Application Design Framework for a Dressed-up Touchscreen with a Tactile Feedback.

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Abstract

It is difficult for persons who are unfamiliar with a touchscreen like elderly or handicapped people to operate the electronic products employing touchscreen as user interface. We aim to realize a touchscreen that can provide the position of buttons and click feeling by a simple mechanism, keeping the flexibility. The proposed touchscreen consists of a switch underneath an LCD panel and the plates with identification number at the top of the LCD panel. When the touchscreen is pushed, the switch underneath the LCD module is also pressed. Thus, the user can get certain click feeling by the switch. For the plate put on the top of the LCD module, the places where icons are displayed in the touchscreen are hollowed out. Therefore, the edges around the buttons on the hollowed part give the user's finger unevenness. That is, the position and boundaries of the icons can be recognized by the finger. In addition, since the type of the plate can be determined by the ID, we can provide a variety of button arrangement according to the plate used. In order to make our touchscreen widely used, a generic design framework of software is needed. Thus, this paper shows a general framework of software, design framework, is showed. Through the application examples on the prototype, we demonstrate that the application can be developed actually by following our design framework.

Keywords: touchscreen, button, framework, welfare.

1. Introduction

It is difficult for persons who are unfamiliar with a touchscreen like elderly or handicapped people to operate the electronic products employing touchscreen as user interface [1]. What cannot recognize the buttons on the touchscreen is one of the significant problems to make the

operation more difficult.

Therefore, the systems supporting operations of a touchscreen by giving finger touch feeling have been developed in the past [2-7]. Their systems are not the same as the sense of the button switch with a click feeling that we are accustomed to. In addition, the users cannot recognize button positions on their systems, and they are not suitable for downsizing of device.

We aim to realize a touchscreen that can provide the position of the button and the click feeling by a simple mechanism, keeping the flexibility. The flexibility means that our touchscreen is able to adapt to any user interface when changing the button sheet. Actually, we have proposed the necessary hardware framework to comprise the features described above [7]. Also, we have developed a prototyped hardware according to the hardware framework. We had some testees operate the prototype. Then, it resulted that our touchscreen is easier to manipulate than the conventional one. Accordingly, the result indicates usability of our proposal. In order to make our touchscreen widely used, we need not only the general framework of the hardware shown in [7] but also a general framework of the software, design framework. According to the design framework, any programmers can develop uniformly the various applications on the touchscreen proposed.

In this paper, after we briefly explain the hardware framework of the proposed touchscreen, we describe the design framework of the application. Then, through the application examples on the prototype, we demonstrate that an application can be developed actually according to the design framework.

2. Hardware framework

Fig.1 shows a hardware framework of the proposed touchscreen system. Mainly, the proposed touchscreen

Fig.1. Hardware framework.

consists of a switch underneath the LCD panel and the plates with identification number at the top of the LCD panel.

When a finger pushes the touchscreen, the switch underneath the LCD panel is also pressed. Thus, this touchscreen gives the user the click feeling that is the same as that of mechanical switch we are accustomed to. Since the touchscreen is only executed by pushing the switch, an incorrect input by just touching can be prevented easily.

For the plate put on the top of the LCD panel, the places where icons are displayed in the touchscreen are hollowed out. Therefore, the edges around the buttons on the hollowed part give the user's finger unevenness. That is, the position and boundaries of the icons can be recognized by the finger. The ID can be read by placing the plates on the reader, the system can determine the type of plate. Therefore, the proposed touchscreen can correspond to the various arrangement of the button. In addition, the plate can be used or not can be use depending on the application. Information such as the placement of the buttons on the screen hierarchy and each layer of the plate and default is stored in a storage device. The necessary information according to the plate switching and button pushing is selected from the storage device.

3. Design framework

Fig.2 shows a design framework of the proposed touchscreen system.

We explain the concept called an object in each screen on the touchscreen. The object has coordinates of the button, images of icons, background images, and programs invoked by pushing a button. By the state transitions among objects invoked by pushing the buttons, the screen switching or the execution content switching is realized.

The object holds the number of the buttons(m) and the

x_0, y_0 : origin coordinates of the touch button

h, w : width and height of the touch button

Fig.2. Software framework.

number of background images(n). Each button has coordinates of the origin (x_0, y_0), and the height and the width of the icon (h, w). The img_p of each button is a pointer to the image displayed when the button is pushed. The img_r is a pointer to the image displayed when the button is released. The act_p is a pointer to a program to be executed when the button is pushed. The $next_s$ is a pointer to the next object to transition when the button is pressed.

According to the concept of Fig.2, basic function groups(library) to develop applications are provided. For example, they are the function to display the image designated for the area of the LCD, the function to be displayed to read background image from the SD card and so on.

Incidentally, it is possible to switch among multiple applications by changing the plates shown in Fig.1. A plate corresponds to one or more applications. Each application corresponds to one or more objects.

4. Adaptation example

We have developed an application using the proposed design framework. This case study develops a calculator on our prototype hardware. Incidentally, the application of the developed calculator can be four arithmetic operations, and is the same as the use of a common calculator.

4.1 System Overview

We explain the structure of the prototype that was used to validate whether our design framework can realize an application or not. Fig.3 shows a block diagram of the prototype.

The LCD module consists of the LCD with the 240x320 of 3.2 inch resistive type touchscreen, the LCD controller of Solomon Systech SSD1289 and the AD converter for the touchscreen of SHENZHEN XPTEK TECHNOLOGY xpt2046.

This prototype uses the plate ID as RFID. The RFID reader is ID Innovations ID-12. The switches underneath the LCD module are push-button switches of OMRON B3F5000.

These three parts are connected to the microcomputer board of Strawberry Linux STBee that equipped with ST Micro's STM32 microcontroller.

Software to run on STM32 calculates the X-Y axis of the finger sent from the AD converter attached to LCD module. Depending on the pressing of the switch, the microcomputer performs the processing corresponding to the default state and the current plate.

Fig.3. Block diagram.

4.2 Application design and operation check

Fig.4 shows the appearance of the calculator we designed and the operation example.

In this case study, the plate we made corresponds to one application and the application has one object. The number of images of the touch button (m) is 16. They include 0-9 of numbers, the sign of the four arithmetic operations, the clear, and the equal sign. The number of the background image (n) is one. The images when pushed and released are same. When each numeric button is pushed, the numeral of the pushed button is displayed in the background image and memorized. When a calculation button is pushed, the action performs four arithmetic operations corresponding to the kind of pushed button, by using memorized numerals. Finally, the action displays the operation result.

Fig.4(a). The enlarged image of the screen.

Fig.4(b). The state of the whole device.

Fig.4. Appearance of calculator and its operation example.

5.Conclusion

In this paper, we proposed a design framework for application in the dressed-up touchscreen with a tactile feedback. Further, this paper indicates that the application can be developed in practice by using the design framework through a case study of a calculator.

As future work, we will increase application examples, and perform an experiment to the more testees.

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