Distinction System of Left and Right Hands Placed on a Keyboard of Laptop Computers

Takuto Nakamura and Buntarou Shizuki
University of Tsukuba
Tsukuba, Ibaraki, Japan
{nakamura,shizuki}@iplab.cs.tsukuba.ac.jp

ABSTRACT

We propose a left–right hand distinction system on the touchpad of a laptop computer. The system uses a mirror and a front-facing camera of the laptop computer to obtain the image around the keyboard and the touchpad. The system distinguishes the left and right of a user's hand by image processing the obtained image. In this paper, we demonstrate that the user can execute different operations while keeping the hands on the home position of the keyboard.

CCS CONCEPTS

• **Human-centered computing** → **Interactive systems and tools**; *Gestural input*;

KEYWORDS

left–right hand distinction; front-facing camera; mirror.

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1 INTRODUCTION

It is convenient for a user to perform various operations while keeping the hands on the home position of the keyboard. To achieve this goal, we propose a new left–right hand distinction system on the touchpad of a laptop computer, considering that touchpads and front-facing cameras exist in many laptop computers. Our system distinguishes the left and right of a user's hand by image processing the images around the keyboard and the touchpad using a built-in front-facing camera of the laptop computer. We attached a mirror to the front-facing camera using our own mirror mount for obtaining the image. Therefore, our proposed system has a feature that it works without additional sensors such as Leap Motion and Kinect.

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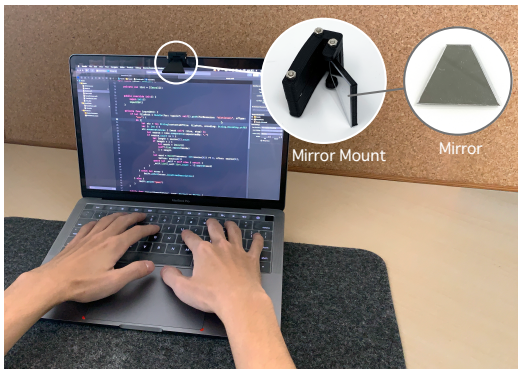

Figure 1: System's overview. A mirror is attached to the front-facing camera of a laptop computer with our own mirror mount. The user can execute the cursor move operation by the right hand, and the screen scroll operation, the caret move operation, and the font size change operation by the left hand, while keeping the hands on the home position of the keyboard.

2 RELATED WORK

Several methods have been proposed for enabling a user to perform various operations while keeping the hands on a keyboard. ThumbSense [3] allows a user to execute mouse operations using the touchpad while keeping the hands on the home position of the keyboard by making particular keys function as mouse buttons or wheels. Keyboard Clawing [2] is a method for detecting the scratched direction and strength from the sound generated when a user scratches the key tops of a keyboard with the nail; it uses this information for computer operations. Athalye [1] developed a system that estimates the distance between a user's finger and a laptop computer display by image processing the reflected image of the finger on the display by attaching a mirror to the front-facing camera of the laptop computer; the system can detect a touch on the display. Zhang et al. [5] proposed a method that distinguishes the left and right of a user's hand based on the touch points obtained from a touch panel, human anatomy, work area, fingers' orientation, and fingers' position. Zheng et al. [6] used fingers, hand, and their posture identification as keyboard shortcuts. They captured the images of fingers and hands on a keyboard by a built-in laptop camera augmented with a small reflector. In contrast to the above methods, we propose a method that uses the front-facing camera of a laptop computer for left–right hand distinction to allow the user to perform various operations while keeping the hands on the home position of the keyboard.

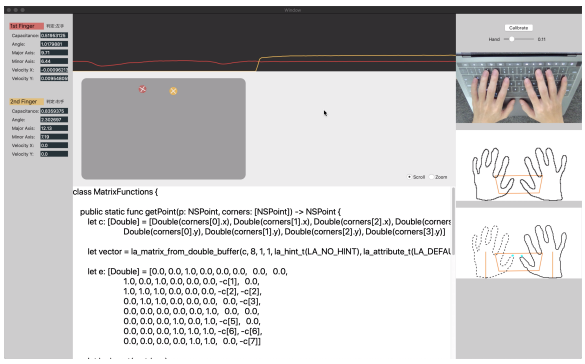

Figure 2: Software that performs left–right hand recognition and assigned operations.

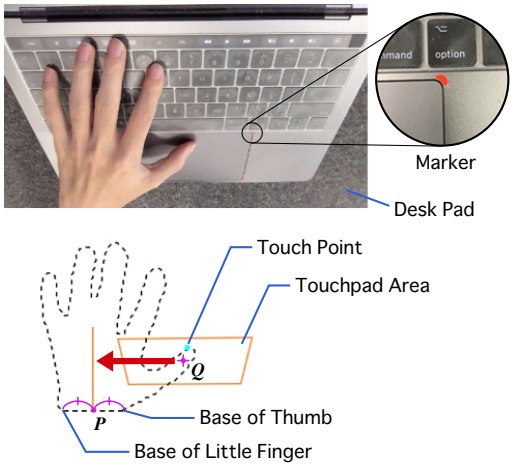

Figure 3: Distinction of left and right hands in the extracted hand area.

3 DISTINCTION SYSTEM

Figure 1 shows the overview of our system. We attached a mirror to the front-facing camera of a laptop computer (Apple MacBook Pro 13" with a 3.5 GHz Intel Core i7 CPU and 16 GB memory) with our own mirror mount to obtain images around the keyboard and the touchpad. We made the mirror by cutting a polycarbonate mirror sheet into a trapezoid with a pair of scissors. We printed the mirror mount with a 3D printer. The angle between the mirror and the screen can be adjusted in the range of 0 to 120 degrees with this mirror mount. In order to simplify image processing, a black desk pad is placed under the laptop computer for hand recognition and four red stickers are attached to the corners of the touchpad for recognizing the area of the touchpad.

We implemented a software that performs left–right hand distinction as an application running on macOS (Figure 2). This software locates the coordinates of touch points on the touchpad using Swift and MultiTouchSupport.Framework. In addition, the software uses AVFoundation.framework to obtain the image from the front-facing camera.

Our left–right hand distinction algorithm is performed as follows. For calibration, the system obtains the image including both the keyboard and touchpad to find the touchpad area. First, the system locates the coordinates of all the touch points if a new touch is detected on the touchpad; in this case, the system also obtains a new image. Next, the system extracts hands' areas from the obtained image (we currently use the algorithm of Song et al. [4]); it finds the left and right coordinates of the bottom of a hand area as the bases of the little finger or thumb (Figure 3). Then, the system distinguishes the extracted hand by comparing the midpoint (P) between the two finger bases with the center (Q) of the touchpad area; the system recognizes the extracted hand as the left hand if P is to the left of Q and otherwise as the right hand. Finally, the system relates each touch point to the left or right hands by testing which extracted hand contains a touch point through projective transformation of the touch point onto the touchpad area.

4 APPLICATION

We implemented the following functions as the application of our proposed system. We assigned the cursor move operation to the right hand and assigned the screen scroll operation, the caret move operation, and the font size change operation to the left hand. The user can perform various operations while keeping the hands on the home position of the keyboard by using the left and right hands appropriately depending on the situation.

5 LIMITATIONS

In our current implementation, human skin color detection is not robust because the front-facing camera is designed such that its exposure and brightness are automatically changed by the operating system. Thus the recognition is strongly affected by ambient light. Moreover, the color of the surface on which the laptop computer is placed must not be close to human skin color; the proposed system cannot extract the user's hands correctly if there exists an object in the image with color similar to the human skin color. In addition, we attached red stickers to the four corners of the touchpad for recognizing the touchpad area. Therefore, our immediate future work is to solve these limitations by improving our image processing algorithm.

Moreover, our current implementation covers the front-facing camera with the mirror and the mirror mount and thus obstructing video chatting. To resolve this limitation, we intend to replace the mirror with a half mirror and modify the image processing algorithm.

6 CONCLUSIONS AND FUTURE WORK

We proposed a left–right hand distinction system on the touchpad using the mirror and a front-facing camera of a laptop computer. The user can perform different operations with each hand without moving the hands from the home position of the keyboard with this setup. Moreover, our system can be widely used with currently available laptop computers simply by attaching the mirror without requiring any additional sensors. Our future work is to resolve the abovementioned limitations. Moreover, we intend to add a hand shape recognition algorithm to enable the user to perform many different operations by posing the hands differently on the keyboard.

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