Usability Issues in Information Systems for Mobile Devices

Jeongyun Heo[1], Wan C Yoon[2]
Department of Industrial Engineering, KAIST[1 2]
Gusong-Dong, Yuseong-gu, Daejeon, 305-701, South Korea

ABSTRACT

Increasing in popularity around the world, the versatile mobile phone continuously finds new application domains. Initially a voice communication device, it has evolved into a multi-purpose information appliance. Usages of mobile phones have recently expanded to business information systems such as stock trading systems, banking systems, and M-commerce systems including the general services such as Short Message Service (SMS), personal information management, and mobile-internet browsing. Despite their technical innovation, many of mobile information systems are still difficult to use. Such poor usability comes not only from the complexity of the task, but also from the restrictions of the mobile device such as small screen size, limited means of input, and dynamic use context.

Screen size limitation is caused not only by technology deficiency, but also by the user's need for a small size device for mobility. A small size screen could cause a page split which could be implemented in a single page in an ordinary desktop screen, so the user should navigate between pages to accomplish a task which could have been done without navigation. As explained above, the limited size of the screen will certainly alter the user's behavior compared with a large screen environment, and usability problems like disorientation and cognitive overload may arise.

This research focuses on the effect of small screen size on the mobile information system usability. Although there has been research on the small screen, most is focused on space enlargement or readability and comprehension problems; therefore, those results do not give sufficient information to influence the design of less complex and more interactive mobile information systems. This paper discusses the key user interface issues of the small screen and proposes a design approach to overcome the page split problem. **KEY WORDS:** Usability, Mobile Information Systems, Small Screen, Bi-Directional Design Process. Mobile Device, HCI

1. Introduction

With the dramatic growth of mobile usages and technological innovation, mobile services have now expanded to business information systems such as stock trading systems, online banking systems, and M-commerce systems including mobile-internet browsing; however, not all of them have gained wide acceptance. Often users consider them too difficult and too complicated to use. The following quotation accurately reflects the dissatisfaction of the online banking service via WAP:

> We have provided online banking via WAP to our customers since early this year. [...] You go down, down, down all these menus, and you wait, wait, wait each time. You're straining to read text on this tiny screen on the phone. Eventually, people just give up.
> From the WAP, Europe's Wireless Dud?, Washington Post (Sept. 15, 2000)

Not only because of the complexity of the banking operation, but also because of significant design limitations such as small screen size, limited means of input, and slow network access time, it is very difficult to design a usable Information Systems user interface for a small screen device.

This research focuses on the effect of small screen size on the mobile information system usability. It seems obvious that a small screen cause some degradation in usability. For example, a small screen could cause the page split which could be displayed as a single page view in an ordinary desktop screen; therefore, the user should navigate between pages to accomplish a task, causing disorientation and cognitive overload. It is obvious that the limited size of the screen will certainly alter the user's behavior compared with a large screen environment.

2. Screen Size: the Limiting Factor of Mobile Devices

The screen size of Mobile Devices is much smaller than those of desktop computers. Screen size limitation is not only caused by technology deficiency, but also by the user need for small size device for mobility. Up-to-date mobile devices have approximately 120*160 pixels whereas a computer desktop display usually has 1024*768 pixels. In other words, the display space of the mobile device is only 2% of the desktop computer. This tremendous shrinkage makes it hard to design a usable interface for mobile devices.

Much work has been put into the effort to overcome such limiting factors. Pad++, Powerview, and DateLens represent research focused on enlarging the screen space using zooming approach like fisheye view(Bederson, et al 1994, Bederson, et al 2003, Björk, et al 2000) Kamba(1996) suggested a transparent widget which could save screen space. Another approach is the RSVP browser which gives user a riffling by displaying the information serially as if the user could riffle the book. By utilizing trade-offs between space and time, users are given an enlarged display(de Bruijn, O. & Spence, R., 2000). All these methods suggest several improvements when compared with simple scrolling of paging of long list display. However it is surprising that there has been little attempt to directly address the design factors that could explain the effect of a task split. Followings are design issues caused by task split.

1. Disorientation

Limited screen size splits information into several separate views that could be presented in single view with a larger display. For example, to book a bus ticket in a desktop environment, a user need to explore 8 windows (http://www.kobus.com); however, this task expands to 18 windows in a mobile environment. Thus, users navigate between more pages to access the same amount of information in a larger display. This expanded number of windows may cause disorientation

2. Mental Model

The user's knowledge of a computer application is often described as a mental model. To easily navigate between several pages, user requires a mental model of the site's structure. Consistency in your user interface allows your users to build an accurate mental model. However, the amplified complexity with increased number of windows may cause inconsistencies, so it is even more important to provide a clearly organized meaningful structure.

3. User in Control

An effective interface puts the user in control of the system, or at least, lets them feel like they are in control. To perform a task with a several displays, users may be forced to follow a sequential procedure. Users with a reduced degree of freedom may not feel like they are in control. So it is important to provide alternative operation procedures like go back, skip, and quit. In addition, consideration of the “locus of attention” is also important. Zimmerman showed that the redesign of the task procedure decreased the total withdrawing time and reduced instances of lost cash cards when using ATM machines. This study shows the importance of the design of task procedure with the small display.

Task split caused by screen size constraints affects the user’s interaction with the system (or user behavior). To solve the above problems, a more global approach should be needed. Only carefully designed interaction could solve the problems intrinsically.

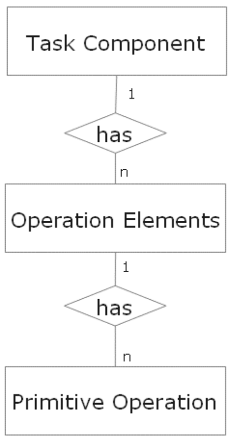
3. Bi-Directional Design Process Reflecting Interface Constraints.

A typical design procedure following the top-down approach starts from the analysis of users’ task, and ends with a physical design of interface. Some researchers suggest that a bi-directional and opportunistic approach may be more practical.(Guindon, 1992, Visser, 1996, Yoon, 2001) Yoon classified the design knowledge of systems as abstracted levels composed of task, operation, and physical interface levels and defined the “design process” as devising a mapping between the given design elements in the upper and lower levels. (Yoon, 2001) As a result, the design of interaction methods tends to be affected by both the given tasks and the available interface elements.

Abstraction Level	Relevant Design Knowledge
Task Level	Task Tree, Task Flow, Task Similarity
Operation Level	Operation/Control Sequence & Availability, Procedural Similarity, Operation's Property
Physical Interface Level	Grouping, Object Shape/Layout, Shared/Common Objects

Table1. Three abstraction levels with relevant design knowledge

Given the constraint of screen size limitation, the designer should devise an appropriate operation sequence fit for limited physical interface level. While applying the interface constraints, display unit size, interaction between the windows, and the layout is decided. In the end, all user interface designs have to generate a selection of interface elements. However ad hoc and diverse mapping may cause severe usability problems as described in previous section. To reflect interface constraints into the bi-directional mapping systematically, this paper proposes new abstract concepts to support this mapping.



Task level	Description
Task Components	- A group of element which performs with a goal - Minimum task unit which forms service procedure with a specific goals like search, log-in, and editing
Operation Elements	- Unit operation elements
Primitive operation	- Physical operations like button click. - Operation without a goal - Subject to system hardware.

Figure 1. Hierarchy of proposed concepts

Table 2. Description of proposed concepts

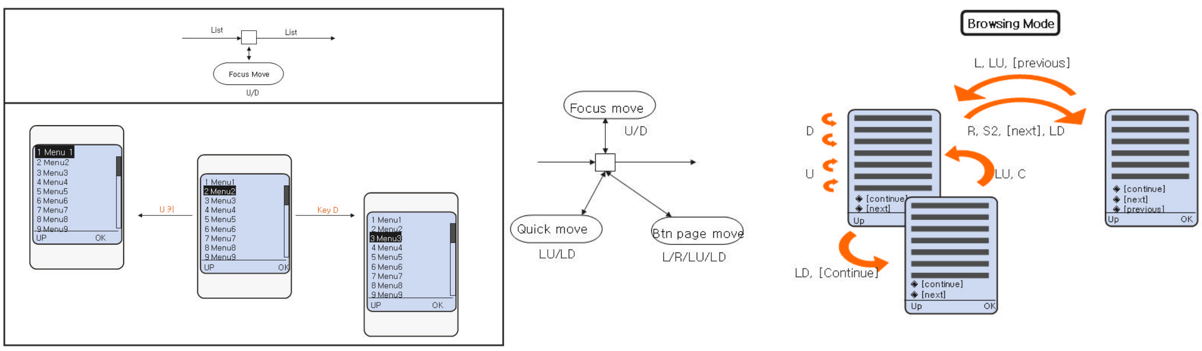
There is a hierarchy of patterns on the task side, where tasks can be broken down into a set of unit tasks, where each unit task has a specific characteristic. This unit task is defined as a task component which forms a service procedure with specific goals like search, log-in, and editing. There exist common and repeating operations. These operations are defined as operation element which constructs task component. Primitive operation is a physical operation like a button click and is subjected to system hardware. Each task level elements is represented using OCD, a modeling tool to represent the interaction between a user and an interface (Yoon et al. 1996). Figure 3 shows the description of operation elements elicited from WAP domain.

When users make use of a service, users experience a serial of operation which is composed of task components. So under the guarantee of the consistency in task component, it is likely to support the mental model construction resulting easy-to-use.

Operation Element	Description
Select list	Select item among the item list.
Page conversion	Switching between pages when information exceeds one page.
Scroll	Upward and downward movement within page or within list.
Focus move	Focus move within page, between pages, and between documents.
Confirm	Confirm of user's decision making such as option selection, submit data, and send mail.
Up	Moves to upper category.
Back	Go back to previous window.
Editing text field	Input, deleting, and modifying the text.

Table 3. Description of operation elements elicited from WAP domain.

Figure 2 shows that mapping between the task component using the operation elements and display design. Operation element is carefully mapped into primitive operation reflecting device interface constraints. So, mapping between task level and interface level using the three task level elements could be easily converted to interface design.



(a) (b)

Figure 2. Task component composed of operation element is mapped into display design;
(a) Operation element- Focus move (b) Task component- Browsing

4. Conclusions

In this paper, a design approach reflecting interface constraints is suggested. Though this research focuses on the effect of small screen size on the mobile information system usability, with the set of operation elements and primitive operation reflects the system constraints, this approach could be successfully adopted in multi-platform environment. Further refinement of the suggesting concept could support the bi-directional design process more effectively.

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