Smartphone User Interface

● Masashi Tanimura ● Takeshi Ueno

Touch-based operations are becoming increasingly commonplace as smartphone use continues to expand. Compared to indirect keypad operations on conventional feature phones, direct operations on a touchscreen make for smooth use of mobile phones without having to learn numerous operation rules and procedures. This article presents Fujitsu's approach to achieving a more intuitive user interface that enhances the direct-operation learning effect and enables even users who are not especially adept at mobile-phone operations to use a smartphone without having to refer to a manual. It also introduces a character input system using Fujitsu's handwriting recognition technology as an example of exploiting touchscreen features.

1. Introduction

The use of smartphones in society began to escalate in 2008, and today, many people can be seen using touchscreens on commuter trains and in other public places. As a result, typical touchscreen operations—such as flick and drag for scrolling and pinch-in and -out for zooming are now familiar to many people. As a result, a variety of operation methods have become possible in contrast to the conventional method of using a keypad to indicate simply up/down/left/right directions. The touchscreen has therefore added more degrees of freedom to the user interface (UI) and has enabled the creation of applications in which look and feel can take many forms.

This paper examines the differences between key-based operations in feature phones and touch-based operations in smartphones and discusses where UI development efforts should be focused together with specific examples.

2. Differences between indirect and direct operations

The biggest difference between the feature-phone key-based UI and the smartphone touch-based UI is that the former consists of indirect operations and the latter of direct operations. Many users have found that being able to execute operations directly on a screen has made overall phone operation simpler. This is because buttons on a screen can be pressed and moved with a finger much like moving an object in the real world. In contrast, indirect operations using a keypad require that the first-time user understand the correspondence between buttons on the screen and keys on the keypad. The user's level of understanding in this regard will differ according to the user's skill in operating machines.

For example, we consider an application that uses the 1-key and 3-key to scale characters down and up in an e-mail message (**Figure 1**). Since there is no inherent reason for scaling characters by using these two particular keys and since an operational description on the screen is often omitted, users other than those adept in mechanical operations may not be able to change the scale of displayed characters. A touchscreen, on the other hand, displays – and + buttons for scaling down and up on the screen itself, enabling this operation to be easily performed. Even users who are not particularly skillful in operating machines can use these buttons. Since pressing a button is a common operation in daily life, a touch-based UI that exploits this commonplace experience is considered to be a UI that many users can intuitively understand.

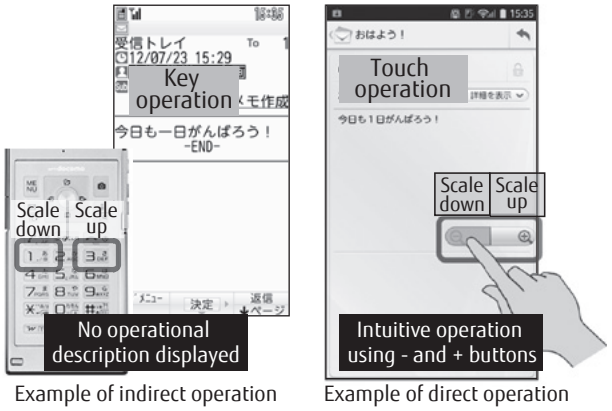

Figure 1
Indirect versus direct operations.

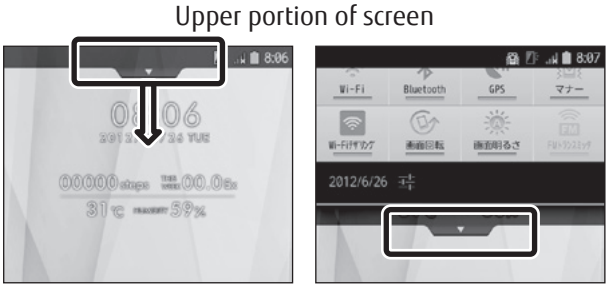

Figure 2
Example of portraying what operations can be performed.

3. Achieving direct operations with a natural feel

As described above, the change from indirect operations to direct operations has made the operation of a mobile phone more natural to the user. This is not to say, however, that an operation will necessarily be intuitive to users simply because it is of the direct type. To achieve intuitive operations, a natural-feeling UI must be provided. This can involve the basic design of a button. Specifically, if a button appears to have a convex shape, the user will recognize it as something to be pushed based on past experiences in the real world, thereby achieving a more natural UI. Similarly, in the case of a screen presenting a list of items, showing that list with the item at the bottom of the screen slightly concealed can indicate to the user that the list continues. A device like this can also help make the UI feel more natural.

Good response is also important in giving the UI a more natural feel. In the real world, an object will start to move as soon as it is pushed. Consequently, if a person were to start pushing a box, for example, and that box didn't start to move until a few seconds later, that would certainly appear strange to that person. This concept can be applied to a touch-based UI: the user must be given feedback to any operation as quickly as possible to avoid an unnatural feeling. Fujitsu considers response to be a very important factor in achieving a natural UI and makes touchscreen response as quick as possible.

Smooth screen movements are important too. Having screen contents move in a gradual, natural manner in response to a touch operation instead of changing abruptly in a flash is essential to expressing screen activity that moves smoothly as in the real world. Of course, achieving a level of smoothness exactly the same as that in the real world is difficult, but it is possible to express screen movement so as not to generate any unnatural feelings in the user. For example, television operates at only about 30 frames per second (fps), but unnatural feelings are rarely induced in viewers. However, when viewing a sporting event having considerable movement like a soccer match, the amount of inter-frame changes can be large at 30 fps, making smooth viewing difficult. In general, a frame rate of about 60 fps must be secured to provide smooth viewing for any scene. For this reason, Fujitsu ensures a frame rate of about 60 fps in its smartphone UI to achieve smooth viewing even for quick movements.

4. Application example

To give a specific example of embodying the UI design points described in the previous section, we introduce NX! Home, Fujitsu's original home UI. We developed NX! Home to enable a large number of users, from first-time smartphone users to smartphone-savvy users, to make the most of their smartphones. For first-time smartphone users, this UI features a variety of techniques to accelerate the smartphone learning process. For example, it adds tabs (status-bar tabs) to the navigation process to indicate to the user that the status bar can be pulled down (**Figure 2**) and adds visual feedback ("touch helper") to give the user a clear sense of touching the screen (**Figure 3**). It also keeps response delay to within 40 ms (40/1000 s) and applies a frame rate of about 60 fps for smooth viewing

Figure 3
Example of visual feedback.

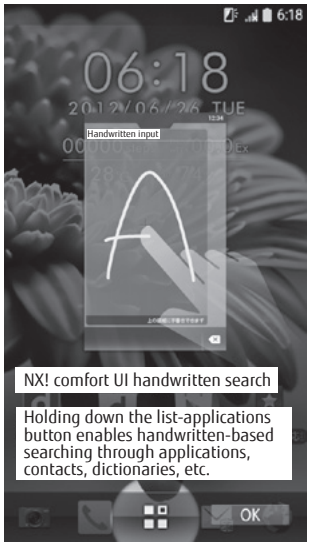

Figure 4
Direct searching using handwritten characters.

as described above so that the smartphone can be used with a very intuitive, natural feel.

We have also equipped NX! Home with functions that can be used in accordance with the user's level of smartphone skills. For users who are relatively adept at using smartphones and who use a variety of smartphone applications, we have provided a function that enables the user to group applications as desired to make it easier to search for and launch applications. Furthermore, for users who are especially skillful in using smartphones, we have developed a function that enables them to search for and retrieve information quickly by directly inputting characters on the home screen using Fujitsu's proprietary handwriting recognition technology, as described in the next section (**Figure 4**). In short, Fujitsu works to improve smartphone ease-of-use by preparing user-friendly functions for different levels of users.

5. Character input by handwriting recognition technology

With conventional Japanese feature phones, the most common method for inputting characters was to use a keypad, which explains why there are now so many users who are unaccustomed to inputting characters on a touchscreen. In the light of this situation, we developed a handwriting input system for smartphone use so that even users unaccustomed to touch-based input can input characters without difficulty. In the past, handwriting input was unable to reach a level that felt natural to the user because of insufficient character-recognition accuracy. Now, however, the high recognition accuracy provided by Fujitsu's new proprietary handwriting recognition technology enables the user to input characters in a natural manner. This technology also enables the user to input Japanese together with English words, numerals, symbols, and emoticons without having to change recognition mode, which gives character input an even more natural feeling. In addition, the touchscreen has made it possible to input characters by using a software keypad and a QWERTY keyboard (as used on personal computers), providing users with a variety of input methods to choose from. However, the increase in the number of possible input methods can be troublesome for users who find switching between input methods difficult to understand. In response to this problem, we have developed an overwriting character recognition technology that enables the user to directly handwrite on top of a software keypad or QWERTY keyboard (**Figure 5**). This new input method enables characters to be input as usual by touching a key while also enabling automatic switching to handwritten mode and character recognition by dragging a finger over the displayed keys in a specific direction or for more than a certain distance. In other words, this

Figure 5
Character input by overwriting.

technology enables the user to input characters simultaneously by key pressing and by handwriting without having to manually switch input methods, thereby making character input even simpler.

6. Conclusion

There are still many users that feel it is difficult to use smartphones because of their reputation for advanced functionality. However, by providing a UI that can be used intuitively and naturally as in Fujitsu's original UI (NX! Home) introduced in this paper, smartphones can be made easier to use than key-based UIs, even for first-time users. Such a UI can also provide advanced operations for high-level users by increasing the degrees of freedom in operations. At Fujitsu, we will continue to emphasize the key points in intuitive-UI development described in this paper with the aim of achieving a UI that even more users will find easy to use.

Masashi Tanimura
Fujitsu Ltd.
Mr. Tanimura is engaged in smartphone UI planning.

Takeshi Ueno
Fujitsu Ltd.
Mr. Ueno is engaged in smartphone UI planning.