Analyzing Mobile Internet Users:

Results from a monitoring study, an experiment, and a survey study

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1. Introduction

Recently, the use of cellular phones and Internet has been spread at an astonishing speed than any other information technologies and the high popularity of these two technologies lead up to sharp interests on mobile Internet. *Mobile Internet* is the usage of Internet via handheld devices such as cellular phones and PDAs.

In order to explore the characteristics of mobile Internet and their implications in human computer interaction, we conducted three related studies: a monitoring study, an experimental study, and a survey study. The monitoring study was conducted to identify general contexts and usability problems that are frequently occurring with mobile Internet, and to explore the relationship between specific mobile contexts and their corresponding usability problems. The experimental study was conducted to identify the causal relations between different contexts and work performance in mobile Internet. Finally, the survey study was conducted to provide guidelines on the design of applications for mobile Internet.

2. A Monitoring Study

Methods: To collect the rich information of mobile contexts without disturbing user s natural use context, we conducted our monitoring study with two complementary data collection methods: a simple pocket diary for a mnemonic aid and a web-based diary for in-depth description of final dataset. Participants were asked to report their use contexts, and usability problems they faced in those contexts by answering to questions formatted in the monitoring diary. Monitoring diary is composed of two parts: specific context questions based on mobile use context, and usability problem in that context. The degree of each construct was measured based on 7-point scale, 0 through 6, for example, undistracted(0) through very distracted(6) in auditory distraction. Part of the usability problem was reported as open-ended. We coded those open-ended usability problems, which participants reported, by using the ten heuristics shown in Table 1 below. In total 36 mobile Internet users participated in our monitoring study for 17days and their profiles were evenly distributed in terms of gender, age, and past experience of mobile Internet.

*Results***:** A preliminary analysis reveals that mobile Internet users are, indeed, involved in widely varying use contexts. Moreover, each characteristic of contexts, such as the time, place, and degree of social interaction and auditory distraction, varies according to changing use situations. As for the usability of mobile Internet, the monitoring study results show that a different context provokes different usability problems. For example, Table 1 below presents the results of frequency of usability problems in two different contexts, indoor and outdoor situation, indicating that occurrence of mobile usability problems is significantly different between indoor and outdoor context (χ^2=18.85, p< .05). This result of chi-square test means that occurrence of usability problem is affected by the change of context. As shown in Table 1, participants in indoor settings, seem to have simple and natural dialog (U1) problem (24.2% of N=347) mostly, while participants in outdoor settings, seem to undergo speak users language (U2) problem most seriously (21.6% of N=190). Consequently, participants seem to have more

difficulty in using mobile Internet indoors in terms of U1, U6, U7, U8 and U10, while outdoors participants in U2, U3, U4, U6, U7, U8 and U9.

	U1*	U2*	U3*	U4*	U5*	U6*	U7*	U8*	U9*	U10	Total
Indoor (%)	24.2	14.2	5.2	10.4	6.6	10.1	18.4	7.2	0.9	2.9	100%
Outdoor (%)	19.5	21.6	7.9	12.6	7.4	7.9	17.4	1.1	2.1	2.6	100%

*U1: Simple and natural dialog	*U6: User control and freedom
*U2: Speak the user s language	*U7: Flexibility and efficiency of use
*U3: Minimize user memory load	*U8: Good error message
*U4: Consistency	*U9: Prevent errors
*U5: Visibility of system status	*U10: Help and Documentation

Table 1. Frequency of Usability problems [χ^2 (9, N=537)=18.85, p<. 05]

3. An Experimental Study

Methods: In order to identify the causal relations between the contexts and user performance in mobile Internet, a controlled experiment was conducted in the laboratory setting. Two types of independent variables were manipulated; the tasks and contexts. In terms of contexts, movements and visual distractions were manipulated. In terms of movements, some subjects were asked to walk on running machines while others were asked to stand still. In terms of visual distractions, some subjects were asked, in addition to the main task, to watch the monitor in front of them and press buttons whenever they saw something on the monitor, while others were asked to do the main task only. Tasks were manipulated in two dimensions; the depth and breadth of the target items in the given structure. In terms of the depth level, some subjects were asked to find an item that was located deep in the hierarchy, while others were asked to find an item that were located at the shallow level. In terms of the breadth level, some were asked to find an item within a long list of alternatives, while others were asked to find an item within a short list of alternatives. In total, one hundred twenty people participated in the experiment, and their profiles were evenly distributed in terms of gender and age.

Data analysis: All subjects were randomly allocated into one of the four context groups in which they were given the same type of cellular phones (Motorola, V Dot) and asked to do eight tasks in sequence. During the entire experiment session, they were asked to think aloud, and their verbal and action protocols were recoded by video cameras. We are in the process of transcribing all verbal and action protocols that will be verified based on the system log files provided from a telecommunication company. We expect preliminary results of the experiment will be available the time of the CHI conference.

4. A Survey Study

Methods: A large-scale survey was conducted in order to identify implications such as which applications the customers want to use and how much they are willing to pay for the applications. Survey questionnaires were designed in order to investigate the impact of the system characteristics of mobile Internet on the service applications by comparing between the mobile and stationary Internet. The survey questionnaire consisted of three categories: general demographics, mobile Internet usages, and stationary Internet usages. The general demographic questions asked basic information of respondents, such as age, gender, educational backgrounds, and the cellular phone number the respondent was using currently. Questionnaires for mobile and stationary Internet usages were to compare these two Internet systems in terms of the overall importance of the three application domains (contents, community, and commerce). We asked respondents to distribute 10 points to the three application domains as the weight of importance both for the mobile and stationary Internet. The questions were intended to identify what kind of services customers prefer and how much they are willing to pay for the services. Respondents were asked to indicate services they preferred to use through mobile and stationary Internet, and then asked how much extra fee they are willing to pay for using the services through the stationary and mobile internet.

The Mobile Internet Consortium was organized in order to gather basic usage data of Mobile Internet.

Sixteen companies participated in the Consortium, including most of major mobile telecommunication carriers and Internet portals. In May 2000, we administered the on-line survey for two weeks. We built a web-based survey site [www.mbiz.or.kr], and the banner of survey site was advertised to the sixteen websites of the companies in the Consortium. In two weeks, we received 19,052 responses in total. All the respondents were verified with the cooperation of mobile telecommunication carriers to check whether they actually owned Internet-enabled phones and had used mobile Internet at least once before the survey. Also, those respondents who failed to answer more than two questions were excluded from the final data set. Consequently, 6,873 respondents were dropped out of 19,052 and the rest 12,129 were retained for further analysis.

Results: As shown in [Figure 1], respondents seemed to place more weight on the stationary Internet in terms of the communication (t =-7.5916, p<0.01) and contents (t = -9.3011, p<0.01) domains, while more weight was given to the mobile Internet in the commerce domain (t = 21.05, p<0.01). Therefore, people prefer stationary Internet for the communication and contents applications, but mobile Internet is more preferred for the commerce application.
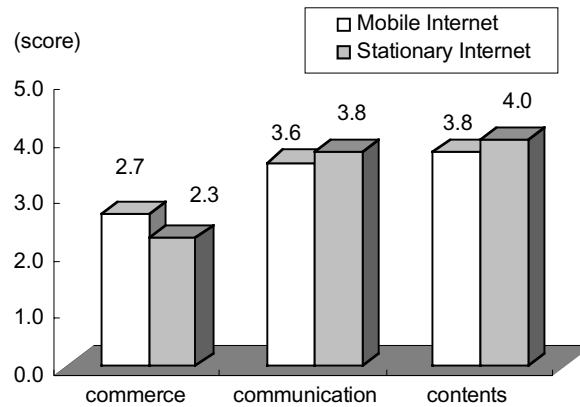
5. Conclusions

The three related studies have been conducted to explore the characteristics of mobile Internet and their implications on Human Computer Interaction. Further studies are in process in order to provide more concrete implications in the mobile Internet domains, such as developing interface style guidelines and application development methodologies for mobile Internet

Biography of Jinwoo Kim

1993: Ph.D. in Information Systems at Carnegie Mellon University.
1994 —presents: Head of Human Computer Interaction Lab at Yonsei University, Seoul, Korea.
2000 —presents: Head of Mobile Internet Consortium at Seoul, Korea.
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