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User-Centered Guidelines for Design of Mobile Applications

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ABSTRACT

In this study, interviews were conducted to derive user-centered guidelines for the interface design of mobile applications. These guidelines cover general design issues in input, display, navigation, and feedback. They address five out of seven elements that describe effective mobile commerce interface design proposed by Lee and Benbasat [7]. Compared to guidelines obtained in prior studies, the guidelines derived from this study are user-centered and can be apply to multiple form factors. The comparison between e-commerce and mobile commerce design guidelines suggest that the mobile context plays the most important role in designing mobile commerce interfaces.

Keywords: mobile commerce, design guidelines, usability, human-computer interaction

1. INTRODUCTION

The convergence of mobile Internet and wireless communication technology has promised users anytime, anywhere access to information for work and personal communications. However, many technology constraints such as small screen size hinder such access through a mobile device. In order to provide truly ubiquitous access to information, design guidelines addressing potential usability problems on mobile devices are essential.

Usability studies on mobile applications have focused on addressing the interface design constraints imposed by a bandwidth limitation and small screen size of handheld devices. Along this line, researchers have proposed several design guidelines for Wireless Application Protocol (WAP) phone applications. Ramsay and Nielsen [8] suggested that many WAP usability problems echoed problems identified during the early stages of Web site development for desktop computers, and could be alleviated by applying good user interface design. Such design guidelines for WAP applications may include: (1) short links, (2) backward navigation on every card, (3) a minimal level of menu hierarchy, and (4) headlines for each card [5]. Similar design guidelines, validated in a separate usability study of WAP phones [2], include: (1) direct, simple access to focused valuable content, (2) simple hierarchies, (3) reducing the amount of vertical scrolling, and (4) reducing the number of keystrokes. These studies focused solely on WAP phones.

Diverse form factors offer different functionalities and have separate interface requirements. Chan et al. [4] systematically reviewed 10 wireless Web sites – ranging from travel, financial services, retail, news, and Internet portals – across three form factors: wireless Palm, WAP phones, and Pocket PCs. They found that user tasks for the wireless sites were designed with steps similar to the wired e-commerce sites and geared primarily for experienced users. Many usability problems, such as long downloads and broken connections, information overload, and excessive horizontal and vertical scrolling, are common to all three form factors. Based on this study, interface design flaws are platform independent, but the more limitations are imposed on the form factors, the more acute the design problems become. These researchers recommend eight guidelines: (1) avoid scrolling, (2) use a flat hierarchy, (3) design a navigation system consistent with a regular Web browser, (4) include a back button, (5) provide a history list, (6) provide indication of signal strength, (7) reduce user's memory load, and (8) limit the search scope to improve search efficiency. Furthermore, Chan and Fang [3] indicated that limited bandwidth and multiple form factors posed constraints for user interface design in terms of the amount and format of content presentation, navigation, and site structure.

Lee and Benbasat [7] proposed a reference framework for designing m-commerce interfaces. This framework consists of seven design elements: context, content, community, customization, communication, connection, and commerce. Venkatech, Ramesh, and Massey [10] assessed usability guidelines for Web and wireless sites and found that ease of use was significantly more important in wireless contexts. Tarasewich [9] has also suggested that context plays an important role in the design of mobile commerce applications. Furthermore, design guidelines and usability methods that work with wired systems do not necessarily work with mobile systems.

However, the design guidelines developed so far have two major shortcomings: 1) Some guidelines may be only applicable to WAP applications; and 2) Some guidelines were derived from expert opinions without real user input. In order to develop user driven design guidelines that are applicable to a broad range of form factors, a study was undertaken as discussed below. In this study, participants were asked to use one of three

types of handheld devices: WAP phone, Palm Pilot, and Pocket PC. Their experience and opinions were elicited through interviews.

2. METHOD

A wireless web site that provided the function of making an advising appointment was developed on three platforms: Palm, WAP phone and Pocket PC. Similar to the regular web site of School of Computer Science, Telecommunications and Information Systems at DePaul University, these wireless versions of a desktop application allow students to make advising appointments with faculty members. Fig. 1 shows sample screen shots of this Web site on the three platforms. Thirty-seven students from DePaul University participated in the experiment. A pre-experiment questionnaire was used to collect background information on the participants. Questions were asked regarding their familiarity with the functionality of the regular web site and their experience with WAP phone, Pocket PC, Palm, and other wireless devices. Among these participants, some had used handheld devices before, while others had not. Most of them had used the advising appointment application on the regular web site before the experiment.

Fig. 1. Sample screens of the experiment Web sites

Nineteen participants were assigned to perform tasks on Palm, nine participants on WAP phone, and nine participants on Pocket PC. Participants were asked to make appointments with their faculty advisors using the handheld device. While the participant was performing the task, the experimenter sat aside, observed the participant's performance, and took notes about any unusual events such as mistakes, comments, and complaints. Each participant's online activities were also recorded into a log file by a server-side program. Upon completion of the task, each participant answered questions during an exit interview as to what they liked or disliked about using the handheld device and about the appointment application.

During the interview, if the participant used any ambiguous terms, follow-up questions were asked for clarification. Each interview took about 45 minutes. All interviews were tape-recorded and transcribed. Based on the transcribed comments, we distilled findings that were independent of the advising application through the follow process:

- Useful comments were extracted from the transcripts and rephrased to reflect similar comments based on authors' professional judgment.
- Each new comment was assigned a unique number and marked with its recurring frequency in the participant's commentary.
- A list of comments for each participant was created.
- Another list was constructed to combine comments from all the participants. Similar or identical comments were consolidated and listed as one.
- Comments were further summarized into categories.

From these findings, we derived user-centered design guidelines as discussed below.

3. USER-CENTERED DESIGN GUIDELINES

Table 1 presents 18 most important design guidelines derived from this study. These design guidelines address users' concerns from the following four aspects of a mobile application: input, display, navigation, and feedback. Because these design guidelines reflect users' response to mobile applications, the findings could be extremely valuable to developers of mobile applications.

The reference framework for mobile commerce interfaces proposed by Lee and Benbasat [7] was used to analyze these design guidelines. As shown in Table 1, the design guidelines from our study address five of the seven design elements for mobile commerce interface design: context, content, customization, communication, and commerce.

Context captures how Web sites are developed, consisting of functionality and aesthetics [7]. Design guidelines concerning navigation of a wireless Web site address this element. Given the mobile setting, navigation functions must be designed to accommodate the context.

Content focuses on what a site presents, comprising the offering, appeal, multimedia mix, and content type [7]. This study indicates that large amount of graphics is not suitable due to the small screen of handheld devices and security information must be presented.

Customization refers to a site's ability to tailor itself or to be tailored by users [7]. Customization reduces information load by filtering unnecessary information. This is consistent with the results from this study. One of the guidelines states that short and concise information display is preferred.

Table 1. User-centered design guidelines for mobile applications

Category	Design Guidelines	Interface Design Elements
Input	• Input on handheld devices must be minimized • Graffitti is preferred by users. It is faster but less accurate compared to soft keyboard.	Communication
Display	• Short and concise displays are preferred on handheld devices. A large amount of graphic and audio/video information is not suitable for handheld devices.	Content / Customization
	• Features indicating security protection must be prominent on handheld devices.	Content / Commerce
	• Products that do not have to be graphically represented such as books and audio CDs are more suitable for online shopping on handheld devices.	Commerce
	• Widely-accepted short names are appropriate for the items in a drop-down menu.	Content
Navigation	• Wireless Web sites must be consistent with regular Web sites. • Exit from an application on handheld devices must be visible. • A hierarchical information structure is helpful and preferred. • A history list is important in the navigation process. • Buttons and menus must be presented on the top of a Web page on handheld devices. • Icons with descriptive and accurate labels are preferred. • Hyperlinks and buttons must be prominent. • Scrolling should be avoided if possible. If scrolling cannot be avoided, use "page-up" and "page-down" type scrolling. • Buttons must be clearly separated from each other. • Access to action buttons in a form should not be obscured by scrolling. • Scrolling in a drop-down menu must be avoided. Items in a drop-down menu should be sorted.	Context
Feedback	• For successful submissions or tasks involving multiple steps (pages), confirmation is necessary.	Communication

Communication is defined as dialogue between sites and users: broadcast, interactive, and hybrid [7]. The design guidelines from our study indicate that during the interaction between sites and users, information input on handheld devices must be minimized and feedback must be provided.

Commerce is concerned with interfaces related to sales of goods and product services [7]. It was found in our study that features indicating security protection must be prominent. It was also found that the so called "low touch" products like books or audio CDs do not require graphic display and are more suitable for online shopping using handheld devices.

Some of the most important findings are further discussed in the following sections.

3.1 Text entry

Text entry on the handheld devices is inconvenient due to lack of efficient input methods. About 90% of the participants brought up this issue. The findings of our study suggest:

- Text entry or typing must be minimized. Users don't like to enter long texts regardless of the input methods: graffiti, soft keyboard, or keypad. No matter which input method is used, it usually takes significantly more effort to type texts on handheld devices than on regular PCs.
- Graffiti is preferred by experienced users because it is faster than soft keyboard. However, it takes users more time to learn graffiti and graffiti is usually less accurate than soft keyboard. Novice users prefer soft keyboard.

3.2 Information display

Information overloading and over-crowded screens are the problems most commonly shared by regular Web applications and mobile applications. However, these problems become more severe for mobile applications because of two factors: the small screen size of handheld devices and the user's mobility. Our study has identified the following unique requirements:

- Short and concise output is preferred. To minimize excessive amount of text information, widely-accepted short names can be used in the display.
- In general, users like graphical icons and buttons but a large amount of graphical and audio/video information is not suitable for handheld devices.
- Scrolling should be avoided if possible. Scrolling is significantly more difficult on handheld devices than on PC computers. Horizontal scrolling is more confusing than vertical scrolling.

- Action buttons or links such as “Submit” and “Search” should not be separated from the input text boxes. Due to the small screen, users are often confused by the separation when trying to figure out how to submit the form.
- Products that do not require graphic display such as books and CDs are more suitable for online shopping on handheld devices. For this type of products, users are not concerned about the graphical details, which cannot be displayed clearly on handheld devices.

3.3 Security

Security has been a major concern in e-commerce. It becomes an even more sensitive issue for mobile applications due to doubts about the security and reliability of wireless connections. About 40% of the participants of this study expressed their concern regarding security with mobile applications. They frequently mentioned that they were not willing to commit online transactions on a handheld device because they worried about the security and reliability of the wireless connection. For mobile applications that involve any online transaction, security assurance is important.

3.3 Tasks

Tasks that can be performed on handheld devices are different from what can be executed on PC computers. As suggested by Anckar and D’Incau [1], mobile applications must address the following five most common mobile values: (1) time-critical needs and arrangement; (2) spontaneous needs and decisions, such as auction, email, and news; (3) entertainment needs; (4) efficiency needs and ambitions; and (5) mobility related needs. In a separate study, Xu, Fang, Chan, and Brzezinski [11] identified five factors contributing to user’s preference of tasks to be performed on handheld devices: perceived usefulness, perceived ease of use, perceived playfulness, complexity, and perceived security. The following users’ responses are consistent with these two studies:

- Users would like to perform tasks that will meet their mobile needs such as sending/receiving emails, and checking flight status.
- Users would like to see an easy and friendly user interface with considerations of all the constraints imposed by handheld devices and mobility.
- Users would like to use handheld devices to entertain themselves in their free time.
- Users would like to perform simple tasks.
- Users are concerned about the security of online transactions.

4. DISCUSSION

Usability for regular e-commerce Web sites has received a lot of attention in both academia and industry. In this section, we will compare design guidelines for e-commerce and mobile commerce and discuss what is most important to mobile commerce users.

Fang and Salvendy [6] conducted a series of interviews to derive customer-driven rules for the design of e-commerce Web sites. Their study captured a broad range of e-commerce Web sites and tasks, and developed the following design guidelines:

- Web page should be clean and not cluttered with text and graphics.
- The width of a page should be less than the width of the browser window to avoid horizontal scrolling.
- Text on the links or buttons should be self -explained and descriptive.
- When linking to another product related Web site, link to the exact product page instead of the homepage of that site.
- Categorize products in a way that is meaningful to regular customers.
- The depth of the categories should be no more than 3.
- Present accurate, consistent, and detailed descriptions of products.
- Provide accurate and full pictures of products.
- Present the size of products in a measurable and comparable way.
- Present the inventory information of a product in the beginning.
- Present products in a table with enough information to make a purchasing decision such as prices and features for easy comparison.
- Present related charges up front and in an accurate way.
- Same products should be presented in the same page, same position.
- Products shouldn’t be removed from the page because of out-of-stock.
- In the shopping cart page, provide a link that directs the customer back to the page he/she left for continuing the shopping.
- Only ask for necessary and meaning information such as name and address. No marketing questions.
- Allow customers to browse the site without logging in.
- Provide a 1-800 number for customers to call.
- Clearly state the return policy in a prominent place.

A comparison between design guidelines for e-commerce sites and mobile commerce sites reveals the following:

- Both e-commerce and mobile commerce sites share some common design guidelines such as avoiding horizontal scrolling and labeling buttons and links clearly.

- Most e-commerce design guidelines are concerned with offering specific and accurate information.
- Most mobile commerce design guidelines are concerned with design constraints imposed by mobile context such as device limitations and user's mobility. Mobile users can only input and view very limited amount of information on handheld devices under mobile conditions. Design of mobile applications must satisfy user's needs and desires.

Findings from the current study are consistent with prior research findings. Mobile context was identified as the most important factor in designing mobile commerce interfaces in two separate studies [9] [10]..

5. CONCLUSIONS

In this study, user-centered guidelines for design of mobile applications were developed. These guidelines cover general design issues for input, display, navigation, and feedback. They address five out of seven elements for effective mobile commerce interface design proposed by Lee and Benbasat [7]. Compared to guidelines derived from prior studies, these guidelines are user-centered and can be apply to multiple form factors. The comparison between e-commerce and mobile commerce design guidelines suggest that mobile context plays the most important role in designing mobile commerce interfaces. However, more studies are needed in the future to address the technical constraints imposed on interface design for mobile devices.

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