An Armband-Type Touch-Free Space Input Device for HCI

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Abstract. In this paper, the design of an armband-type non-touch space input mouse for human computer interface is presented. Demand for a non-touch type input system has been increasing with the development of large-display technology. One of the non-touch type input system is a system based on gesture recognition. There is a lot of research on gesture recognition systems based on vision, but the presented device has advantages in terms of accuracy. The globe type input system is already developed, but the users do not want restrictions on finger actions. Unlike a glove type device, an armband device type does not constrain finger movements. We designed an armband- type space input mouse by using arm movement and wrist gesture actions.

Keywords: Armband, Non-touch, HCI, 3D space.

1 Introduction

Interaction technologies between a computer and a user are changing not only from interactions based on a traditional keyboard and mouse in the desktop environment, to the interactions based on a user's natural behavior in a three-dimensional input space, but also from interface based on audio-visual displays to realistic interfaces by using human touch senses. A variety of research for input device is being conducted [1]-[4]. Demand for a non-touch type input system has been increasing with the development of large-display technology. One of the non-touch type input system is a system based on gesture recognition. There is a lot of research on gesture recognition systems based on vision, but the presented device has advantages in terms of accuracy. Users would like to control devices by using small motions. The globe type input system is already developed, but the users do not want restrictions on finger actions. Unlike a glove type device, an armband device type does not constrain finger movements.

In this paper, the design of an armband-type non-contact space input for human computer interface is presented. An armband-type non-touch 3D space input mouse is I/O interface technology for manipulating various devices using a user's arm/wrist gestures. The user wears the device on the wrist in contactless 3D space environment, such as a large smart interactive TV or HMD. We designed an armband-type space input mouse by using arm movement and wrist gestures. The practical considerations of an armband-type non-touch space input system are the contactless interface based on multi-sensor; the natural behavior of users such as arm, and wrist motion recognition; and convenience, such as small size unrestricted motions.

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2 Design of an Arm Band-Type Space Input Mouse

We designed an armband-type space input mouse that uses arm movements and wrist gestures. Unlike a glove type device, the armband device type does not constraint on the finger movements. Therefore, wearing the armband, users can type on a keyboard and wear gloves.

This type is a non-touch space input mouse that uses arm movements and wrist gestures(bending actions), as consisting of gyro sensors, accelerometers and proximity sensor array. The point of the mouse can be moved by recognizing arm movements from data processing of the IMU sensors, such as gyro sensors, and accelerometers. From data processing the proximity sensors array, a user can right/left-click input with wrist bending gestures.

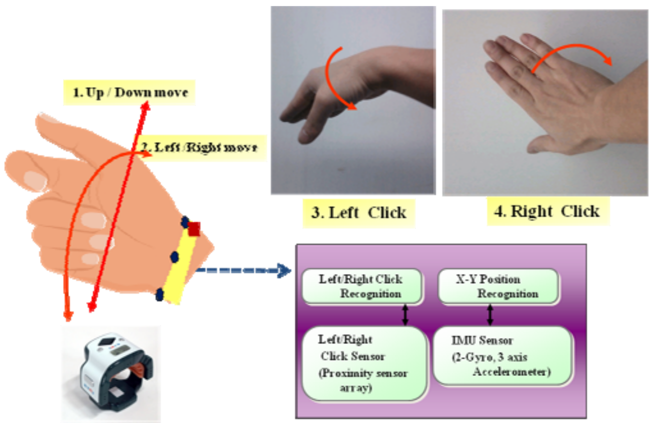


Fig. 1. Non-touch 3D space input mouse: Armband-type

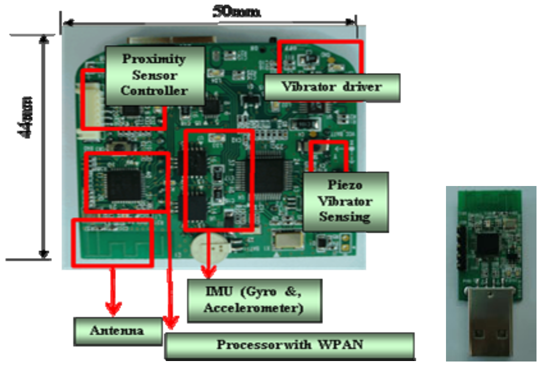
This space input system can also be used by a surgeon wearing surgical gloves to see MRI images etc. In other words, this device can also be used as a space input mouse in areas with special environmental constraints. It can be used by disabled people with impaired fingers, as well as for game, and portable handheld information devices. Like a PC mouse, this armband type space Input mouse also has six kinds of basic functions such as up, down, left, and right move and left click, and right click.

Figure 1 shows how to click by using the non-touch 3D space input mouse(armband-type). This armband-type space input system consists of IMU sensors to recognize arm gestures, and proximity sensors array to recognize wrist bending gesture.

3 Implementation and Experimental Results

3.1 Non-touch 3D Space Input Mouse Prototype

The armband-type non-touch 3D space input mouse is I/O interface technology for manipulating various devices using a user's arm and wrist gestures with wearing on the wrist in contactless 3D space environment, such as large displays or HMDs. The focus of the second type of mouse prototype is on improving accuracy. And Haptic feedback was also considered. In addition, by using the wrist gestures, this system is available to some disabled people with impaired finger. The non-touch 3D space input mouse board(armband-type) and the USB type receiver dongle for wireless communication are shown in figure 2. The USB type receiver dongle is for IEEE 802.15.4 wireless communication and support of HID. The system consists of an MCU with WPAN, IMU sensors, a proximity sensor array, and a vibration motor. The two gyro sensors and accelerometer are used to move the pointer. The proximity sensors array is used to recognize wrist gestures. In this system, infrared-type and capacitance-type proximity sensors are used respectively. The accuracy of left/right clicking using wrist gesture was very good. The capacitance type and infrared type sensors had almost the same accuracy. The mouse can be used for mapping between instructions and various wrist gestures.



(a) (b)

Fig. 2. (a)Non-touch 3D space input mouse board: Armband-type. (b) The USB type receiver dongle for wireless communication.

We adapt IEEE 802.15.4 as the wireless network part of this system that provides a low powered wireless data transmission. This wireless network communication based on IEEE 802.15.4 can be useful in a multi-pointer. And the vibration motor is used for realistic vibration feedback. After recognizing of wrist gestures, this system provides vibration feedback for users. Figure 3 shows the non-touch 3D space input mouse prototype for armband-type. The figure also shows the location of the proximity sensor array. To introduce the hands-free concept, the tilt information of the accelerometer sensor was used. Depending on the slope(roll) of the wrist, we divide pointer states into two classes: a mouse point active state and a halt state. In an active state, the mouse pointer can be moved freely. On the other hand, in a halt state, the mouse pointer is halted for hands-free of users. This is to prevent the unintended input as a result of the user's hand gestures. This method provides more convenience to users.

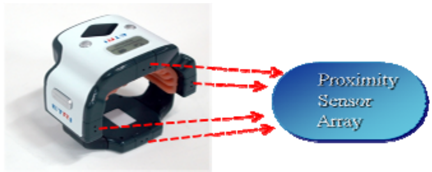


Fig. 3. Non-touch 3D space input mouse prototype: Armband-type

This function has the concept of calibration of the pointer and hands-free. Table 1 shows the main feature and specifications of the non-touch 3D space input mouse prototype for armband-type.

Table 1. Main features and specifications of the Non-touch 3D space input mouse prototype: Armband-Type

Main features and Specifications
- IMU(gyro sensors and accelerometers)-based pointer manipulation : data range:-300 ~ + 300 deg/sec, resolution: 0.1 deg/sec, support of Projected X, Y - Improve accuracy : the wrist gesture recognition using a proximity sensor array(left/right click, scroll, etc) - Accuracy (left / right click) : 99 % - Vibration for realistic feedback - Low power wireless communication based on WPAN(802.15.4) - Compatibility : support of human interface device spec. (HID standard protocol)

3.2 Signal Processing for the Armband Space Input Mouse

The signal processing for the armband-type space input mouse are as follows.

- FIR filtering, Normalize , Feature extraction, Power extraction
- Moving average Windowing Processing, Adaptive threshold
- Silence period for robust, Rule based reasoning.

4 Applications of the Armband-Type Space Input Mouse

The armbands system can be used in various applications. The applications of the armband space input mouse are as follows.

- An entertainment system(Games/Simulation/Smart TV)
- A virtual control in VR, AR(3D UI control)
- A space mouse
- An HCI for a surgeon wearing surgical gloves and HMDs.
- An input device for disabled people with impaired finger

The applications of the armband space input mouse are shown in figure 4 .
We expect this input system to be used as one of the HCI systems. The applications of the armband space input mouse are shown in figure 4 . We expect this input system to be used as one of the HCI systems.

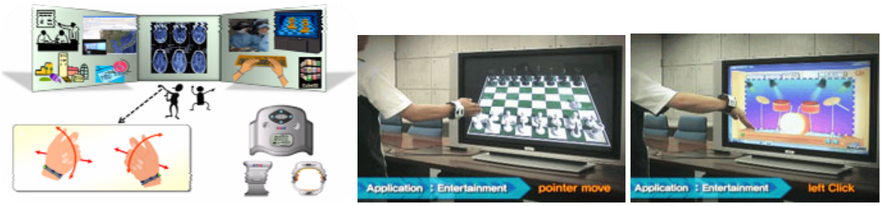


Fig. 4. Applications of The armband-type space input mouse

The armband-type space input mouse type is used in entertainments(games). It can also be used for smart TV or IPTV. The armband-type space input mouse was tested for effectiveness by applying for many applications.

5 Conclusion

In this paper, the design of an armband-type non-touch space input for human-computer interface is presented. The armband-type space input system was implemented for a feasibility test. And the system was tested for effectiveness. The applications of the armband space input system are presented. The extended gesture functions are tasks for the feature.

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