Interaction Technique Distinguishing Fingers and Its Applications

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Abstract

We proposed Finger-Specific Interaction (FSI) as a novel interaction concept for interactive surface. FSI enables a system to identify fingers and deal with the difference of fingers. It means each finger has a separate meaning in FSI. For instance, while current interactive surfaces consider single touch by using the index finger and single touch by using the middle finger as the same operation, our approach considers them as completely different operations. The number of input primitive of current interactive surfaces is one. On the other hand, the number of fingers used in operation is the number of input primitives in FSI. FSI significantly increases the amount of information for input because the combination also increases. We applied FSI to interactive surfaces. In this paper, we describe a concept and effectiveness of FSI, a vision-based prototype system and a paint tool with FSI as an application.

keywords: Finger-specific, touch interaction, interactive surface, mobile device

1 INTRODUCTION

We proposed Finger-Specific Interaction (FSI) as a novel interaction concept. In FSI, a system identifies fingers and deals with the difference of fingers. By using the difference of fingers, it becomes possible to increase the number of input primitives and realize eyes-free interaction. In addition, FSI has a potential to create a new style or method of operation.

We applied FSI to interactive surfaces as an example of concrete usage scenes. In this paper, we describe a concept of FSI and a new touch interaction style by FSI. Then, we introduce a prototype system of FSI and applications assumed practical scenarios of interactive surfaces.

2 RELATED WORK

FSI identifies fingers, which are a part of human body. As granularity of identifying human, there are three levels: person, hand and finger. DiamondTouch[2] is a research identifying person. DiamondTouch can identify the difference of multiple users. By using this technology, conflicts between multiple users do not arise. FSI can also identify person because it can identify fingers which is smaller granularity than person. Therefore, FSI includes the advantages of DiamondTouch. As a research identifying hand, an interaction technique distinguishing left and right hands[8] was proposed. FSI also includes the advantages of this technique because FSI can identify hand. As researches identifying finger, finger-count was used to operate a linear menu[1] and the combination of fingers are applied to menu operation[7]. These researches used the combination of fingers like guitar codes. While FSI is based on the difference of individual finger, we assume combining each finger. On this point, these two researches are near FSI concept. It can be said that FSI is a concept including all above researches because FSI identifies human in the smallest granularity.

3 FINGER-SPECIFIC INTERACTION

3.1 Concept

FSI is an interaction concept that identifies fingers used for operation. By FSI, it becomes available to use the difference of fingers for interaction. For instance, while current interactive surfaces consider single touch by using the index finger and single touch by using the middle finger as the same operation, our approach considers them as completely different operations. In other words, each finger has a separate meaning in FSI. In current system, touching an object on a screen by a finger is a meaningful input in many cases. In FSI, on the other hand, touching action itself is a meaningful input.

3.1.1 Increase of input primitives

Most existing interactive surfaces use input data the coordinates value and their change in time as input information. They deal with all finger touches as the same input because they cannot detect the difference of fingers. Thus, the number of input primitives is one. In contrast, FSI can deal with each finger touch as a different input because FSI can identify fingers. Thus, the number of input primitives is the number of fingers used in operation. In multi-touch environment, combining multi fingers is available. When the number of fingers using a operation is n, the number of input vocabularies is $2^n - 1$. Here, we consider three-point touch operation by one hand, and two-point by one hand and one-point by another hand. While current systems deal with the two operations as being the same one, a system adopting FSI deals with the two operation as completely different.

In terms of input primitives, FSI is especially compatible with mobile devices equipped a small touch screen like PDA or smart phone. Some mobile devices adopt multi-touch operations to increase the number of input vocabularies. However, multi-touch operations on small screen are not always comfortable. By adopting FSI, mobile devices enable users to perform various input operations by only single-touch. We expect that FSI-adopted mobile devices are particularly useful and FSI improves the usability of mobile devices.

3.1.2 Realization of eyes-free interaction

General interactive surfaces do not provide a user with physical feedbacks because the user operates an object displayed on them by his/her fingers. Thus, eyes-free interaction is difficult because the user has to look at the object when operating it. In FSI, human's motor output i.e., touching action, becomes command for a computer. When selecting a menu item in current interactive surfaces, for instance, a user has to look at the menu item, then correctly touches the item. By using FSI, on the other hand, what the user should do is simply touch with his/her finger. In other words, the touching action itself becomes an operation of command selection. Therefore, FSI enables the user to perform operations without using GUI on a surface. For this reason, FSI can be seen as an interface directly connected human's motor output and command selection.

In general, a user has to look at a display when s/he operate a mobile device with touch screen like music player. However, adopting FSI with the mobile device enables the user to operate it while putting the device in his/her pocket or bag without looking at the screen. Thus, it is said that FSI is compatible with mobile devices in terms of eyes-free interaction.

4 PROTOTYPE SYSTEM

We developed a 450×300mm-size interactive surface as a prototype system (Figure 1 left). In order to realize FSI, the system has to detect touch coordinates and touching fingers. This prototype system detects touch coordinates and touching fingers respectively, then integrates both data.

We adopted FTIR(Frustrated Total Internal Reflection) [4] as a touch detection technique. For identifying fingers, we used a camera, color markers and polarizing filters. We placed the camera above

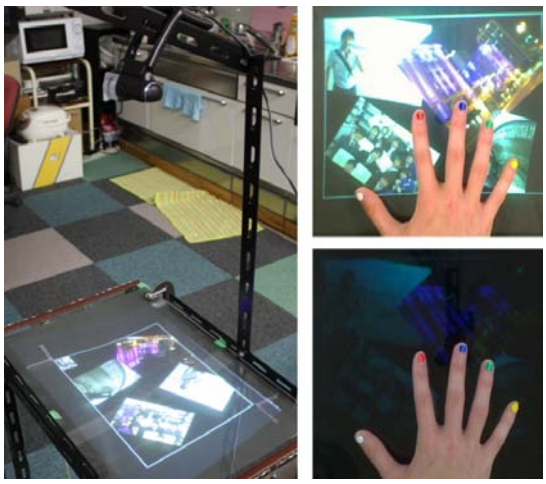


Figure 1: Left: our prototype system. A camera for detecting touched fingers is placed above the screen. Upper right: a raw image. Lower right: an image with polarizing filter.

the table and the system identifies fingers from the camera images. In this prototype system, we pasted a marker on nails to identify fingers with high accuracy. The marker is an 8mm-size colorful seal at a very reasonable price. We paste different color's marker on each nail and the system detects finger's position by color data included in an image taken from the camera. However, if simply taking a image above the surface, the system wrongly detects projected images on the surface as the marker's color (Figure 1 upper right). We resolved this problem by using two polarizing filters used in [6]. We put a 450×300mm-size polarizing filter on the surface and a small filter to the camera in orthogonal direction. By this filtering, the projected images are blocked and camera can take only hand above the surface (Figure 1 lower right). We used relative positions of both touch coordinates and touching finger's position on the surface to integrate them.

Although this implementation enough to work as a tabletop system, we have to take other approaches for implementing for mobile devices. We are trying to use an electric mechanism.

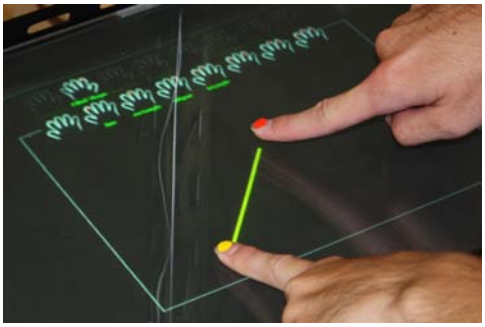
5 PAINT TOOL WITH FSI

We developed a paint tool as an application of FSI. We assume that this paint tool is used on large screen interactive surfaces. General paint tools have a lot of modes like pen, drawing shape, pasting image and so on. In addition, a lot of parameters like shape size or color exist. For that reason, in general paint tool, a user has to switch the mode and set the parameter by GUI operations.

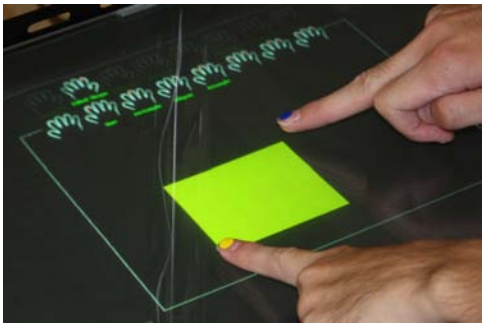
On the other hand, a paint tool with FSI do not require such GUI operations. This paint tool uses three fingers (index, middle and fourth finger) of both hands for operations. In bimanual operation, asymmetric-dependent task[3] that a dominant hand is used for fine actions or operations that require precision while a non-dominant hand is used for coarse actions or operations that not require precision, was proposed. It is demonstrated that the asymmetric-dependent task shows good performance[5]. We applied this to our paint tool. We assigned main operations to fingers of dominant hand and sub operations to fingers of non-dominant hand.

Operation style bases on bimanual operations, i.e., mode selection by non-dominant hand and operation by dominant hand. When a user touches only fingers of dominant hand without non-dominant hand (i.e., with 0 fingers of non-dominant hand), images are pasted depending on touched fingers. We assigned filled shape mode to index finger and vivid color choosing mode to middle finger. For instance, when touching index finger of dominant hand with index finger of non-dominant hand, a line is drawn between these fingers (Figure 2(a)). Substituting middle finger for index finger of dominant hand, a filled rectangle is drawn (Figure 2(b)).

We assigned modifier command like shift key of keyboards to fourth finger. The fourth finger makes sense by touching with index or middle finger. We assigned lined shape mode to the combination of index and fourth finger of non-dominant hand and pastel color choosing mode to the combination of middle and fourth finger.



(a) Drawing a line by touching index fingers of both hands.



(b) Drawing a filled rectangle by touching index finger of non-dominant hand and middle finger of dominant hand.

Figure 2: Two-point touch

6 CONCLUSIONS

We discussed around FSI which is a concept of interaction identifying fingers and adaptation of FSI to interactive surfaces. We developed and introduce a prototype system and an application of FSI.

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