The Research of Feedback in Human-Computer Interaction of Touch Screen Mobile Devices

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Abstract: The research object of this paper is the feedback in human-computer interaction (HCI) of mobile devices with touch screens. Through a contrast analysis on the models of feedback of the traditional non-touch screen mobile devices and the new ones with touch screens, the paper proposes that, to build a new effective feedback mechanism on touch screen mobile devices, enhancing visual feedback and establishing multi-channel feedback mechanism are two important design methods. Then the paper concludes several user-centered design principles in the design of feedback on touch screen mobile devices, such as simulation and metaphor, clarity, no interference, intelligent and user controllable principles, etc.

Keywords: feedback, HCI, touch screen, mobile device, usability

1. Introduction

With the development of Mobile Internet and Electronic Information Technology, mobile devices like smart phones and tablets, have been playing very important roles in people's life. Mobile devices provide platforms of information exchange and information consumption. The large screen of touch screen mobile devices enhances the efficiency of output. As a result, many mobile devices cancelled the physical keyboard, and the touch screen becomes the main media of human-computer interaction (HCI). Then the form of HCI of mobile devices has changed.

Steve Jobs, Apple CEO, announced that the technology of touch screen on iPhone is a revolution in the history of human-computer interaction. The large touch screen enhances the efficiency of output, meets users' demands of web-based information and multimedia applications. However, without physical keyboard, touch screen mobile devices will have a loss of convenience of input and quality of the feedback to some extent. Now, many touch screen devices don't have effective feedback mechanisms, which often brought users negative experiences. Therefore, how to ensure the quality of the feedback in human-computer interaction of touch screen mobile devices becomes a current important subject.

2. Contrast of Two Feedback Models

Feedback is a common concept in Control of Science and Electronic Information Technology. It means that machines provide information to make users know whether an operation has been completed and the result of the operation[1]. Nielson said system should give users continuous feedbacks to tell them what position they are in, and how to respond to users' input[2]. The quality of feedback affects the efficiency of human- computer interaction. It is also a very important principle of usability. The lack of feedback may lead users to error operation or repeated operation, and causes negative experiences.

(1) Feedback Model of Non-Touch Screen Mobile Devices

The traditional mobile device, which is equipped with non-touch screen and physical keyboard, is similar to a personal computer (PC) in the form of human-computer interaction. The navigation button on a non-touch screen mobile device has similar function with the mouse in a PC. The physical keyboard is the major input module just like a PC, and the output of information is also realized by the screen. Blackberry produced by RIM Company and Nokia E-series smart phones are typical products of non-touch screen mobile devices (figure 1).

Fig. 1 Non-touch screen mobile devices.

The feedbacks in the operation of non-touch screen mobile devices consist of visual feedbacks via screens, feedbacks through touch and spatial sensation via entity buttons on the keyboards, feedbacks through auditory sensation via the noise of pressing buttons and the optional prompting sound from stereo system. As shown in figure 2, in the human-computer interaction of non-touch screen mobile devices, users can receive feedback signals via 4 channels of sensation. This mode of feedback is clear and effective. And we find visual, touch and spatial sensation are the major channels for users to receive feedback signals, while auditory sensation is a minor channel.

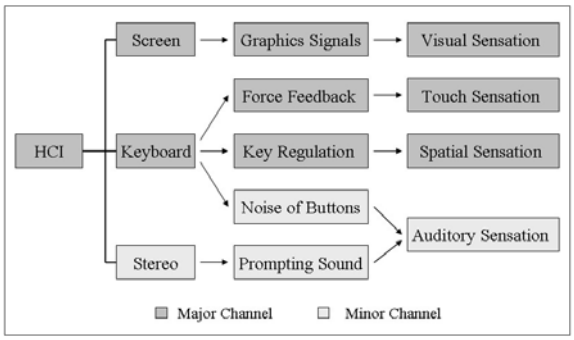

Fig. 2 Feedback model of non-touch screen mobile devices.

(2) Feedback Model of Touch Screen Mobile Devices

Compared to the non-touch screen mobile devices, the human-computer interaction of touch screen mobile devices has changed a lot. The touch screen became the major I/O component of the device, while the physical keyboard is greatly cut. Many devices only have few entity buttons, such as smart phones and tablets based on Google's Android or Apple's iOS (Fig. 3).

Fig. 3 Touch screen mobile devices.

When users click on the plane of a touch screen to input commands, they cannot feel force feedback and key regulation like pressing entity buttons. So users cannot gain clear and accurate feedback through touch and spatial sensation. Therefore, users must mainly rely on graphics and audio feedback signals in the HCI of touch screen mobile devices. Compared to the non-touch mobile devices, auditory sensation becomes more important, but the importance of touch and spatial sensation becomes minor, as shown in figure 4.

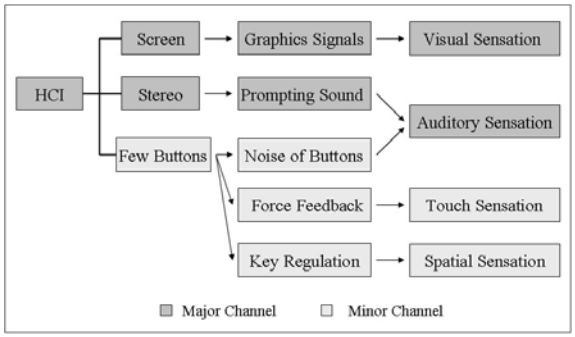

Fig. 4 Feedback model of touch screen mobile devices.

3. Methods of Feedback Design on Touch Screen Mobile Devices

The new form of HCI of touch screen mobile devices asks for new design methods of feedback. There are two common design methods to improve the quality of feedback on touch screen mobile devices, which are to enhance the effect of visual feedback and to establish multi-channel feedback mechanism.

(1) Enhance the Effect of Visual Feedback

Through visual sensation, people received 70% of all information from outside[3]. Visual sensation is the primary channel to receive feedbacks. And therefore, enhancing the effect of visual feedback is the preferred method to improve the quality of feedback.

Whether in the operation with immediate response, or in the operation needing some waiting time, dynamic graphics is the most effective way to convey feedback. On Apple's iOS devices, when users click on a virtual push button, they can see the shadow of the button gradually changing just like pressing an entity button. When users are in the waiting time of loading a new web page, it appears an animation with a cursor turning around on the screen, which informs users the current status of the device. Android devices will add color block behind the icon as visual feedback when users click on the icon. On HP webOS devices, an animation feedback of water ripples will take on when users click on the touch screen, which is precise and funny (Fig. 5).

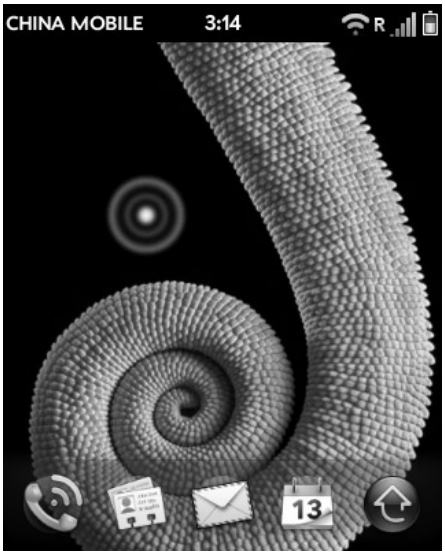

Fig. 5 Visual feedback of clicking on HP webOS devices.

(2) Establish Multi-Channel Feedback Mechanism

Compared with single channel feedback mechanism, the advantage of multi-channel feedback mechanism is very obvious. First, the perception it brings to users is tridimensional and legible, which makes human-computer interaction natural and efficient. Secondly, benefiting from its parallel mode, the mobile device can still guarantee efficient feedback via other channels when a sense channel of the user is occupied or inconvenience to use.

As discussed in the feedback model of touch screen mobile devices, auditory sensation is the second important channel to receive feedback signals, which usually cooperates with visual channel. Commonly, the multi-channel feedback mechanism consists of visual and audio feedback signals. On Apple iPod Touch 4, when users move the visual slider to right to unlock the screen, they will hear an audio feedback signal. When users type a letter on the virtual keyboard, the letter will be enlarged as a visual feedback signal (Fig. 6), and at the same time, the device will make a prompting sound like the noise made by a true typewriter as an audio feedback signal.

Fig. 6 Type on Apple iPod Touch 4.

Besides, we may make full use of the few entity buttons to convey feedback via touch and spatial sensation. HP TouchPad, the new tablet based on webOS, has only three entity buttons, but all of the buttons have good force feedback and appropriate key regulation. When users take a screenshot by pressing the home and power button, the device will make a sound feedback signal like the sound of camera shutter, and at the same time, the screen appears an animation of a twinkling light yellow roundness (Fig. 7). The feedback of this operation is comprise of four sense channels, such as visual, auditory, touch and spatial sense, which is tridimensional and legible.

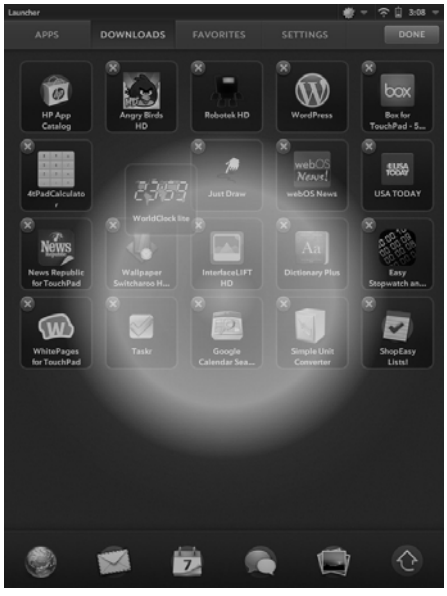

Fig.7 Take a screenshot on HP TouchPad.

In addition, in order to enhance tactility of touch screen in feedback mechanism, many companies like Immersion Corporation are developing and testing new kinds of touch screen which can provide force feedback when clicking on it. For example, RIM Company has equipped a force feedback touch screen named “SurePress” on Blackberry 9530.

4. User-Centered Design Principles of Feedback Design

User experience is the principal standard of the quality of feedback in touch screen mobile devices, good feedbacks should be easy to understand, legible, no interference, and even make human-computer interaction funny. In order to achieve this, we should follow user-centered design principles in the design of feedbacks, and well consider users’ physiological and psychological traits and behaviors.

(1)Simulation and Metaphor

Research tells us simulation and metaphor of reality in the design of feedback signals can improve user experience of mobile devices. When audio and graphic feedback signals in man-computer interaction are simulations or metaphors for the real world objects, users can quickly form distinct perception, and understand the meaning of the feedback signals.

Real sound and graphics reflect the complex interaction among objects in the real world, and they convey information related to users’ existing experiences, so the feedback signals which simulate them are easy to understand. The audio feedback signals of locking and unlocking the screen on Apple iPhone 4 simulate a real lock. The visual feedback signal of flipping over a page in iBook, a built-in application of iPhone 4, simulates a real book.

Metaphor is also an important principle in the feedback design of touch screen mobile devices. For instance, webOS devices turn on an animation of a growing breathing “HP” logo in the process of reboot. The execution of deleting items on an iOS device shows an animation which is a metaphor for balling up the paper and throwing it into a dust bin. Those animation effects associate with the meanings of the operation and status of devices, users can easily understand the feedbacks. However, the use of metaphor principle must be reasonable and based on users’ existing experiences. And the meanings of feedback must follow the principle of oneness. To make metaphor effective, it’s important to reduce the requirements for speculate in the use of products[4].

In the design of feedback, following simulation and metaphor principles reasonably can not only improve the efficiency of human-computer interaction, but also bring users a lot of fun. It is of great significance to improve user experience.

(2) Clarity and No Interference

Clarity is one of the most important principles of feedback design. The device may lead users to confusion, even add unnecessary cognitive burdens, if several channels of feedback don’t work well together, or different kind of feedbacks use the same or similar signals. Feedback design must be based on user experience, and consider the oneness of the meanings of feedback signals. It is one-sided only to pursue the amount of feedback channels.

Several mobile platforms are supporting the function of multi-task. When system is running a background task, it is necessary to avoid the interference made by the feedback of current operation. When a HP TouchPad is playing music as a background task, the audio feedback of current operation will temporarily shut down automatically, only providing other feedback signals except audio channel, so as not to interfere with music.

(3) Intelligent and User-Controllable Feedback

If the operating status of mobile devices changed, intelligent feedback would automatically change to adapt to the physiological and psychological traits of users. When users are listening music with an earphone on Apple iPad 2, the sound intensity of audio feedback will automatically reduce to a comfortable level for ears, ignored the current system settings of sound intensity. Intelligent feedback can not only reduce operating frequency, but also improve user experience.

User-controllable feedback means that users can open, close or adjust feedback signals freely. For instance, in the occasions where users don’t want to make noise such as in a meeting, feedback could be shut off or adjusted in system settings of the device.

5. Conclusion

Feedback is a key link in human-computer interaction of touch screen mobile devices, which is directly related to user experience and operating efficiency. The development of Mobile Internet Technology, the increase of content consumption based on information, and the extension of social activities via network, will expand the application field and increase the number of users of touch screen mobile devices. We should solve the new problems of feedback in the new form of HCI, use reasonable methods and principles in feedback design, and ensure the quality of human-computer interaction.

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