Animated Dynamic Highlighting

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1. Introduction

The recent years have seen an exponential increase in the amount of information available through the Internet on any given topic. Information retrieval techniques have been steadily improving and can provide a mass of relevant results, but those results still have to be processed and digested by a human reader. Information professionals need technology that helps people absorb large amounts of text quickly. We introduce *Animated Dynamic Highlighting (ADH)*, an interactive, user-controlled technology to improve presentational aspects of the reading task. We present the research underlying the ideas of *ADH*, the *ADH* technology itself, and some results from an initial user study evaluating its effectiveness and usability.

2. Background

The study described in this paper is part of a larger effort at PARC called *Productive Reading*. We are looking at ways in which computation can be applied to the reading process, in two major ways: to enhance document content, and to enhance the user experience of reading.

The current model of the reading interface is heavily based on the static experience of words imaged on paper. This model has been carried over directly to the presentation of text to the computer screen. Some attention has been given to using computation to modify the presentation structure of documents (Beveret al. 75-87; Walker et al.), but with certain exceptions (Chang et al.). These presentations are inherently static.

The major exception to this is the presentation technique commonly known as *rapid serial visual presentation (RSVP)*. The overview of studies in *RSVP* given in Sicheritz suggest that a dynamically altered presentation of text may be able to enhance comprehension without negatively affecting reading speeds. However, *RSVP* is often found to suffer from some serious disadvantages, notably eyestrain, usually attributed to the fact that the user's eyes do not move from a fixed position, and user anxiety, due to the inability to look back at previously-read text. Other studies such as Castelhano et al. have demonstrated ways to alleviate some of these issues.

3. ADH

3.1. What ADH does

The goal of *ADH* is to preserve the apparent advantages of *RSVP*, while mitigating the apparent disadvantages. It paces the user through an electronic document, sequentially highlighting parts of the text, each a few words long, without modifying the spatial layout of the original page, so that the reader's eyes move in a normal reading fashion. The speed with which the highlighting moves depends on properties of the chunks and on a base speed set by the user. The reader can adjust the speed, and also restart *ADH* from any point in the document. The reading speed may be at a speed somewhat faster than the user's habitual reading speed.

3.2. The viewing technology

The *ADH* presentation system is part of a larger system at PARC for archiving and reading documents, called *UpLib* (Chang; Mackinlay; Zellweger). The *UpLib* system includes a document reader, called *ReadUp*, which normally supports a conventional page-oriented document display. *ReadUp* was modified to present documents in both *RSVP* and *ADH* mode.

John Glenn Installed in Smithsonian.

WASHINGTON, DC — John Glenn, the first American to orbit the earth and the oldest man ever in space, is being honored by the Smithsonian National Air and Space Museum, which has installed **the former U.S. senator** as the centerpiece of its upcoming Milestones Of Flight exhibit.

"John Glenn's life has been a living testament to the power of human vision," NASM director Gen. John R. "Jack" Dailey said at Sunday's dedication ceremony. "Generations of Americans will be inspired by his nobly dangling form, which so eloquently evokes both the wonder of physical flight through the air and that even greater flight — of the human spirit."

Above: Glenn hangs among other national treasures in the Smithsonian.

The Marine Corps band played the national anthem as Dailey unveiled a space-suited Glenn in his new place of honor, suspended 40 feet above the floor of the museum's breathtaking Gallery 100. He occupies a space near his Mercury "Friendship 7" orbiter capsule and between Charles Lindbergh's Spirit of St. Louis and the Bell Airacomet, the first American turbojet aircraft in regular production.

The NASM will display Glenn in his original 1962–vintage flight suit, which he wore for his historic orbital space flight, until December 2004. Beginning next year, Glenn will alternate monthly between his 1962 and 1998 spacesuits. On occasions of historic

Figure 1: A document page shown with ADH highlighting

3.3. Phrase-breaking technology

The text of a document is first annotated with part-of-speech tags using the *Inxight* tagger. In contrast to most taggers, the *Inxight* tool has a large inventory of labels to distinguish between different types of determiners, adverbs, and pronouns. While the information is less detailed than a syntactic parser could produce, the markup makes it possible to divide the text into semantically coherent pieces. We have defined a large set of phrasal patterns and compiled them into finite-state transducers (Beesley; Karttunen). The transducers are applied in a cascade taking the output of one pattern matching step as input to the next one. This process splits the input text into phrases proceeding from larger constituents (sentences and clauses) to smaller constituents (NPs, VPs, PPs) and their components. Each phrase should contain between 2 and 4 content words (such as nouns, verbs, adjectives, and adverbs); the boundaries of syntactic constituents are in most cases preserved. An example of a partitioned sentence is below:

```
<phrase>The Marine Corps band</phrase>
<phrase>played the national
anthem</phrase> <phrase>as Dailey
unveiled a space-suited Glenn</phrase>
<phrase>in his new place of
honor,</phrase> <phrase>suspended 40 feet
above the floor</phrase> <phrase>of the
museum's breathtaking Gallery
100.</phrase>
```

Finally, the established phrase boundaries are projected back to the original source text to enable the dynamic highlighting in presenting the text to the user.

3.4. Display timing

Each phrase is allocated an initial display time based on the user-selected speed. This base span is then modified in a number of ways: shorter phrases get somewhat less time, longer ones more time. The timespan is further modified to reflect the findings in Just; Carpenter: phrases ending a line, at the end of a page, at the beginning of a new line, or ending a sentence all receive varying amounts of extra time, reflecting the extra time human subjects tend to take with these kinds of phrases. Finally, the occurrence of linguistic constructs in the phrase, such as pronouns and compound nouns, is used to modify the timespan in additional ways.

4. User Study

4.1. Method

The goal of the user study was to assess the effectiveness of *ADH* and to compare it to *RSVP* (Sicheritz); the same phrase-breaking and timing were used for *ADH* and *RSVP*. Eighteen test subjects, mostly researchers and interns, were given three alternative modes of presenting documents: plain (not modified in any way), *ADH*, and *RSVP*. The texts contained simple factual information and were followed by questions testing the recall accuracy. The first stage of the experiment used documents with automatic phrase breaking, the second one used manual phrase breaking.

The subjects were also asked about their reactions to the *ADH* and *RSVP* technologies.

4.2. Results

Although there were too few subjects for significant results, some interesting trends emerged. Overall, *ADH* was found to be faster than either plain or *RSVP* mode; it was also somewhat less accurate. In general, there was a tradeoff between speed and accuracy in *ADH*: the faster a document was read, the less accurate was the recall. However, both the speed and accuracy results were better with manual phrase-breaking than with automatic phrase-breaking. Users found both *ADH* and *RSVP* to be somewhat annoying, but rated *RSVP* worse than *ADH*. However, most said they would use *ADH* again for skimming through short articles, especially with improved phrase-breaking and timing algorithms. On the other hand, most users rejected future uses of *RSVP*. The lower user ratings and reading speeds may be the result of novelty shock. The results are nevertheless encouraging: younger subjects in particular were very enthusiastic about *ADH*, and the user study produced many suggestions for future improvements and well as possible applications of *ADH*.

5. Conclusion

ADH is one of the many possibilities inherent in the idea of actively presented text. Interfaces that attempt to work with the user in understanding the underlying text would seem to have wide applicability for reading text of all kinds, from technical papers to email to biography, particularly in overview reading, such as Adler's *systematic skimming* and *superficial reading* (van Doren; Adler). They may offer special advantages to those with reading disabilities, or for specific tasks, such as proofreading. Our initial investigations into this technique seem promising, and a number of improvements in both phrase analysis and presentation timing are already being investigated.

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