Improving the Usability of a Wearable Input Device SCURRY™

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ABSTRACT

In this paper, a finger-click recognition method is proposed to improve the recognition performance for finger-clicking of a wearable input device, called SCURRY™. The proposed method is composed of three parts including feature extraction part, valid click discrimination part, and cross-talk avoidance part. Two types of MEMS inertial sensors are embedded into the wearable input device to measure the angular velocity of a hand (hand movement) and the acceleration rates at the ends of fingers (finger-click motion). The experiment applied to the SCURRY™ device shows the improved stability and performance.

Keywords

Wearable Input Device, Initial Sensor, Finger-clicking, SCURRY™

INTRODUCTION

Current mobile computing device manufacturers have a difficulty in putting information into their products, and require different input devices that are easy to control and small to attach. As a result, researchers have introduced various input items such as chording devices [1-3] and finger devices [4-5]. However, these are difficult to handle or to learn how to use. We introduce the concept of a hand wearable input device SCURRY™ [6], which can be used as both keyboard and mouse.

The SCURRY™ device is composed of two kinds of inertial sensors: gyroscopes that read the angular velocity of a hand movement and accelerometers that read the acceleration of a click motion.

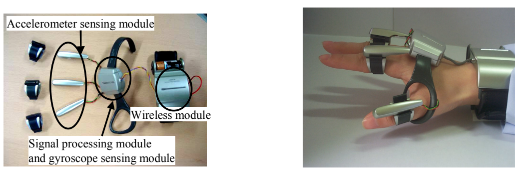

Figure 1: SCURRY™, a new wearable input device

In this paper, we propose a finger-click recognition method, that can improve the recognition performance for finger-clicking of the wearable input device. The experiments were conducted to verify the effectiveness and efficiency of the proposed method.

SCURRYTM KEYBOARD SYSTEM

Hardware

A wearable input device, SCURRY™, has three function blocks, which are the sensing block, the signal processing block, and interface block. The sensing block consists of two kinds of sensors: two gyroscopes that sense the up and down, left and right movements of a hand and four accelerometers that sense the click motion of each finger of the hand (Figure 2).

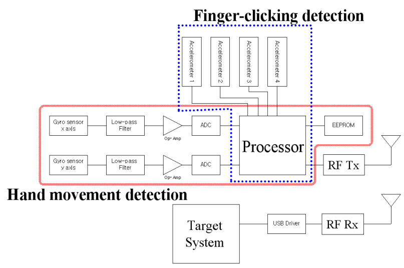

Figure 2: Schematic diagram of SCURRY™ hardware

Input Mechanism

A pointer is displayed on the screen while the human operator with SCURRY™ interacts with a target system. The pointer can be displayed with virtual keyboard in case that the device is used for a wearable keyboard. Through the finger-clicking and hand motion, the human operator can select any character, event, or operation on the virtual keyboard spatially without physical touch. As such, SCURRY™ can be used as a wearable mouse by allowing any three fingers to be operated as the left, middle, and right mouse buttons in similar manner as it allows the human operator to point and selects any character, event, or operation by both his hand motion and finger-clicking as a wearable keyboard.

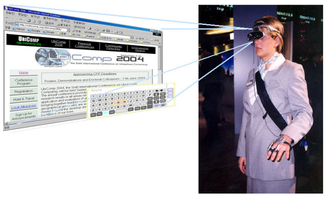

Figure 3: Input mechanism

Finger-click Recognition

The operator's input on the developed input device is motion and finger-clicking. As these two movements are obtained from the outputs sensed by the gyroscopes and accelerometers respectively, unintentional noises or cross-talks between the fingers or between the hand motion and the finger-clicking cause wrong or inaccurate data. The result degrades a recognition performance, even a wrong operation or recognition failure of the finger-clicking. For these reasons, the method for exact finger-click recognition is proposed composed of the three parts:

- *The feature extraction part* extracts the feature signal to determine whether the accelerometer output is generated by the finger-clicking with the operator's intention. The feature signal is extracted based on the latency between the two low-pass filtered outputs and the subtraction amount of them.
- *The valid click discrimination part* determines exactly which finger is clicked from all the accelerometer outputs. Once the feature signal extracted in a finger is determined as the valid finger click, the other feature signals generated during predetermined time are ignored to avoid wrong operation caused by either noises or another cross-talk.
- *The cross-talk avoidance part* allows the hand motion and finger-clicking not to be coupled by making them to be transferred separately after they are determined as the human intention.

EXPERIMENTAL RESULTS AND DISCUSSIONS

The recognition performance of the finger-clicking with the proposed method is examined by a simple experiment and

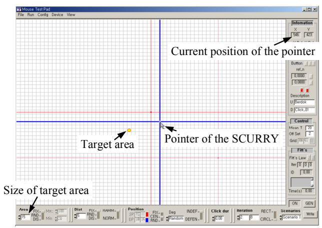

Figure 4: An observed environment

compared to that without the method. The environment (Figure 4) generates a target circle with 15pixel radius at random position. The task is given to see whether the human subjects on the developed device, SCURRY™, can point the random-made target position and generate the finger-clicking on it in given time (figure 4). In case that the human operator can make the finger-clicking successfully on the circle within the given time, the finger-clicking is counted as the successful operation.

Five subjects participated in the test composed of 4 sets with 20 per one trial. The experimental results showed about 15% of the performance improvement for the exact finger-click recognition are achieved with the proposed method (Figure 5).

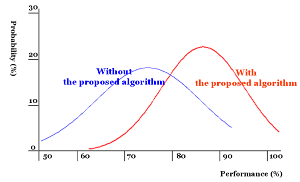

Figure 5: Performance comparison of the finger-clicking with/without the proposed method

CONCLUSIONS

A finger-click recognition method composed of the three parts (feature extraction, valid click discrimination, and cross-talk avoidance) was proposed to improve the recognition performance for the finger-clicking on SCURRY™. Observed environment is designed to examine how the entire proposed method including the three parts verified respectively in the above improves the recognition performance of the finger-clicking. The experimental results proved that the performance of the finger-clicking is improved by the proposed method.

REFERENCES

1. Handykey Corp., Twiddler, http://www.handykey.com
2. Fukumoto, M. and Tonomura, Y., Body Coupled FingerRing: Wireless Wearable Keyboard, *CHI97 Conference Proceedings*, Atalanta, Mar. 1997, pp.147-154.
3. Rosenberg, R. and Slater, M., The Chording Glove: A Glove-Based Text Input Device, *IEEE Trans. Syst., Man, Cybern.,* vol. 29, May 1999, pp.186-191.
4. Carsten, M., System and method for keyboard independent touch typing, US Patent 6,670,894 Dec. 2003.
5. Perng, J. K., et al., Acceleration sensing glove (ASG), *3rd ISWC IEEE,* Calif., pp. 178-180, Oct. 1999.
6. Lee, S., et al., SCURRY Keyboard - A New Wearable Input Device, *6th IEEE ISWC*, WA, Oct. 2002.