Two-Level Artificial-Landmark Scrollbars to Improve Revisitation in Long Documents

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ABSTRACT

Navigating to previously-visited pages is a trivial yet fundamental task in linear control-based document viewers. These widgets e.g., scrollbars often do not work well particularly for long documents. Existing solutions try to tackle this issue with bookmarks, search, history, and read wear but limited in terms of effort, clutter, and interpretability. To improve the revisitation support in long documents, we investigated the use of artificial landmarks similar to the visual augmentations available in physical books: coloring on page edges or indents cut into pages. We developed several artificial-landmark visualizations to represent page-locations in the scrollbar for many hundreds of pages long documents, and tested them in studies where participants visited multiple locations in long documents. Results indicate that using two columns of landmark icons significantly improved revisitation performance and preferred by users. Our two-level artificial-landmark augmented scrollbars can be a new way to support spatial memory development of long documents – and can be used either in isolation or in congregation with current techniques.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI) → Interaction paradigms**

KEYWORDS

Spatial memory; artificial landmarks; scrollbars; revisitation.

ACM Reference format:

E. S. Mollashahi, M. S. Uddin, and C. Gutwin. 2018. Two-Level Artificial-Landmark Scrollbars to Improve Revisitation in Long Documents. In *Proceedings of the International Conference on Advanced Visual Interfaces, Castiglione della Pescaia, Italy, May 2018 (AVI'18)*, 2 pages.
DOI: https://doi.org/10.1145/3206505.3206588

AVI '18, May 29-June 1, 2018, Castiglione della Pescaia, Italy

ACM ISBN 978-1-4503-5616-9/18/05.
DOI: https://doi.org/10.1145/3206505.3206588

1 INTRODUCTION AND BACKGROUND

Linear control widgets such as scrollbars are a basic mechanism to navigate in linear documents like PDF. These popular controls are present in both desktop-based one-dimensional document readers such as Adobe Acrobat and e-readers on tablets such as Kindle or iPad. Though they are appropriate for linear fashion document navigation (e.g., scroll to move down or swipe up for next page), these controls do not always work well when documents are long, and people perform complex navigation. Specially, when users want to go back to locations in the document that they have visited before, these traditional navigations provide very little support. To provide better non-linear navigation support (and revisitation in particular) in long documents, several techniques have been proposed which includes search, explicit bookmarks [1], Dwell-and-Spring [3], and implicit read wear visualizations [2]. Each of these techniques has its own strengths and weaknesses depending on the situation.

Landmarks, are visual features (e.g., structures) that help us in real-world navigation [4], can also be useful in computer interfaces [2, 6–8]. Artificial landmarks [8] have the potential to support users' spatial memory development, and they can provide efficient retrieval and revisitation of desired locations: recalling the location with reference to the landmarks and visiting it. Researchers recently added artificial landmarks in the form of abstract icons and thumbnails [9] to augment the scrollbar of a document viewer. Although landmarks can significantly improve revisitations for short documents, it is not clear how this technique will perform in hundreds of pages long documents.

To investigate the use of artificial landmarks and their support in spatial memory development for successful navigation in long text documents, we developed several novel artificial-landmarks augmented scrollbar designs. Inspired by real-world landmarking features present in long textbooks (e.g., colored page edges or indent cuts), we place two columns of landmarks in a two-level hierarchy (see Fig. 1). We developed three separate designs and used abstract icons, letters and digits respectively as landmarks. We then compared these designs with a single-column icon scrollbar and a standard no-landmark design, where participants visited and revisited various locations in a long document with a custom web-based reader. Results showed that all two-level artificial-landmark scrollbars yielded better revisitations compared to the single column landmark scrollbar. In particular, double-icon design was significantly faster than all other designs.

Our work makes two main contributions. First, we show that artificial landmarks support spatial memory development and can successfully be used in long documents. Second, we demonstrate three new artificial landmarks augmented scrollbar designs, and show that the two-column icon design outperformed others both in performance and in user preference.

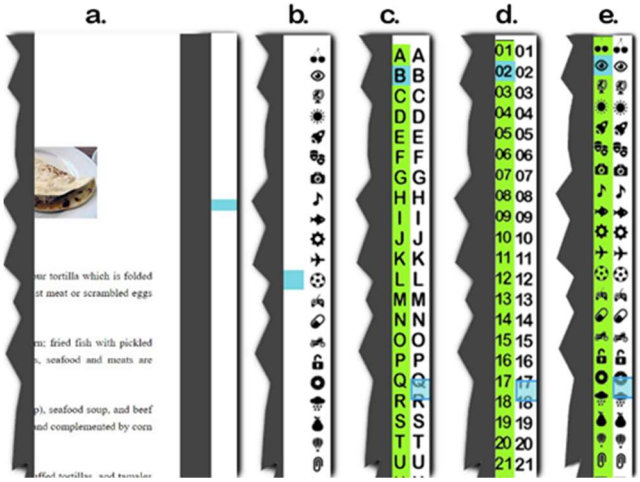

Figure 1: Study interfaces with augmented scrollbar(s), additional scrollbar is highlighted in green. A: Custom document viewer with standard scrollbar; b: Single-Icons with one column of icons; c: Double-Letters, d: Double-Digits; e: Double-Icons.

2 DESIGN OF TWO-LEVEL SCROLLBARS

Since a single column landmarked scrollbar may not provide precise revisitation in a long document, we used two columns of landmarks to form a two-level hierarchical scrollbar design[1]. We built five document viewer interfaces for evaluation:

Standard: Single-Scrollbar with No Landmarks. It uses a single plain scrollbar with standard interaction features (Fig. 1a).

Single-Icons: Single-Scrollbar with Icon Landmarks. Following the [9], it uses 30 monochrome icons (placed vertically; Fig. 1b) in a single-column to augment the scrollbar.

Double-Icons: Two Scrollbars with Icon Landmarks. To support precise revisitation, this design introduces a second scrollbar along with the existing one, each with 30 icons (Fig. 1e).

Double-Letters & Double-Digits. The *Double-Letters* and *Double-Digits* designs are similar to *Double-Icons*, but augmented with 30 letters and digits respectively as landmarks (Figs. 1c and 1d).

3 STUDY AND RESULTS[1]

We carried out a lab study with 17 participants with four landmarked scrollbar designs (*Standard* was removed from this study based on the preliminary study result), where participants visited and revisited various locations of long text documents using custom readers. Our study revealed that all landmarked design supported rapid spatial memory development, and the *Double-Icon* design outperformed all other designs in terms of trial completion time and scrollbar interaction (e.g., mouse-wheel scroll, click, etc.) with 11859ms (s.d. 15090ms) and 14.7 interactions/trial (s.d. 50.0) respectively (all p<.003). Subjective responses also favored *Double-Icon* design over others. Our results provide valuable information for the designers of document readers, particularly for the very large in length, that artificial landmarks can be a useful addition to navigation technique that can work either alone, or in conjunction with currently available techniques.

4 DEMONSTRATION SETUP

The demonstration setup consists of all the five document reader interfaces, which were implemented in an Acer Aspire 4750G laptop, with a 14-inch 1366 x 768 screen, and running on Windows 10. The interfaces were written in JavaScript. The demo consists of tasks involving visit and revisit of various locations of long text documents with customized readers.

5 CONCLUSIONS AND FUTURE WORK

We explored the use of artificial landmarks to improve revisitation support in long documents. We found that all artificially augmented designs improved spatial learning and revisitation. In particular, using two columns of icon landmarks yielded the best revisitation performance with the lowest effort scores. In future, we plan to run studies with auto-extracted thumbnails, and in different sizes of devices to their effect on revisitations. We also plan to merge our landmarked methods with available navigation approaches (e.g., bookmarks, and visit wear) to see how these techniques perform in combination for realistic document revisitation tasks. We invite people in the AVI community and interaction designers to come and talk to us in demo session, and provide valuable feedback on these designs.

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[1] This is an extended abstract entry for Demo at AVI 2018. A fully refereed article [5] with details on design, study and results can be found in the proceeding of AVI 2018.