PWIG - Interactive Paradigm of Direct Touch Interaction

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Abstract. The direct touch interaction is considered as an important part of natural human-computer interaction and has become one of the hotspots in recent years. However, current touch interactive designs still rely on traditional WIMP paradigm seriously. To prompt and develop a dedicated user interface for direct touch interaction, in this paper, we explore the interactive features of the touch user interface through statistical analysis method. We classify and summary on the components of user interface from three current mainstream mobile platforms, further abstract the components for touch operation paradigm and finally propose an interactive paradigm based on the Post-WIMP environment: PWIG (Page/Frame, Widget, Icon/Button and Gesture) paradigm. After the evaluation of PWIG paradigm, we think PWIG paradigm is more suitable for direct touch interaction and should guide the design of the natural user interface for direct touch systems.

Introduction

"User Free" [1] is the goal of current HCI researches. The studies on Natural User Interfaces (NUIs) are pursued by numerous human-computer interaction researchers. The return to maore natural, more efficient and more intelligent is the direction of development. Through natural human-computer interaction, the user can use speech, action and other natural expressions to achieve with computer equipment seamless interaction. It can obviously reduce the interaction difficulties and improve the interaction efficiency [2, 3].

In NUIs, people use the natural interaction skills formed by daily communication in the world to access the services provided by computer is more in line with human cognitive law. It can be said that in the traditional graphical user interface, people through the continuous adaptation of computers to improve the efficiency of interaction and for the next generation of the natural human-computer interaction interface, the design of a computer system should be more suitable for human requirements.

Direct touch technology [4], especially the multi-touch technology, breaks the mouse single operation deadlock and allows hands-free interaction as possible. Multi-touch technique supports multi-point input simultaneously, which makes it possible for many people to work together. Touching gesture interaction is treated as a more natural and compelling human-machine interaction way, which accords with the cognitive of users and enhances the interaction of naturalness, becomes a hotspot for many researchers.

Although the multi-touch research shows great prospects, there are few studies of touch technology on the general design and implementation of user interface. Users lack of the guidance of cognitive theory and method to the touch technology. There is no dedicated user interface designed for direct touch systems so far. Current direct touch systems mainly use Graphical User Interfaces (GUI) which base on the desktop metaphor and use WIMP (Window, Icon, Menu, Pointing Device) paradigm.

Apparently, WIMP is not perfectly suited for direct touch interaction. Firstly, mouse click is a main computer operation approaches in GUI paradigm. However, the mouse operation is a one-handed operation and is an artificial distortion of people's natural gesture. The frequent interactive actions such as menu selection, button selection and keyboard input is not accord with human nature interaction habits. For unskilled users, current operational interface layout is discrete,

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complex and with a heavy cognitive burden. The utilization rate is very low. And, secondly, the point accuracy of the finger is far below the accuracy of the mouse. The occlusion of the finger greatly influences the touch accuracy.

In this study, we explore the interactive features of the touch user interface and propose a kind of natural and efficient touch interaction paradigm - PWIG paradigm, which is as far as possible the use of people's natural habit, to alleviate the cognitive burden and improve operational efficiency.

Related Work

Alan Kay's first setup of the mouse and keyboard to (doing) and icons (image) in the object-oriented programming environment Smalltalk (abstract reasoning) presented in the computer Xerox Alto. And the graphical user interface as we recognize today, was framed. Short later, Merzouga Wilberts, framed these ideas within the concept of WIMP (Window, Icons, Menus and Pointers) that became the default within GUI.

Since 1990s, researchers have been focused on the next generation of user interface research. Green and Jacob [5] first proposed a Non-WIMP interface. They summarized four Non-WIMP interaction styles: Virtual Reality, Embedded Interfaces, Notebook and Hypermedia. Non-WIMP interface does not use a desktop metaphor, completely abandon the traditional WIMP interface.

In 1997, Van Dam [6] discussed a Post-WIMP interface. He thought that a post-WIMP interface is one containing at least one interaction technique instead of depending on classical 2D widgets such as menus and icons. Ultimately, it would involve all senses in parallel, natural language communication and multiple users. From the research content, Non-WIMP and Post-WIMP interface are targeted to those with conventional WIMP interaction in different ways in the new interface and interactive mode research. However, the Post-WIMP interface does not completely resign the WIMP interaction mode. From the perspective of the development of the current user interface, the Non-WIMP interface is to become the mainstream user interface still has a long way to go. The studies will become a hotspot in the field of human-computer interaction in quite a long period of time. For pen-based user interface, Tian et al. [7] proposed a pen-based interaction paradigm based on the environment of Post-WIMP: the PIBG paradigm. PBIG paradigm was based on Pen-Paper metaphor, which was analogous to the user's real working environment. Compared with WIMP paradigm, the information presentation style and interaction style changed. Widget containing application information was changed from Window to Paper and Frame, and user's action changed from mouse pointing to pen gesture. PIBG paradigm by simulating the daily paper and pen environment, using the original user knowledge, could significantly reduce the user cognitive burden and improve operational efficiency, and also the perfect oriental culture inheritance.

For touch interactive environment, many researchers have done a lot of work on touch gestures and interface design [8-12]. In 1983, Nakatani [13] proposed the soft machines, which implemented the display of "soft controls" to make soft controls operable like conventional hard controls by using the synergistic combination of real-time computer graphics and a touch screen. A series of self-help service products, such as the automatic vending machines and ATM machines, are all based on the idea of "soft machines". In 2005， Han [14] proposed a FTIR-based low-cost multi-touch equipment, which had greatly reduced the research cost of multi-touch technology. The development of Microsoft Surface in desktop computing and multi-touch technology in the field of mobile computing has been successfully commercialized, touching gesture interaction as a natural and novel interaction way that attracts increasingly attention.

In a summary, our survey of the existing work suggests that very limited work has been conducted to investigate the paradigm of direct touch systems. It is valuable to study the fundamental paradigm of touch UI so as to further understand and boost the development of direct touch technique.

A Case Study on UI Design for Paradigm

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To explore the paradigm for direct touch technology, we concentrate our work into the current two mainstream operating systems (i.e., Apple iOS 4.3 or up, Google Android 2.3 or up) which support direct touch interaction well. We believe these two commercial operating systems have been developed for many years and have been accepted by thousand million people. Thus, the UI design, UI components and manipulation style in these systems are the most important references for our studies in interactive paradigm.

Beside the two systems, we also choose a classical commercial operating system, Windows Mobile Phone 6.5, as a contrast system. We totally choose ten popular applications from the integrated applications of the operating system and the common applications. Six applications come with operating system and other 4 applications are picked up from common software.

For each application, we count the number of each UI component and further calculate the usage rate of such component in the main screen and function pages of ten applications.

Figure 1d shows the total usage rate of each interface components used in ten applications and Figure 1a, 1b and 1c show the usage rates in three platforms respectively.

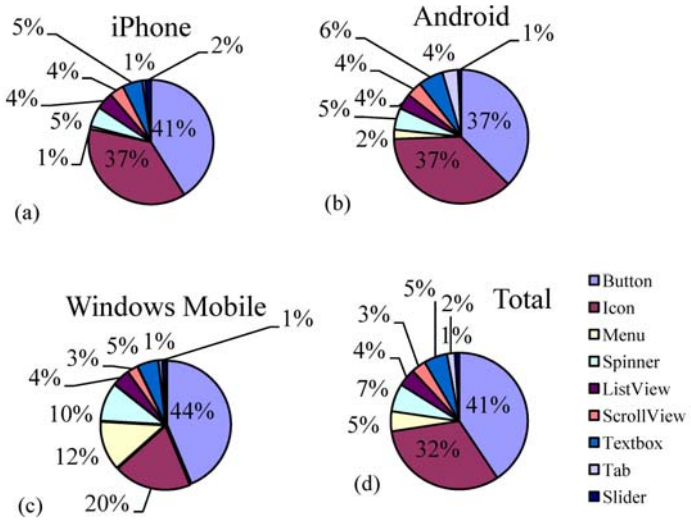

Figure 1: The usage frequency of interface components in the three platforms

According to the statistics, we can see that the TOP 4 usage rate components are the same in IPhone and Android platforms, and Button and Icon are still the components whose usage frequency are higher in Windows Mobile system, but menu as the typical interface components of WIMP paradigm in Windows Mobile applications also has a higher frequency of use (13%), the menu in the iPhone and Android platforms in the applications use accounted for only 1% and 2% of the ratio.

PWIG paradigm.

We propose a touch interaction paradigm based on the Post-WIMP environment: PWIG paradigm - Page/Frame, Widget, Icon/Button and Gesture.

Page/Frame: Page/Frame is the core of the interaction which has a similar effect with Window of WIMP paradigm. It is the interactive component carried core application information in touch user interface paradigm. It does not only accepts user's finger touch inputting information but also is responsible for managing and organizing all kinds of interface Button, Icon as such components of the Frame, it is the containers for presenting interface information.

Widget: Widget includes various functions of components, such as Textbox, SelectList, Tree, Slide components and so on. The emergence of Widget expands touch user interface component types and makes the functions of touch user interface richer.

Icon/Button: Icon/Button is a kind of typical direct manipulation components. Although icons and buttons are the components used in traditional WIMP paradigm, but due to its direct manipulation characteristic that are also the important direct manipulation components in PWIG touch interface paradigm. Icon is a kind of interface components that through graphic symbols icon to

convey information, it is more visual to convey the semantic information than buttons. Button is a kind of control components can respond to user operation command.

Gesture: Gesture is the main interactive approach in touch user interface. It can be divided into two types: Touch and Slide. Hand gesture is a main interactive approach of touch interaction and used by peopole in daily life. It makes the interaction more natural, more intuitive and greatly reduces the user's cognitive load.

Conclusions

PWIG paradigm, which is simulating users' daily operating environment and using the natural habits, can significantly reduce the cognitive load and improve the interaction efficiency. The contribution of the study would help to spur further research in several promising directions as follows: further improve the interactive paradigm of direct touch technique, evaluate gesture operating performance, further adopt hand input properties and design of multi-touch interaction techniques.

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