Enhancing Document Navigation Tasks With a Dual-Display Electronic Reader

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ABSTRACT
We present a prototype dual-display e-book reader that is designed to improve the electronic reading experience. Our device uses lightweight embodied interactions to support unselfconscious local navigation. We incorporate mechanisms such as Space Filling Thumbnails, which take advantage of the increased display space on our device to aid global navigation. To accommodate the need for cross document operations and flexible layout of documents in the workspace, our prototype provides detachable faces that can operate independently.

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INTRODUCTION
Reading devices now on the market boast excellent battery life and display quality. However, only a limited set of reading activities can be performed using their single display surface. Laboratory and ethnographic studies point to the importance of having multiple displays in reading; Adler et al. [1] write:

“[…] judging by the degree to which multiple displays were used across our whole sample, we can surmise that at least two functionally interlinked screens might be more generally useful.”

Fortunately, the e-paper [4, 8] found in existing reading devices, with its unique property of only consuming power when the display changes, directly enables the construction of practical dual-display e-books.

To explore the potential of a multi-display device, we have built a dual-display prototype using readily available technology (see Figure 1). We have also implemented a set of interactions to support navigation tasks that people commonly perform while reading [1, 6, 7, 9]. These navigation tasks fall into three categories. Unselfconscious local navigation tasks include manipulating the material to expand or contract the reading area [6], flipping backwards through the document to re-read passages [6, 7], and casual flipping while performing other activities. Global navigation tasks include jumping to specific places of interest in the document, and cross-document navigation tasks involve reading from multiple documents simultaneously [1, 9].

In our demonstration, participants will have a chance to use our prototype and examine how the unique affordances of a dual-display reader allow for novel interfaces and interactions that can improve the electronic reading experience.

A DUAL DISPLAY ELECTRONIC READER
Our prototype resembles and behaves similarly to a traditional paper magazine. The device consists of two faces that are connected using a hinge. Each face contains an LCD screen, sensors and a small computer. Initially, the user is presented with two displays side-by-side, but the faces swivel about the hinge to fold behind each other and can also be detached from the hinge.
On-board accelerometers in conjunction with a Bluetooth link to a context server allow the system to sense motion and compute the relative orientation of the two faces. Through this, the system can detect gestures and automatically update the displays as the user manipulates the device.

**Unselfconscious Navigation**

Our device aims to support unselfconscious local navigation activities with gesture-based controls that push these frequent interactions into the background [5].

**Reading Area Expansion and Contraction** - In our device, users can seamlessly transition between viewing a larger portion of the document in a side-by-side view, and narrowing the scope by folding one face behind the other in a compact back-to-back configuration (Figure 1, top). Enlarging the reading area provides the reader with a broader overview of the content, while contracting the reading area allows the reader to prune away distractions [6]. Furthermore, the ability to change the form factor of the device allows the device to adapt different reading environments. For example, the back-to-back configuration is appropriate when space is at a premium and also allows for one-handed operation.

**Flipping Back / Flipping Forward** - When the user is in the back-to-back mode, our device detects a flipping gesture (Figure 1, bottom). Flipping the device in a clockwise motion shows the previous page and flipping counterclockwise shows the next page. The flipping gesture provides a familiar means to rapidly consult adjacent pages.

**Face Fanning** - In the side-by-side configuration, fanning a face (moving one face toward the other) allows the user to traverse the document. Fanning the right face moves one page forward, the left face, a page backward. The fanning gesture is an example of how physical properties unique to a dual-display reader—the assembly of the faces, in this case—provides opportunities for new interactions. The ability to operate the device without having to search for small controls allows users to more easily multi-task while reading.

**Global Navigation**

We provide a Space Filling Thumbnail (SFT) system [3] to present thumbnails of every page in the document and to allow rapid access to any page. SFTs take advantage of the increased display area of a dual-display device by showing larger thumbnails with more recognizable features. A bookmarking feature allows the user to quickly return to locations of interest. Leveraging the fact that two displays are available, users can use the bookmarking system to recall and perform side-by-side comparisons of different locations in a document similar to the feature in 3Book [2].

**Cross-document Navigation**

To facilitate operations across different documents, the two faces of the E-book can be detached (Figure 2). When the faces are detached, they can display different documents and be operated in parallel. Physically separate faces also aid multi-document navigation tasks by allowing the user to lay the faces in an arbitrary configuration in the workspace, enhancing organization and ergonomics [9]. When the faces are reattached, the device automatically returns to dual-display operation.

**CONCLUSION**

Thanks to advances in display technology, electronic reading devices with two displays will soon be available. Consequently, we set out to design interfaces and interactions to leverage the affordances of a two-display electronic reader to allow better support for the broad spectrum of interactions during reading. To aid us in our exploration, we built a prototype dual-display e-book reader with detachable, motion-sensitive faces. The project was funded through NSF Grants #00447730 and #0414699.

**REFERENCES**