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AirGrabber: Virtual Keyboard using Miniature Infrared Camera and Tilt Sensor

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Abstract

This paper presents the "AirGrabber", a virtual keyboard suitable for wearable computers, by which a user can enter characters by "typing" in the air on a virtual keyboard. The AirGrabber detects keystrokes by monitoring the motions of the fingers and hand through a miniature camera and a tilt sensor on the user's wrist.

Keywords: Wearable Computer, User Interface, Virtual Keyboard, Miniature Infrared Camera, Tilt Sensor

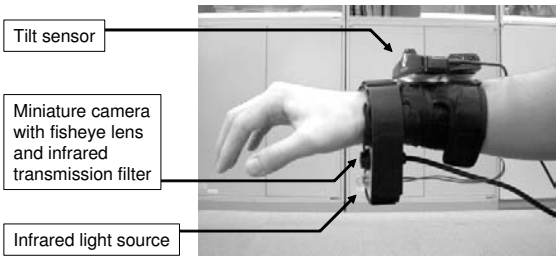

Figure 1: AirGrabber device

1. Introduction

The purpose of this research is to develop the character input device for wearable computers, by which users can input characters with the same feeling as using traditional keyboards. Although a number of "virtual keyboards" have been proposed, thus far the devices have been difficult to use because of restricted functionality or the requirement for special operational methods. We propose "AirGrabber", a novel virtual keyboard which consists of a miniature infrared camera and a tilt sensor attached at user's wrist.

2. Proposed method

To input characters by typing motion without physical keyboard, the system must recognize (1) which virtual key is ready to be typed and (2) whether a user types the key or not. In the proposed system (figure 1), for (1), relative position of a hand on a virtual keyboard is matched with tilt angle of user's wrist which can be measured by the tilt sensor. For (2), movement of user's fingertips is measured from images of the infrared camera under user's wrist.

2.1. Recognition of typing motion

The recognition of typing motion is achieved by the following steps of analysis of captured images:(1) extract hand region, (2) detect fingertips and (3) judge typing motion.

To catch the whole fingers in the viewing field of the miniature camera, a fish-eye lens is attached to the camera. To extract the hand region stably, the infrared light is attached under the camera and the infrared transmission filter is inserted. Using infrared light enables simple thresholding process to extract the hand region.

For the detection of fingertips from the binarized image of extracted hand region, we adopt two different methods for improving accuracy of detection. The Hilditch's line thinning algorithm is applied to the binarized image and the downward end points are regarded as fingertips. At the same time, the edge line is extracted and the downward arch lines on the edge line are regarded as fingertips.

For judgment of typing motion, we detect the rapid downward movement of fingertips.

2.2. Change of enable/disable of keyboard

The motion of user's palm relative to user's wrist is detected and used for change of enable/disable status. This detection is executed whether the hand region totally disappears from the captured image. When the virtual keyboard becomes enable, the tilt angle of user's arm is set as the home position of the virtual keyboard for enabling users to use the proposed virtual keyboard in any preferable posture.

3. Experiments

Experiments reveal that (1) the selection of keys ready to be typed is achieved within 1 second, (2) the average accuracy of typing motion recognition is around 90 %, and (3) the input of ordinary sentences by "AirGrabber" is possible, but it takes about seven times as long as using ordinary keyboards.

4. Conclusion

We proposed the virtual keyboard "AirGrabber" for wearable computers. Through the experiments its capability as character input device was shown.

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