Proposal and Evaluation of a Document Reader that Supports Pointing and Finger Bookmarking

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Abstract. Pointing and finger bookmarking effectively support reading from paper. However, current electronic media do not support these operations. Readers are discouraged to trace or point text with fingers on popular touch-screen tablet devices because the gestures may cause undesired view changes. Also, bookmarking with the current interface does not provide the ease of finger bookmarking. For solving the problems mentioned above, we proposed a document reader that provides seamless switching between pointing/tracing and touch operations, and integrate features that simulate finger bookmarking by using simple gestures. The results of two experiments (proof reading and cross reference reading between pages) show that participants performed the tasks faster with the proposed system than with the conventional touchscreen systems.

Keywords: Active reading · Pointing · Tracing · Finger bookmarking

1 Introduction

Pointing and finger bookmarking effectively support reading from paper [1]. Tracing text while reading can help skipping over the text, and pointing at documents act as a temporary placeholder that help going back and forth between various locations within the document [2]. Finger bookmarking helps to flip over to other pages faster [3].

These behaviors effectively support reading from paper, but current electronic media do not support them. For example, unlike pointing using both hands, mouse cursors are not able to point multiple points at once [4]. Ironically, readers tend to hesitate to point or trace the text in the documents on a "touch" screen device, fearing

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that unexpected behavior may occur [2]. Early works indicate that bookmarking with the current interface does not provide the ease of finger bookmarking [3, 5].

In this paper, we will propose a document reader that encourages readers to point and trace documents while reading from a touch panel device by preventing unintended operations to be triggered, as well as functions equivalent to finger-bookmarking. Our proposed system enables to tangibly handle documents in an intuitive manner, such as tracing the text across the screen using fingers and pointing at the text. Also, our proposed system aims to mimic the ease of finger bookmarking on paper documents.

2 Proposed System

2.1 Preventing Unintended Touch Operations

In general, unintended operations due to touching the touch panel can be prevented by temporarily disabling touchscreen operations. However, disabling or enabling touchscreen operations by switching back and forth between modes can hinder time efficiency [6].

To shorten the operation time, main operations are assigned to the dominant hand and mode change operations are assigned to the non-dominant hand. This enables for some operations to overlap [7]. As illustrated in Fig. 1 (top), with our proposed system, users slide their thumb diagonally upward to switch from the "reading mode" that does not accept touchscreen to the "operation mode" that accepts touchscreen operation. To encourage the use of the non-dominant hand, the area that detects this gesture is limited to the left side of the screen for a reader whose dominant hand is the right. The screen is switched from the operation mode to the reading mode by taking the hand off the screen as in Fig. 1 (bottom).

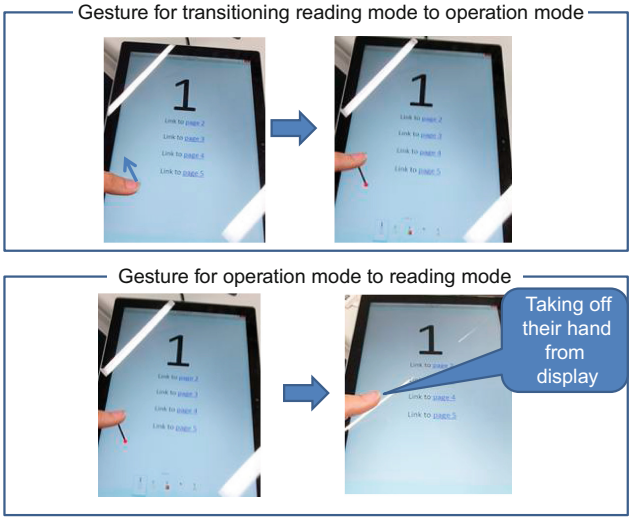

Fig. 1. Gesture for reading mode to operation mode (top), Gesture for operation mode to reading mode (bottom)

2.2 Imitating Finger Bookmarking

Some studies have attempted to imitate finger bookmarking electronically [8, 9]. Wightman proposed a page navigation interface in which bookmarks are placed by turning physical tabs that are attached to the hardware they have designed [8]. Yoon proposed a touch-bookmark interface where the user touches and holds the page to be bookmarked. As long as the page is held, the user can flip to other pages and the bookmarked page can be referred to at any time [9]. These systems make bookmarking easy and simple.

However, even with these systems, the reader has to consciously decide whether or not the page is note-worthy enough that they may want to refer back to, and act upon this decision to leave a bookmark of some sort. On the other hand, when using paper, the reader does finger bookmarking subconsciously, not giving much thought of whether they will actually go back to the bookmarked page. To encourage using finger bookmarking functions, it is desirable to improve usability of the finger bookmarking interface to the subconscious level as on paper documents. Also, it is observed that the reader is most likely to return to the first page they started looking through the pages [1], so we thought a system simulating finger bookmarking should automatically bookmark the starting page.

Therefore, we propose a system that automatically records the first page of where the series of page operations start. As described in the previous subsection, we have designated the default mode of the touchscreen device to the reading mode. The mode needs to be switched in order to turn the page, and the page where the reader is on when the mode switch operation is triggered, is automatically bookmarked. When the thumb is slid down diagonally, the screen will show the bookmarked page (Fig. 2). In the operation mode, page thumbnails are displayed in the bottom of the screen so that the mode can be identified visually.

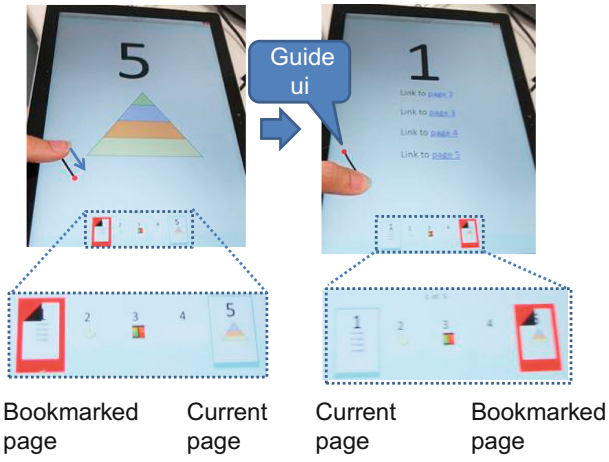

Fig. 2. Gesture for move back to bookmarked page

3 Evaluation

We conducted two experiments to evaluate the effectiveness of our proposed system by comparing it with conventional reading systems. The aim of Experiment 1 was to confirm whether our proposed system encouraged pointing to text and improved reading performance. The aim of Experiment 2 was to evaluate the effects of the finger bookmarking interface.

3.1 Experiment 1: Proof Reading

Hypothesis. This experiment contains the following two hypotheses.

Hypothesis 1. There will be more pointing to the text in the document with our proposed system than with a conventional system.

We think that users are less hesitant in pointing at the screen if they know any unintended actions are not triggered when they accidently touch the screen. Thus, we hypothesize that our proposed system will encourage pointing.

Hypothesis 2. Reading from our proposed system will be faster than reading from a conventional system for proof reading.

We think that our proposed system, in comparison to a conventional system, can help find errors more efficiently due to the fact that there will be more pointing at the text.

Method.

Design and Participants. The experimental design was a one-way within-participants design. The factor was a media condition (conventional system and proposed system). Each participant performed all conditions and performed two trials in each condition. The order of the media used in their trials was counterbalanced to cancel the overall effects of the trial order.

Participants were 24 Japanese native speakers (all right-handed). They were in their 20's or 30's. Each participant had more than three years of experience using a PC, more than ten months of experience using touchscreen devices, and corrective eyesight of more than 14/20. Another condition that we included in the recruitment process was for the participant to have a score of 600-700 on the TOEIC (Test of English for International Communication) test within the last two years.

Materials. We created documents for the experiment based on articles from Japanese newspapers.

One document was used in a single task. Each document was one page long. In each text document, the Japanese text and its English translation were printed and we intentionally included errors: mismatches between the Japanese text and the corresponding English translation. We included five errors in each document, such as "father," written in Japanese, and "mother," written in the corresponding portion in English.

Task. The task was to find inconsistences between the text described in Japanese and its English translation. The time limit was six min. The task trials were terminated when participants detected all five errors or when the time limit was reached.

Media Condition. The following two systems were used:

- Proposed system: Each document was displayed with our proposed interface.
- Conventional system: Documents were displayed using a normal tablet reader that triggered page turns, etc. by swiping and tapping motions. The appearance was made to look exactly the same as our proposed system.

Apparatus. The tablet used in the experiment was Surface Pro 3 (Microsoft Corp). The operating system was Windows 8.1.

Results and Discussions. Figure 3 presents the number of observed pointing to text behaviors per minutes. We counted pointing by watching the video of the experiment. We counted the number of times that a finger was pointing at the screen, regardless of whether it was touching the screen or not. The error bar shows the standard error of the mean. It is the same throughout this paper.

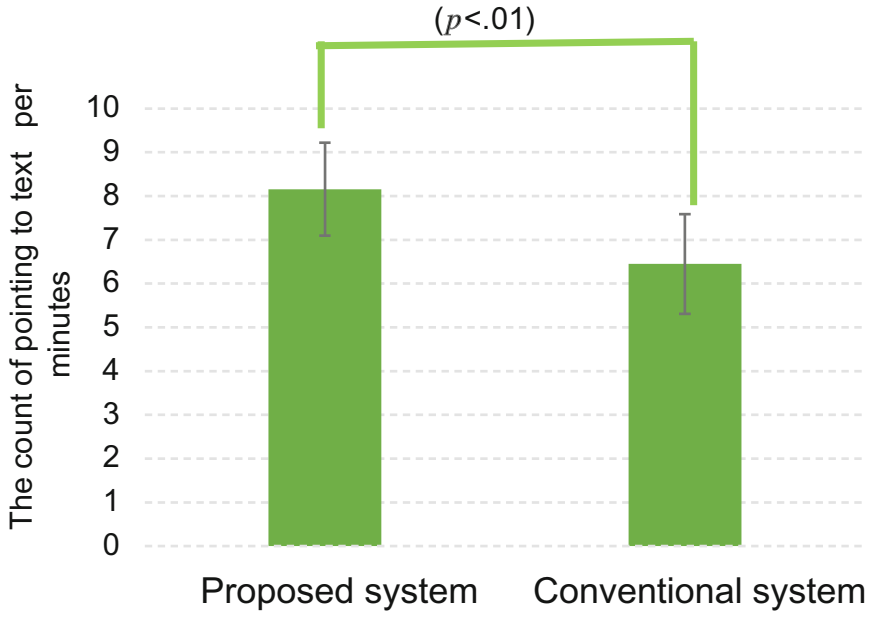

Fig. 3. The number of pointing to text per minutes

A paired t-test revealed a significant difference between the media [$t(23) = 3.1$, $p < .01$]. Participants pointed to the text 26.5 % more when using our proposed system than when using the conventional system. This supports our first hypothesis that there would be more pointing to the text in the document with our proposed system than with the conventional system.

We argued that there were less pointing for the conventional system because users were afraid that it may cause unintended actions. 12 out of 24 participants triggered unintended actions using the conventional system. In the interview afterwards, the participants reported that, "we accidently touched the screen because we were focused with the task." We consider that the unintended actions triggered by pointing made users aware of the gesture and refrain from repeating.

Figure 4 presents the number of error detection per minutes.

A paired t-test revealed a significant difference between the media [$t(23) = 2.9$, $p < .01$]. Participants detected 31.7 % more errors using our proposed system than using the conventional system. This supports our second hypothesis that reading from our proposed system would be faster than reading from the conventional system for proof reading.

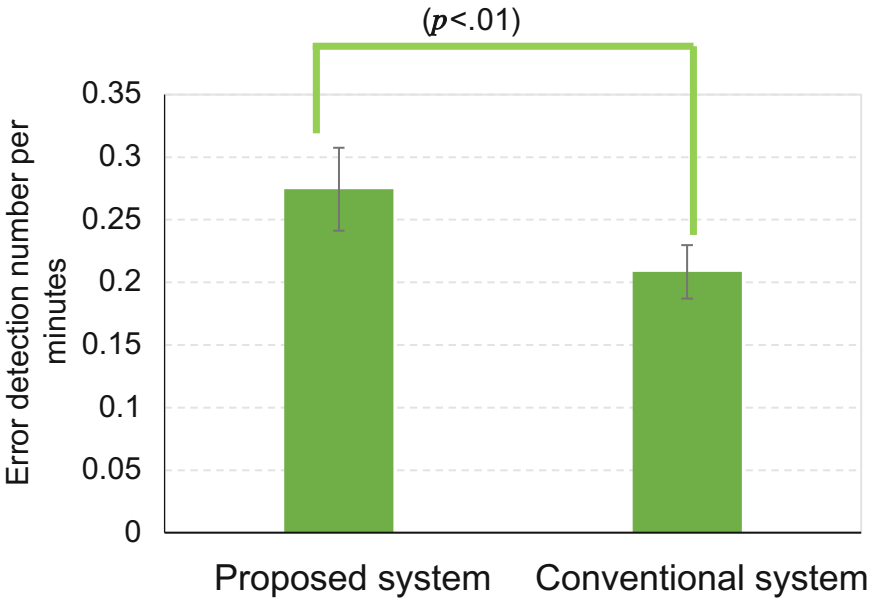

Fig. 4. The number of error detection per minutes

These results indicated that our proposed system effectively support proof reading by encouraging pointing to text. Furthermore, in the interview afterwards, a participant reported that, "(Even in the conventional system) I would point the text without touching the screen, but my fingers would start to shake so I could not point at the exact location." "I could point at the exact location (using our proposed system) and it was less tiring." Our proposed system not only encouraged pointing, but it helped in pointing at the exact location because the finger could be placed there.

3.2 Experiment 2: Cross-Reference Reading Between Pages

Hypothesis. This experiment contains the following hypothesis.

Hypothesis. Reading from our proposed system will be faster than reading from a conventional system for cross-reference reading between pages.

We hypothesize that reading efficiency will improve with our proposed system with a feature that simulates finger-bookmarking, compared to a conventional system without this feature, because going back and forth between pages will be easier.

Method.

Design and Participants. The experimental design was a one-way within-participants design. The factor was a media condition (conventional system and proposed system). Each participant per-formed all conditions and performed two trials in each condition. The order of the media used in their trials was counterbalanced to cancel the overall effects of the trial order.

Participants were 24 Japanese native speakers (all right-handed). They were in their 20's or 30's. Each participant had more than three years of experience using a PC, more than ten months of experience using touch-panel devices, and corrective eyesight of more than 14/20.

Materials. We created documents for the experiment based on the statistical data provided by the Japan Paper Association. The document was 17 pages long: 2 of the pages were the front and back cover, 14 pages contained only graphs, and one page contained only text.

We intentionally included errors: mismatches between the content of the text and the information presented by the graphs. We included 21 errors in each document. For example, the text says that the collection rate of paper recycling in Belgium is 52 %, but the graph indicates 53 %.

Task. The task was to find inconsistences between the information obtained from the text and the graphs. The time limit was six minutes. The task trials were terminated when participants detected all 21 errors or when the time limit was reached.

Media Condition. The following two systems were used:

- Proposed system: We used our proposed system as a document viewer.
- Conventional system: We used Adobe Reader DC as a document viewer. We explained various page navigation features provided by the application and did not restrict their use to complete the task.

Apparatus. The apparatus was same as experiment 1.

Results and Discussions.
Figure 5 presents the number of error detection per minutes.

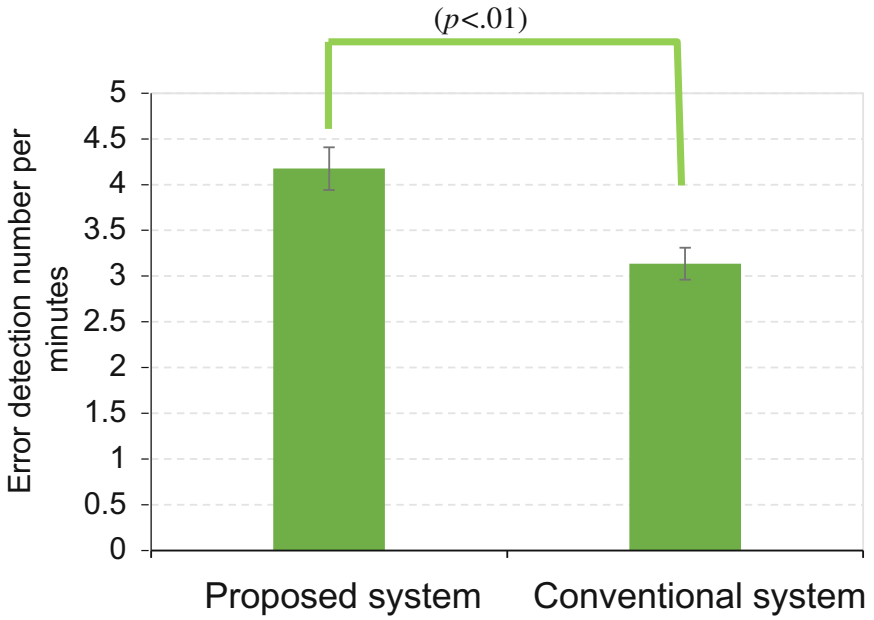

Fig. 5. The number of error detection per minutes

A paired t-test revealed a significant difference between the media [$t(23) = 7.6$, $p < .01$]. Participants detected 33.2 % more errors when using our proposed system than when using the conventional system. This supports our hypothesis that reading from our proposed system would be faster than reading from the conventional system for cross-reference reading between pages.

In the interview afterwards, participants commented on the proposed system saying, "There was minimal stress because I could flip right back to the intended page," "I could use it like paper (finger-bookmarking)." On the other hand, on the conventional system, a participant said, "Thumbnails were okay, but I didn't memorize which pages the graphs were on, so it was a struggle to have to check the thumbnails for the pictures each time I wanted to go back." Thumbnails are effective, but these comments suggest that finger bookmarking is more efficient for going back and forth between pages.

4 Conclusion

In this paper, we proposed a document reader that prevents unintended reactions to occur from misinterpreted pointing and tracing, and integrates a feature that enable bookmarking at ease, much like finger bookmarking.

We verified the effectiveness of our system by the two experiments. The first experiment revealed that our proposed system enabled detecting errors more quickly than when using a conventional system in proof reading. Also, pointing to text was

performed more frequently using our proposed system than using the conventional system. These results indicate that our proposed system effectively support proof reading by encouraging pointing to text.

The second experiment revealed that our proposed system enabled detecting errors more quickly than using a conventional system in cross-reference reading between pages. This suggests that finger bookmarking supported going back and forth between pages.

In this study, we verified the effectiveness of our proposed system when the readers were reading individually. We will continue to verify the effectiveness of our proposed system when several people refer to documents for collaborative discussion. Pointing is frequently done during discussion when a reader wants to efficiently communicate a certain point [10]. Therefore, there is a possibility that our proposed system that encourages pointing would support smooth communication. We need to compare the communication process between our proposed system and conventional system in the future to further verify this.

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