Multi-finger AR Typing Interface for Mobile Devices

Satoshi Sagara
Saitama University
255 Shimo-Okubo, Sakura-ku,
Saitama City, 338-8570, Japan
sagara@is.ics.saitama-u.ac.jp

Masakazu Higuchi
Saitama University
255 Shimo-Okubo, Sakura-ku,
Saitama City, 338-8570, Japan
mhiguchi@mail.saitama-u.ac.jp

Takashi Komuro
Saitama University
255 Shimo-Okubo, Sakura-ku,
Saitama City, 338-8570, Japan
komuro@mail.saitama-u.ac.jp

Abstract
In this paper, we propose a user interface that enables multi-finger typing in the space behind a mobile device. By using the augmented reality (AR) technology, a virtual keyboard is superimposed on the rear camera image, and a hand region of the camera image is again superimposed on that image, which makes it possible to perform input operation as if there were a real keyboard. The system recognizes only key pressing actions and does not recognize a hand or fingers, which enables stable recognition and multi-finger input. Further, key typing at any place on a plane and in the air is possible. Demonstration using an experimental device showed that multi-finger input using a virtual keyboard displayed on the screen was realized.

Author Keywords
augmented reality; virtual keyboard; multi-finger input

ACM Classification Keywords
H.5.2 User Interfaces: Input devices and strategies
Introduction
In recent years, mobile devices such as smartphones equipped with a touch panel are widely used. One of the advantages of a smartphone is that it allows the user to carry out tasks such as editing of documents which have mainly been carried out on a PC. However, the screen of a smartphone is small because of its portability, and operations on the small screen are difficult, which impairs the convenience. This problem is particularly prominent in character input.

To solve this problem, input with wearing a special device, and input on a keyboard projected on a plane have been studied [1]. However, wearing a device on the body is cumbersome and the projection of the keyboard requires a certain area, which restricts usage environment.

For this problem, a system that allows input operation by recognizing the movement of a finger in the air with the front-mounted camera has been developed [2]. This system does not restrict usage environment. However, there are problems that input operation is not intuitive because the operation is indirectly carried out through a cursor, and that this system supports only one finger operation.

On the other hand, the research of an interface with the rear camera, instead of the front camera has also been conducted [3]. In this research, the system recognizes the tips of multiple fingers and the users can touch a virtual object which is superimposed on the display using the augmented reality (AR) technology. However, it does not recognize motion of the hand, and high-speed input operation on this system is difficult.

System Configuration
Figure 2 shows the system that was used in the demonstration. The system consists of a small display, a small monocular camera, and a PC. The display is a 4.3-inch USB display, and the camera is mounted on the back of the display. The image size and frame rate of the camera are 640 x 480 pixels and 50 fps (frames per second), respectively. In this study, we used a PC instead of a real mobile device as a first step for investigating the usability of the proposed interface.

In this paper, we propose an interface using the rear camera of the mobile device which enables the user to input with a virtual keyboard superimposed on a camera image displayed on the screen. Since the direction of the camera and viewing direction of the user are the same and the hand region is superimposed over the virtual keyboard, it is possible to type keys with a feeling as if there were a real keyboard. Also, the system does not recognize the hand and fingers, but recognize only hand motion, stable recognition is realized. In addition, the system supports multi-finger operation, which is faster than one finger operation. Further, key typing at any place on a plane and in the air is possible.
Typing Recognition
Optical flow is used for recognition of key pressing actions. It is calculated only in the skin color region in the captured image which is extracted using the range of the HSV color space,

\[100 \leq H \leq 115, \ 60 \leq S \leq 255, \ 65 \leq V \leq 255\]

Figure 3A shows the image that leaves only the skin color region of a camera image.

To detect the position, the obtained optical flow is scanned from the top left, and the first detected point that has larger motion than a certain value is set to be the search start point. Figure 3B shows the determined search start point and the search range. Figure 3C is an image representing the intensity of the optical flow, and a brighter pixel indicates larger motion. Figure 3D shows the largest moving point within the search range with a blue frame. The central point of the blue frame is recognized as the position where a key is pressed.

By using the largest moving point, it is possible to detect the finger that moves most largely even if the multiple fingers move at the same time.

In the cases when the whole hand moves, and when the mobile device moves, optical flow occurs on the whole hand. To deal with this problem, the detection of the key pressing action is determined by whether the number of flows is above threshold in a whole image.

AR Keyboard
We have created an application using the developed system which enables multi-finger typing on a virtual keyboard. By superimposing the skin color region over the virtual keyboard which is drawn on the camera image, it is possible to input with the sense that there were a real keyboard. Figure 4 shows an image that superimposed the user’s hand onto the virtual keyboard. When the action is detected by the method described above, the corresponding key on the keyboard with its position is pressed.
The layout of the virtual keyboard is a widely used QWERTY keyboard. The reason for this layout is that, if the keyboard is near the one familiar to the users, it is possible to make the input operation intuitively without special training.

Figure 5 shows the images of key typing in the developed application. From left to right, a ring finger, a middle finger, an index finger and a thumb are used for typing and multi-finger input is realized. By performing pressing actions with a finger on the virtual keyboard that is superimposed on the screen, it is possible to input characters. When a key is pressed, the key is displayed in red for a certain period of time to feedback the user information about which key is pressed.

Conclusions and Future Work
In this paper, we proposed a user interface that enables multi-finger typing using the rear camera of a mobile device at any place in the three-dimensional space. This interface enables input operation on AR keyboard without being limited to a small operating space and the user can perform more comfortable input even with a mobile device. Future works include improving the detection algorithm, which will make input operation faster and more comfortable.

References