Perceptually guided scrolling for reading continuous text on small screen devices

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Reading on a small screen is made difficult by the frequency with which it necessary to change from one line to the next, and from one page to the next. While a good layout makes it easier to find the next line on the screen when the text stays still, little help has been available when the text is advanced. A solution is presented that guides the readers eye to the right place by subtly modifying the look of the text as it is scrolled.

keywords: reading, scrolling, visual guide, small screen device

Introduction

Mobile phones are turning into general communication devices, and they will soon be required to handle e-mails and other forms of text communication as well as voice communication. As more and longer text is read on the small screens of these devices, an efficient and pleasant method for reading text is critical. In this paper a robust and efficient design called *Wiping* is proposed which improves reading on a small screen in a mobile environment. The main problem addressed by Wiping is *scrolling*, or revealing new content on the screen, as this is highly disruptive to the reading process. Page by page scrolling (rather than line by line) is the best way of decreasing the frequency of scrolling, and therefore essential to high speed reading on small screens, but paging can be confusing. The main contribution of Wiping is the addition a perceptual guide during scrolling to help the user in *refocusing* after paging.

This design has been motivated by thoughts about visual perception, although no claims of any deep understanding of perception is intended. The design also acknowledges what Djabri & Karlsson [2] call *aesthetics in use* and especially *engagement*, the benefits of well tuned and pleasant interaction and dynamic properties. These are considered to be very promising in meeting the challenge of designing for handheld devices.

Scope

The design described here was developed for use in the interfaces of smart phones with a high resolution screen with a physical size of 3 x 4 centimetres, which

means about 6-7 lines of text, each of 15-22 characters. This should be taken into account when comparing with other work.

Presenting text on a small screen

While studies have shown that a larger screen is superior to a smaller when reading text in a traditional page format (see [3] for an overview), several presentation forms (RSVP and Segmented Text Presentation) have shown that it possible to achieve *better* reading performance on a small screen in special cases. And unlike other types of information, such as images, tables, maps, etc., continuous text is read sequentially, and does not require a large display or lots of jumping around to be comprehended. So, why is reading from a small screen difficult?

Two main factors affect reading in a page-oriented presentation: the static format of the text (layout), and how text is advanced (scrolling). Layout affects mainly how the attention of the reader moves from one line to the next, whereas scrolling affects how attention is shifted when the text is advanced on the screen (e.g. from one page view to the next).

Both these actions must be as efficient as possible on a small screen, simply because of the large number of times they must be performed.

Layout

The short line length on a small screen reduces the number of characters/words that can be presented and read continuously before requiring a *return sweep*, i.e. refocusing the eye at the beginning of the next line. Refocusing from line to line is improved by text design, in which the start of the next line is where one expects it to be on the page, and the lines themselves are distinct enough to work as visual guides in the return sweep process. Text layout for a small page is not trivial and in need of further investigated, but text layout in general is a well researched area, and resources such as [3] and [4] can provide many helpful tips applicable even on a small screen.

Scrolling

The small number of lines which can be displayed simultaneously requires the user to advance text, or scroll, frequently. After moving text, the reader must refocus on the correct part of the text. Physical media such as books provide perceptual cues during this refocus, and the proper position to refocus on is predictable. When text is moved on a screen, such guidance is rarely provided. In the case of *line by line* scrolling, the text lines that otherwise provide invaluable help during the return sweep are suddenly moved. If the text is moved in larger steps, no clues at all are given as to where to continue reading.

Only in the case of *page by page* scrolling do the borders of the screen work as perceptual guides, and this method promises a simple and efficient solution. However, internal research shows that a complete lack of context between screens is uncomfortable for users.

Design

When a new text presentation method was designed for the type of device described in the introduction, some principal design decisions could be made based on the analysis above. Page by page scrolling was adopted in order to reduce the number of refocuses when the text was advanced. Improving perceptual guidance and improving context during scrolling became the main design goals. A principle of keeping at least one line on screen between pages was adopted to maintain some page to page context, and to make it obvious that no content had been skipped
The visual presentation of advancing text showed the greatest room for improvement. When a new page appears instantly there are no cues as to what has happened, but this can be helped by animating the transition. Different step sizes during the animation were tried, and step sizes equal to a whole or half line height were found to create unpleasant visual artifacts. Decreasing the step size to1/3 or 1/4 of the line height produced a smooth and pleasing result, apart from one visual artifact: the partially visible lines moving off the screen. For some reason (aesthetic or otherwise) this proved unpleasing, and solutions were sought to hide or remove this effect.. A radical solution was adopted: simply hide (or dim) all content that will be scrolled off the screen.
The result is *Wiping*, named for the similarity with a windscreen wiper.

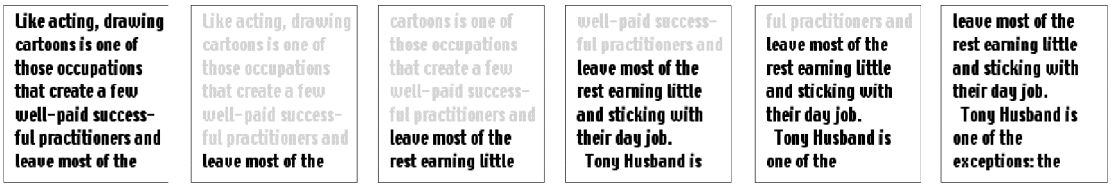

Figure 1: Wiping. In frame (1) a normal page of text is shown as it appears during reading. When a key is pressed to advance the text, the part of the text that will be removed from the screen is removed or greyed out (frame 2), and the scrolling occurs (frame 3-6).

Initial use showed that Wiping reduced the minor visual artefacts described above, but it was also evident that Wiping helps the reading process in other ways.
No full explanation has yet been found, although theories have been suggested, pointing to the perceptual guidance that Wiping provides while scrolling to the

next page. Hiding content which no longer has interest because it has already been read, allows more attention on the new content moving onto the screen.
During scrolling, the screen is divided up into two areas: 1) the old text that is moving off the screen, and 2) the text that is remaining or moving onto the screen. The quickly moving border between the light part of the screen (where content has been hidden) and the darker part of the screen containing text triggers very low level centres in our visual perceptual system (see [1]). The eyes of the user follow this edge almost automatically, and at the end of the animation the user is already looking in the right place to continue reading.

Evaluation

Initial peer evaluation has revealed that most users don't notice the blanking of content during the scrolling unless it is pointed out to them. One interpretation of this is that the users' attention is completely on other parts of the screen, tracking the incoming content. It has also been noted that Wiping promotes a certain rhythm in the reading process, and since it is easy to predict when the text should be advanced (while reading the last line) the user can prepare for this.
A small usability test of Wiping has been run with five subjects, recording only user preferences and comments during the test. It was found that most users found Wiping useful, although some subjects found it confusing and preferred traditional scrolling. This result is encouraging enough to recommend further work and tests.

Conclusion

Other methods of presenting text may be superior to Wiping under specific conditions. Wiping, on the other hand, provides a very flexible solution that easily accommodates slight distractions, and places no requirements on the type of text it can handle. It can also claim to be part of a comprehensive solution for scrolling on small screen devices (patents are pending for all parts of this). Wiping has yet be tested thoroughly using performance measures, on a real device, and in realistic mobile environment, but the design appears sound, and should stand up to these challenges. There are also possibilities for extending the design. Promising directions include refining the appearance of the visual guide in addition to indicating progress in some manner.

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