HAND GESTURE INTERFACE FOR WEARABLE PC

Isao NISHIHARA, Shizuo NAKANO

Department of Electronics and Informatics, Faculty of Engineering
Toyama Prefectural University
Kurokawa 5180, Imizu city, Toyama, 939-0398 Japan
E-mail: nishihara@pu-toyama.ac.jp

ABSTRACT

There is strong demand to create wearable PC systems that can support the user outdoors. When we are outdoors, our movement makes it impossible to use traditional input devices such as keyboards and mice. We propose a hand gesture interface based on image processing to operate wearable PCs. The semi-transparent PC screen is displayed on the head mount display (HMD), and the user makes hand gestures to select icons on the screen.

The user's hand is extracted from the images captured by a color camera mounted above the HMD. Since skin color can vary widely due to outdoor lighting effects, a key problem is accurately discrimination the hand from the background.

The proposed method does not assume any fixed skin color space. First, the image is divided into blocks and blocks with similar average color are linked. Contiguous regions are then subjected to hand recognition. Blocks on the edges of the hand region are subdivided for more accurate finger discrimination.

A change in hand shape is recognized as hand movement. Our current input interface associates a hand grasp with a mouse click.

Tests on a prototype system confirm that the proposed method recognizes hand gestures accurately at high speed. We intend to develop a wider range of recognizable gestures.

Keywords: wearable PC, man-machine interface, image processing, color detection, movement recognize

1. INTRODUCTION

Technology is creating a ubiquitous network to link the many computers needed for daily life. PCs are connected simple and easy to network. The mobile network can support the user when outdoors. As a result, the computer comes to be necessary part of the human life.

The wearable PCs always can connect to network, and support user in various scenes. User can search information of the sightseeing or the advertisement of the shop through the computer while walking the outside.

But, it is difficult to use the traditional keyboard or mouse, as input devices while moving. Our solution is a hand gesture interface for operating wearable PCs in a simple and easy manner.

2. PURPOSE

An output device and an input device are necessary for PCs to operate. A semi-transparent version of the wearable computer's screen is displayed on a HMD so as to overlay the real world.

In this research, we discuss about input technique of the wearable PCs. In particular, the purpose is to realize optimized input interface of wearable PCs with hand, which is free for user.

Because hands and feet are the high parts of the degree of freedom among user, it is easy to operate it by using hands and feet.

And, as for the movement of hands and feet, a user is efficient with the wearable PCs.

Therefore the interface with using hand is the most effective because input interface has directly sense. Thus, the movement to grasp an icon by hand is close in an operation sense for the click operation with the mouse. Therefore the interface is proposed, that grasping for as click operation.

3. HAND GESTURE INTERFACE

The user mounts Head Mount Display (HMD) and a small camera on the head. The small camera has the view of the user. (See Figure 1) PC recognize in real-time at the same time by this in the view of the user.

The PC generates the icons screen to display. And the generated screen is composed with an object related to, and it is displayed by a screen in HMD. The computer is operated by hand gestures, i.e. the user grasps an icon on the screen. User's view is composed with real scenery and icons. And user also can see hand region for matching hand region and icon, then click icons by grasping with hand. (See Figure 2)

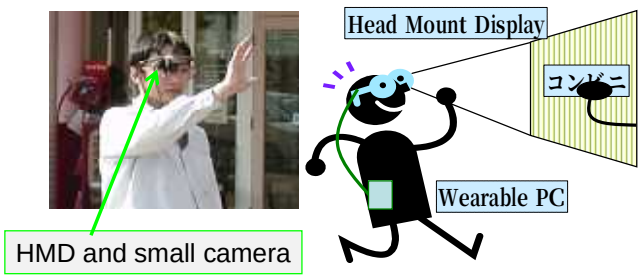


Figure 1: System overview

Figure2 : User's view

4. HAND RECOGNITION METHOD

Variable hand color area

In condition to add nothing to a hand, it is necessary to perform recognition by the camera image for technique to recognize form of bill outdoors. Technique using movement / a color / an outline of image is existing for recognition method from an camera image.

The movement of image is very difficult to extract hand movement because whole image changes are exists in camera image on head. Next, an outline is also difficult to extract, because there is a lot of processing, which is not suitable for real-time processing.

The color processing has some difficulty when there is similar color with skin in background, but the difference of a sudden color plans the extraction of the hand region by putting the supposition that there is not so.

The images captured by a color camera mounted on the HMD are divided into blocks. The image is divided to blocks of 8x8 pixels; the average color of each block is determined. The judgment whether a block is a hand region or not is made according to its average color.

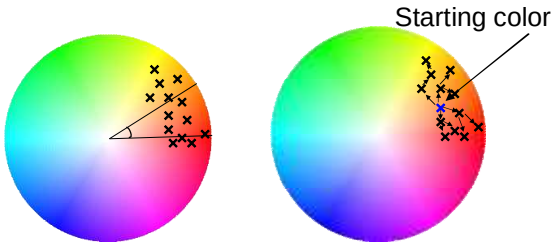
Since skin colors are widely distributed in the color space of tone in pictures captured outdoors, the proposed method accepts significant changes to the color decision space. This reduces the frequency with which background blocks are erroneously recognized as hand regions.

Conventional image recognition schemes use a fixed color area and so cannot cope with the change in skin color created by various lighting environments found outdoors.

Accordingly, the proposed method does not use a fixed hand color range. The skin color changes by the influence of the shadow slowly by a place. There are few differences in a block next to each other with hand region, and there are large differences of the color in the hand region and background region. Therefore the recognized skin color is enlarged by the change of the color to neighborhood block. (See Figure 3)

By using this method, the hand region is able to extract more precise than the method with the fixed color area. First, neighboring blocks that have similar average color are linked. This linking is continued until a shape similar to a spread hand is found, see Figure 4.

Figure 4 show typical results of hand region extraction. (a): input images, (b): result with fixed color area, and (c): result with proposed method.



(a)Fixed hand color area (b)Variable hand color area

Figure 3: Decision area of skin in color space

(a)Input Image (b)Fixed color area

(c)Variable color area

Figure 4: Results of extracting hand region via skin col

Variable hand color area

There is the case that there are a hand region and a background region in the same block at a stage extracting the external color domain. Furthermore, there is influence for the detection of the finger tips, in using blocks.

To extract the hand precisely, edge blocks (blocks whose average color difference from that of the center blocks) are subdivided, see Figure 5. The subdivided blocks are subjected to the same joining process described in 3.1.

Figure 6 shows a typical result of block subdivision. (a): input image, (b): result without subdivision, (c): result of proposed method. The hand region is recognized more accurately.

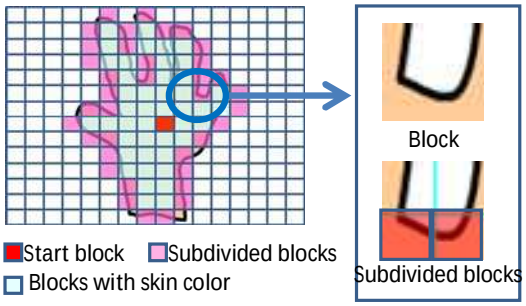


Figure 5: Method of diving block for hand region

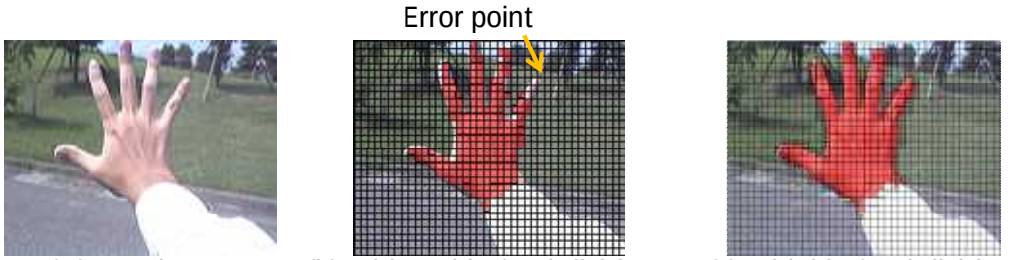


Figure 6: Result of extracting hand region with block subdivision

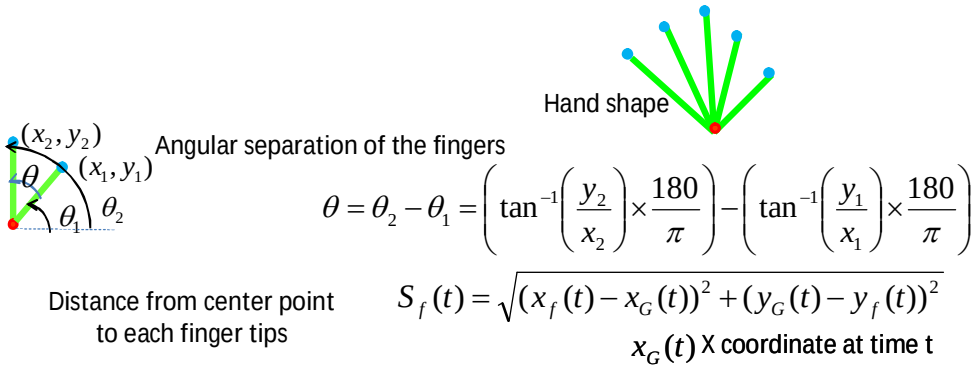


Figure 7: Calculating hand parameters

Variable hand color area

The hand parameters are calculated from hand shape. The center of gravity of the extracted hand region is as a position of the center point of hand region. Thus, the finger tip positions are detected by using the radical nature of the hand region.

Distances from the center point hand region to each finger tip are calculated. The angles between the fingers are also calculated as hand parameters with each image, see Figure 7.

Variable hand color area

Hand movement is recognized by a change in hand parameters. The movement to grasp is different from the movement to turn and to move, and it is it with important operation to judge as input interface. The movement with high possibility is defined to perform.

The changes of the parameters are defined as the basic movement. In the case of grasping, the distance parameters are becoming small at same time, and the angles are not changing.

We equate a hand grasp with a mouse click. Hand movement is judged changes in the positions of the fingers. When a grasping gesture is made, the distances from the center to each finger tip change by the same amount; the

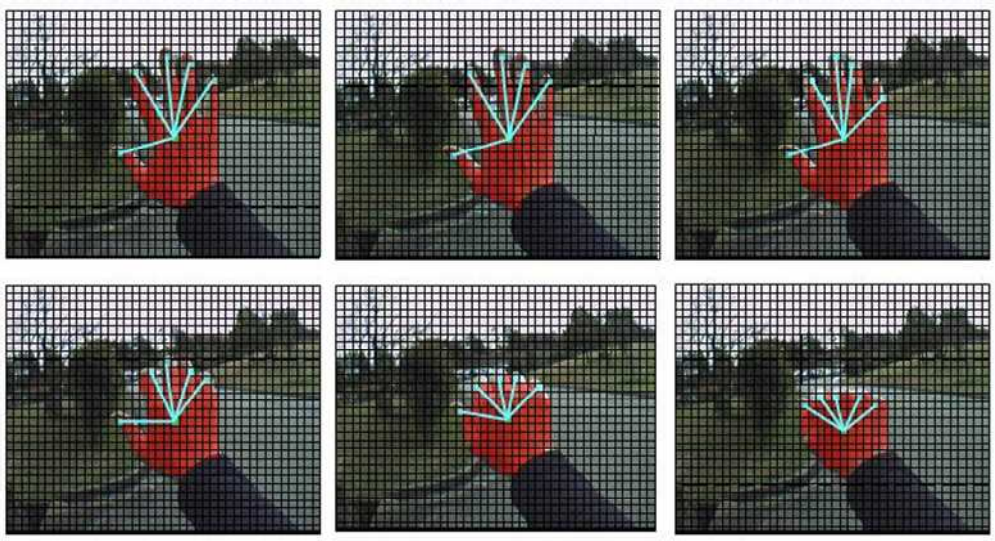
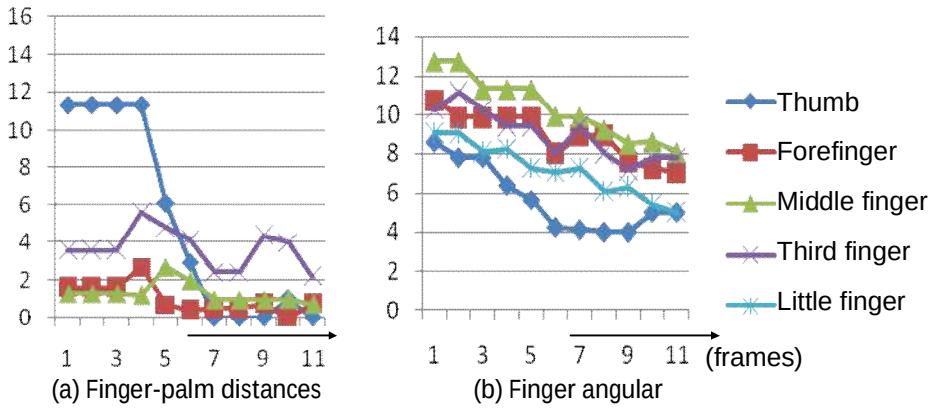


Figure 8: Hand Grasping movement



(a) Finger-palm distances (b) Finger angular

Figure 9: Graph of finger parameters

angles change only slightly.

Variable hand color area

Figures 8 show the extraction of grasping hand movement. Figure 9 shows the change in parameters with time. These results show that the grasping movement can be accurately detected regardless of hand orientation.

5. HAND RECOGNITION METHOD

The method proposed herein was shown to accurately detect hand region and to realize hand gesture input system with high speed in outdoors. The simple hand grasping interface is realized.

However, it is necessary for the user to examine the combinations of many movements. We intend to develop methods to extract more sophisticated changes in hand shape and motion to extend the range of interactions that can be made with wearable PCs.

Acknowledgement

As for the thing of cooperation of Ryusuke Matsuda, this study was pushed forward. Thanks for his cooperation.

REFERENCES

[1]Ryusuke Matsuda, Isao Nishihara, Shizuo Nakano; "A study of operating interface for wearable PCs", The 2006 student's meeting for research in Hokuriku area, E-13 , 2006.03.11 (Written in Japanese)

[2]Ryusuke Matsuda, Isao Nishihara, Shizuo Nakano; "A study of input interface for wearable PCs", The 2006 electricity relation society Hokuriku branch union rally(2006 JHES),F-6,2006.9.16,(Written in Japanese)

[3]Ryusuke Matsuda, Isao Nishihara, Shizuo Nakano; "A study of input interface for wearable PCs", The 2007 electricity relation society Hokuriku branch union rally(2007 JHES),F-58,2007.9.5,(Written in Japanese)