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An experiment with content distribution methods in touchscreen mobile devices

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ABSTRACT

This paper compares the usability of three different content distribution methods (scrolling, paging and internal links) in touchscreen mobile devices as means to display web documents. Usability is operationalized in terms of effectiveness, efficiency and user satisfaction. These dimensions are then measured in an experiment (N = 23) in which users are required to find words in regular-length web documents. Results suggest that scrolling is statistically better in terms of efficiency and user satisfaction. It is also found to be more effective but results were not significant. Our findings are also compared with existing literature to propose the following guideline: "try to use vertical scrolling in web pages for mobile devices instead of paging or internal links, except when the content is too large, then paging is recommended". With an ever increasing number of touchscreen web-enabled mobile devices, this new guideline can be relevant for content developers targeting the mobile web as well as institutions trying to improve the usability of their content for mobile platforms.

1. Introduction

Several aspects of the usability of interfaces have already been addressed in Personal Computers (PC) including characters, formatting, contrast and color, and dynamic text (Mills and Weldon, 1987) or line length (Dyson and Kipping, 1998). However, it is also necessary to study similar and other usability aspects in mobile devices because of the substantial differences that exist between them and PCs, especially concerning the size of the screen. Such differences may have a negative influence in the efficiency of users (Jones et al., 1999; Parush and Yuviler-Gavish, 2004). The degree of interaction is usually higher when using a small screen (Dillon et al., 1990) because of the limited amount of information that can be displayed. Therefore smaller screens require that the user scrolls more times and more often to go through all the content.

Several studies have compared different aspects of usability when performing tasks with screens of different sizes, where more or less information can be showed at a glance. Although Kim and Albers (2001) found that there was no difference between a small screen (a PDA in their study) and a larger one (PC) in terms of the number of errors made to complete a task and time taken; most studies found differences in effectiveness (Jones et al., 1999), efficiency (Lai and Wu, 2014; Parush and Yuviler-Gavish, 2004) and satisfaction (Dillon et al., 1990). Such differences evidence the necessity to study independently the interfaces of mobile devices. For instance, adaptive systems that accommodate web pages to mobile interfaces have been developed to try to improve the usability of mobile navigation (Ahmadi and Kong, 2012; Lee and Bahn, 2005).

One of the major issues concerning usability for mobile devices is the scroll. Scrolling happens when the information that has to be displayed does not fit in a single screen, "overflowing" off the screen out of immediate view (Sanchez and Wiley, 2009). This results in a serious usability problem (Nielsen, 1997) when the user is reading since it is necessary to handle the device and the information being displayed simultaneously, and this can interfere reading (Wästlund et al., 2008). The problem is aggravated when the user is in front of a small screen as she will have to go through more pages to read the same amount of text (Dillon et al., 1990).

Nowadays, with an ever increasing number of accesses to the mobile web, it is also becoming increasingly important to study the usability of web interfaces in mobile devices. Research to date has studied mobile devices with stylus, keyboards or even with

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simulated devices in computers, but today the most common mobile device is a touchscreen smartphone. The objective of this paper is to analyze the usability of methods to present information for users of web content in mobile devices with touchscreen.

The most common content distribution method is vertical scrolling. It is used for texts (Andersen, 2005), documents and web pages (Yin and Liu, 2010). This paper sets out to test whether vertical scrolling in mobile devices is more usable in webpages than other methods like paging or internal links in terms of effectiveness, efficiency and user satisfaction. Results of our study can be relevant for mobile web developers who are involved in designing interfaces, and also for companies and organizations interested in increasing the readability of their web sites and applications. We provide a new usability guideline to improve the usability of regular-length web documents displayed in touchscreen mobile devices.

The paper is structured as follows. Section 2 presents related work pointing the necessity of studying scrolling in web interfaces for touchscreen mobile devices. Section 3 presents the method and experimental design. Section 4 presents the results of experimentation. Section 5 presents discussion comparing our findings with previous studies. Finally, Section 6 outlines conclusions.

2. Related work

Scrolling in mobile devices was initially studied for the native menus of mobile devices and in simple web menus displayed in such devices. Different studies about device menus found similar results. For example, Wang et al. (2004) suggested using hierarchical menus with a maximum of two levels, which inevitably increases vertical scrolling. Similarly, Buchanan et al. (2001) found that vertical scrolling is the best method for most users. Contrastingly, results of studies dealing with web menus were mostly contradictory. For example, Geven et al. (2006) concluded that using deeper hierarchies is better than using wider menus, thus suggesting using more levels instead of having too many options per level; while Parush and Yuviler-Gavish (2004) found that limiting depth rather than width is preferable.

In order to try to mitigate the negative effects of scrolling, different hardware and software alternatives have been devised both for PC and mobile devices. Studies on hardware solutions for PC compared diverse gadgets like (1) a wheel mouse, a touchpad and a scroll ring (Wherry, 2003), or the combination of (2) a standard mouse, a wheel mouse, a mouse with an integrated joystick, and the simultaneous use of a mouse with an integrated joystick and a standard mouse (using both hands) (Zhai and Smith, 1999). Although in mobile devices it is harder to integrate and test similar solutions, Fallman et al. (2004) presented and tested a prototype with a sensor connected to a PDA. Their approach was unrealistic because the mobile device should be laid flat to operate properly. Software scrolling techniques for PC include accelerated scrolling (Hinckley et al., 2002), animated scrolling (Klein and Bederson, 2005), the combination of a rougher scrolling with one mouse and precise scrolling with another mouse (Yin and Liu, 2010) and Speed Dependent Automatic Zooming (SDAZ) (Igarashi and Hinckley, 2000). SDAZ combines scrolling and automatic zooming thus facilitating the movement of the scroll while the user is searching for information on the screen. SDAZ has also been tested in mobile devices but results were not satisfactory (Jones et al., 2005). SDAZ has even been tested in devices with a tilt sensor but users still preferred the traditional method using the stylus of the device instead of the sensor (Eslambolchilar and Murray-Smith, 2008).

Other solutions that try to mitigate the negative effects of scrolling in mobile devices include (1) different implementations of multi-flick for pointing devices (Aliakseyeu et al., 2008); (2) using a double scrollbar (horizontal and vertical); (3) grab & drag, which enables navigation in the information space by dragging the portion currently being displayed; (4) ZEN (Zoom-Enhanced Navigator), which is an adaptation for mobile maps and mobile web pages of Overview&Detail approaches (Burigat et al., 2008); (5) RSVP (Rapid Serial Visual Presentation) in which the text is displayed on the screen word by word (Hedin and Lindgren, 2007; Juola et al., 1995; Öquist and Lundin, 2007); and (6) leading, which automatically moves the text from right to left, pixel by pixel (Juola et al., 1995; Öquist and Lundin, 2007). However, all these techniques require special software in order to operate and this software is usually not readily available on consumer devices.

Scrolling has also been studied as a method to display textual information, and it is usually compared with paging. Paging consists in dividing the whole content in several chunks that fit in the screen allowing the user to navigate between them. In terms of efficiency, results on PC are contradictory since Baker (2003) found that users performed tasks more efficiently with scrolling while Dyson and Kipping (1998, p. 171) found that users did it faster using paging. In terms of comprehension of the text, results also differ significantly. Studies that concluded that scrolling provided better text comprehension (Sahin and Alsancak, 2011; Sanchez and Wiley, 2009) contrast with other findings that suggest that users had a better "sense of the text" when using paging (Piolat et al., 1997, p. 583). Positive aspects of scrolling are that it reduces manipulation (van Nimwegen et al., 1999) and user's mental workload (Wästlund et al., 2008).

Scrolling and paging have also been compared as content distribution methods in mobile devices, but there are far fewer studies in this area. Findings on opinions of users about both methods differed, since in one study scrolling was preferred (Fukaya et al., 2011), whereas in another study it was not (Costa et al., 2007). Contrasting results have also been found in terms of efficiency or reading speed because results showed that scrolling was better (Costa et al., 2007) but also that paging was better (Öquist and Lundin, 2007). Furthermore, we think that the results of these studies should be taken with care in relation to web text displayed on touchscreen devices. The study of Costa et al. (2007) was conducted with PDAs, so the interaction method was a stylus. The study of Öquist and Lundin (2007) was carried out with a device with keyboard, while Fukaya et al. (2011) studied applications that display PDF documents.

Summarizing, studies about scrolling in mobile devices compare or propose techniques that cannot be run on current devices because they are not natively supported and require installing additional software. Also, to the best of authors' knowledge, there are no works that study vertical scrolling in web pages displayed on touchscreen mobile devices, which are common today. This paper presents an experiment that compares scrolling with alternative content distribution methods (paging and internal links) that can be natively run in web pages displayed on mobile devices. Currently, there are no guidelines or recommendations concerning vertical scrolling in touchscreen mobile devices. Existing guidelines are for PC (ISO, 2008) or date back to 2008 (Rabin and McCathieNevile, 2008), when most mobile devices were not tactile. This paper then contributes to knowledge by suggesting a new guideline about content distribution in touchscreen smartphones. Next section describes the experimental design to test and compare the effectiveness, efficiency and satisfaction provided by different content distribution methods in order to determine the most usable for displaying web documents in touchscreen mobile devices.