Characteristics Using Additional Devices

Several studies obtained characteristics of paper books on portable devices using additional sensors or devices. Chen et al. designed a dual-display e-book reader, which supports embodied interactions like paper books [7]. TouchMark [8] introduced physical tabs on each side of the device to enable gestures such as page thumbing and bookmarking. Izawa et al. proposed Flip Interface, which obtained flipping using two flip sensors that consist of multiple film-like capacitive sensors [9]. These studies offer natural interaction easily. However, they only ensure a part of the characteristics.

4.3 Expansions of E-Books

There are several studies in which the e-book readers are capable of interacting naturally, in the same way as paper books. Yoon et al. introduced Touch-Bookmark, a lightweight technique for E-books [10]. To use this technique, users can bookmark and turn pages to do simple finger gestures on a touch screen. Kim et al. designed a novel touchscreen interaction technique for lightweight navigation; it enables consecutive flipping to do a bezel gesture on a tablet [11]. These studies enable lightweight navigation only with a tablet device. However, these techniques cannot be controlled as intuitively as paper books.

Our work has solved the aforementioned problems. However, the interface described in this study is not as natural as those that use a physical interface.

5 Conclusions

We developed a prototype of an e-book reader called Book-Like Reader, which obtains the same user-friendly navigation of a paper book using a tablet device and a few sensors. Our Book-Like Reader behaves like a paper book, and users can interact with it in a similar way. However, some characteristics of paper books have not been achieved, like quick navigation. In future work, we intend to improve the application behavior to make it more similar to paper books and more user-friendly. In addition, we intend to enhance our application so that it can handle major e-book formats, like epub.

References

1. android_page_curl. https://github.com/harism/android_page_curl/
2. OpenGL ES. https://www.khronos.org/opengles/
3. Back, M., Cohen, J., Gold, R., Harrison, S., Minneman, S.: Listen reader: An electronically augmented paper-based book. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI 2001, pp. 23–29. ACM, New York (2001)
4. Yamada, H.: Sequencebook: Interactive paper book capable of changing the storylines by shuffling pages. In: CHI 2010 Extended Abstracts on Human Factors in Computing Systems, CHI EA 2010, pp. 4375–4380. ACM, New York (2010)
5. Watanabe, J., Mochizuki, A., Horry, Y.: Bookisheet: Bendable device for browsing content using the metaphor of leafing through the pages. In: Proceedings of the 10th International Conference on Ubiquitous Computing, UbiComp 2008, pp. 360–369. ACM, New York (2008)
6. Fujita, K., Itoh, Y., Kidokoro, H.: Paranga: An electronic flipbook that reproduces riffling interaction. Int. J. Creat. Interaces Comput. Graph. **4**(1), 21–34 (2013)
7. Chen, N., Guimbretiere, F., Dixon, M., Lewis, C., Agrawala, M.: Navigation techniques for dual-display e-book readers. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, CHI 2008, pp. 1779–1788. ACM, New York (2008)

8. Wightman, D., Ginn, T., Vertegaal, R.: Touchmark: Flexible document navigation and bookmarking techniques for e-book readers. In: Proceedings of Graphics Interface 2010, GI 2010. pp. 241–244. Canadian Information Processing Society, Toronto, Ont., Canada (2010)
9. Izawa, K., Suzuki, N., Akabane, K., Yamakawa, H., Maruyama, J., Aikawa, T., Kubomoto, R., Sibayama, F., Takenaka, H., Kobayashi, S.: A proposal of new interactions with directly-manipulable 'mekuri' interface. In: IPSJ Interaction 2011, pp. 123–130, (2011). in Japanese
10. Yoon, D., Cho, Y., Yeom, K., Park, J.H.: Touch-bookmark: A lightweight navigation and bookmarking technique for e-books. In: CHI 2011 Extended Abstracts on Human Factors in Computing Systems, CHI EA 11, pp. 1189–1194. ACM, New York (2011)
11. Kim, S., Kim, J., Lee, S.: Bezel-flipper: Design of a light-weight flipping interface for e-books. In: CHI 2013 Extended Abstracts on Human Factors in Computing Systems, CHI EA 2013, pp. 1719–1724. ACM, New York (2013)