Flexible and Wearable Hand Exoskeleton and Its Application to Computer Mouse

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Abstract. This paper proposes a flexible and wearable hand exoskeleton which can be used as a computer mouse. The hand exoskeleton is developed based on a new concept of wearable mouse. The wearable mouse, which consists of flexible bend sensor, accelerometer and bluetooth, is designed for comfortable and supple usage. To demonstrate the effectiveness of the proposed wearable mouse, experiments are carried out for mouse operation consisting of click, cursor movement and wireless communication. The experimental results show that our wearable mouse is more accurate than a standard mouse.

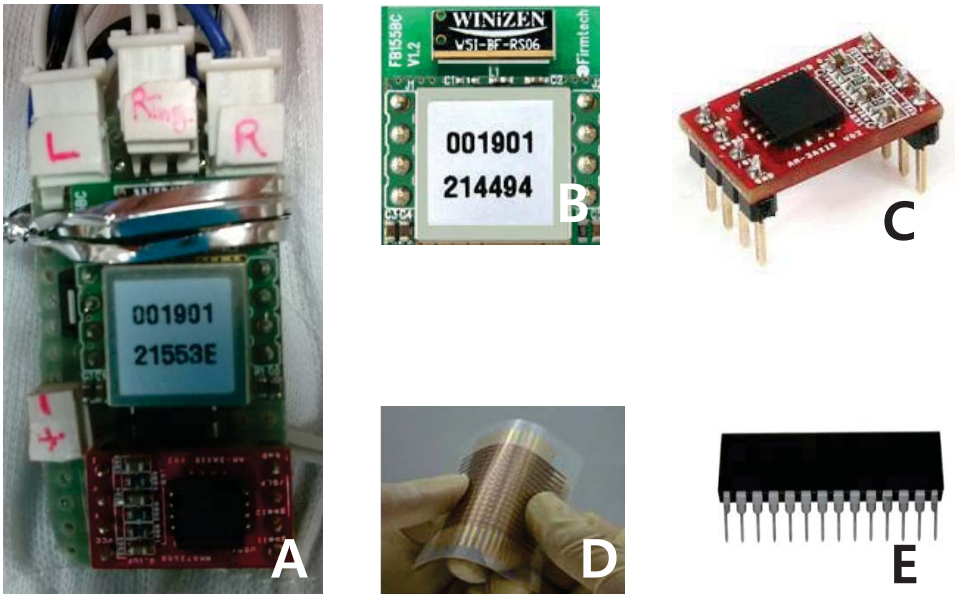
Keywords: wearable mouse, hand exoskeleton, computer pointing devices, cursor positioning, perceptual user interface.

1 Introduction

For most people who use computer, a mouse is assumed to be a standard device widely used. The concept of standard mouse is simple and useful to click and move the mouse point. However, there exist several inconvenient disadvantages. First of all, the standard mouse need bigger place than certain place for hand to grab. Secondly, it is under space constraints on the transparent or uneven space. Finally, It is impossible for our hand to use the keyboard and the mouse at the same time.

A lot of wearable or exoskeleton applications have been developed for its convenient reasons. Therefore, recently, in most of wearable or exoskeleton applications, those are on walking assistance for people with mobility problems or military purpose. Many types of wearable mouse were developed such as wearable wrist support for computer mouse [1], wearable computer pointing device [2] and wearable inertial mouse [3]. Although there have been various researches on wearable mouse, they are not convenient and have several problem when put to use.

The previous mouses have several problems. Thus, in this paper, wearable and flexible mouse is developed to solve those problems. The proposed mouse consists of flexible sensor to click, accelerometer to move the pointer and bluetooth for wireless communication with computer. On account of improved accuracy



(a) Board overview (b) Bluetooth (c) Accelerometer (d) Flexible sensor (e) ATMEGA8

Fig. 1. Wearable mosue main hardware components

and delicacy of this mouse, it can be applied in the domain of game, art and construction design.

This paper is organized as follows. Section 2 describes hardware design. In Section 3 and Section 4, performance property and technology of wearable mouse are described. An experiment result is discussed in Section 5. Finally, conclusion and further work are described in Section 6.

2 Hardware Design

2.1 Wearable Mouse Overview

The wearable mouse is composed of bi-directional flexible bend sensor, three axis low-g micromachined accelerometer, WLAN-bluetooth chip antenna and ATMEGA8-16PU in Fig. 1. The two bi-directional flexible bend sensors are placed on the forefinger and middle finger so that their movement is detected. It decreases resistance when it is bent or flexed in either direction. The use of three axis Low-g micromachined accelerometer allows the wearable mouse to sense movement of mouse pointer. WLAN-bluetooth chip antenna(w51-BF-RS) which is embedded in bluetooth module is used for wireless communication between the wearable mouse and the computer in order to give and take signals without USB. ATMEGA8-16PU which is 8-bit AVR with 8K bytes in-system programmable flash is used to program.

Fig. 2. Overall structure.

2.2 Overall Structure Design

The mouse has three main functions, i.e., click, cursor movement and communication with computer. It is composed of buttons, photo sensor, and rotary encoder. However, it is under space constraints on the transparent or uneven space and is impossible for our right hand to use keyboard and mouse at the same time. Thats why, in this paper, wearable and flexible mouse is developed to solve those problems. In order for wearable mouse to have these essential mouse functions, flexible bend sensor, accelerometer and WLAN-bluetooth chip are used in Fig. 2. Flexible bend sensor is in charge of click instead of button of standard mouse. Accelerometer is used for cursor movement up and down instead of photo sensor of standard mouse. USB receiver is not used because WLAN-bluetooth chip can be operated for wireless communication with computer.

3 Performance Property

Table 1. Flexible sensor performance methods

	Flexible sensor performance methods
Right click	While both forefinger and middle fingers with flexible sensors are bent, bend and spread out middle finger
Left click	While both forefinger and middle fingers with flexible sensors are bent, bend and spread out forefinger
Scroll wheel up	While both forefinger and middle finger with flexible sensors are spread out, slightly incline right part of hand
Scroll wheel down	While both forefinger and middle finger with flexible sensors are spread out, slightly incline left part of hand

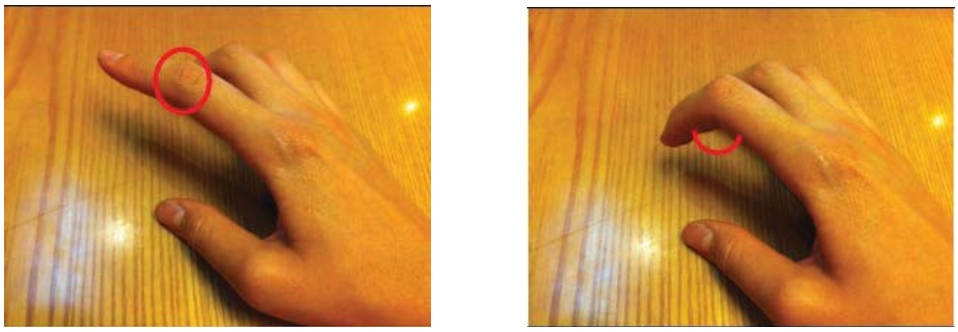


Fig. 3. Left click: like standard mouses left click, sensing whether left flexible sensor is bent or not is in charge of left click.

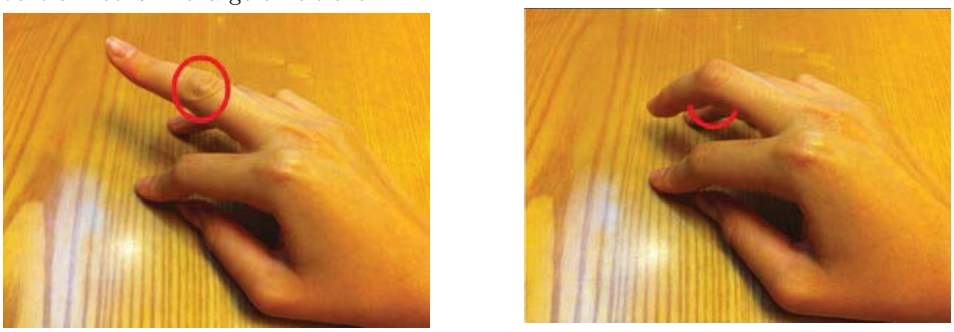


Fig. 4. Right click: like standard mouses right click, sensing whether right flexible sensor is bent or not is in charge of right click.

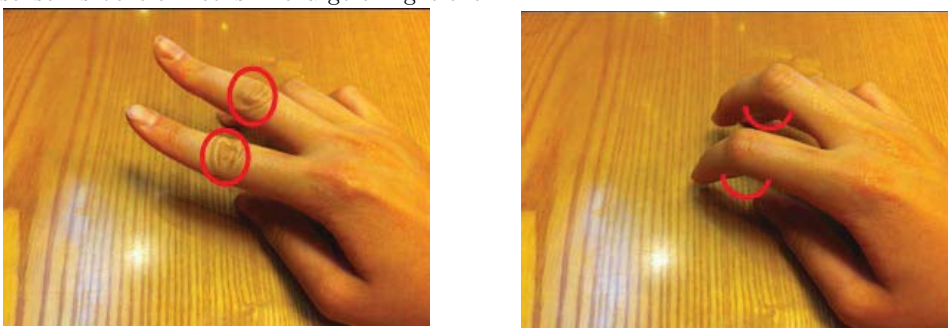


Fig. 5. Drag: like drag ofstandard mouse, sensing whether both flexible sensors are bent or not is in charge of drag.

Table 2. Accelerometer sensor performance methods

Accelator sensor performance methods	
Cursor movement up	Hand move up
Cursor movement down	Hand move down

4 Technology of Wearable Mouse

Table 3. Advantages of flexible and wearable mouse

Problem of standard mouse	Strong point of wearable mouse
Portable problem	Wearable mouse has effective size and shape because it is attached on the hand
Space constraints	Transparent and uneven spaces do not affect the performance of the wearable mouse
Effectiveness problem	Wearable mouse is more convenient because it is possible for our hand to use keyboard and mouse at the same time
Inconvenience of touch pad and joystick	Wearable mouse is more familiar and practical by using only hand movement
Obvious fact	Wearable mouse is break from the normal design idea

5 Experimental Results

5.1 Experimental Setting

An experiment was carried out with both standard mouse and wearable mouse independently, in order to determine the accuracy of each device. For this purpose, the mouse tracker program was used to observe both trajectory pattern. The mouse tracker program was run 30 times for each device. And the average trajectory pattern result can be observed in Fig. 6. The experiment setting for the standard mouse was comprised with a commercially available laser mouse with its corresponding mouse pad.

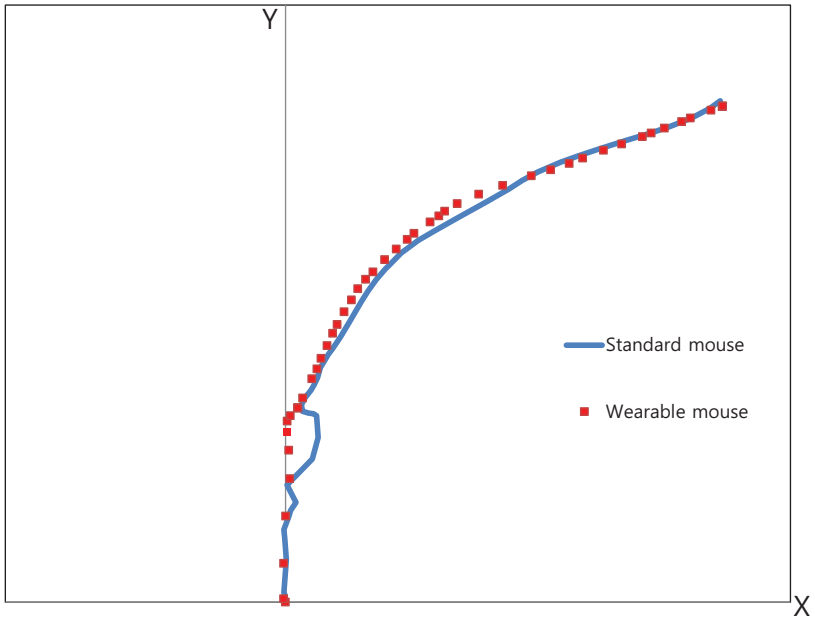
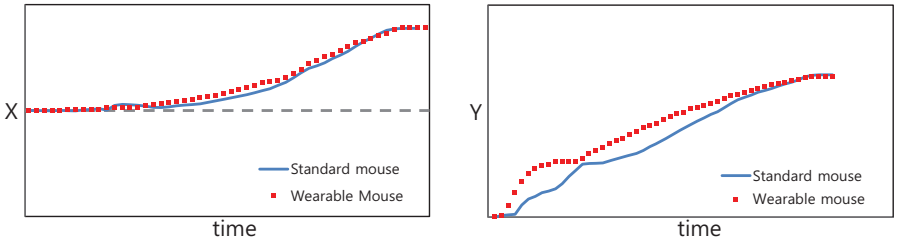


Fig. 6. Y versus X mean tragectory.



(a) X trajectory versus time (b) Y trajectory versus time

Fig. 7. X and Y time-course.

5.2 Experimental Results

One of the drawbacks of this setting is the existence of friction between the mouse and mouse pad and between the users arm and the desk, causing slight inaccuracies in the mouse trajectory. Even though during the experiment, both devices reached the goal point successfully, a big difference could be observed between both trajectory patterns. This phenomenon is due to the existence of friction, previously explained, in the standard mouse. Furthermore, for a standard mouse to operate correctly, it has to be in permanent contact with a smooth surface which cause friction, leading to accuracy errors if it is momentarily lifted from such a surface. However, when the wearable mouse is used, there are less accu-

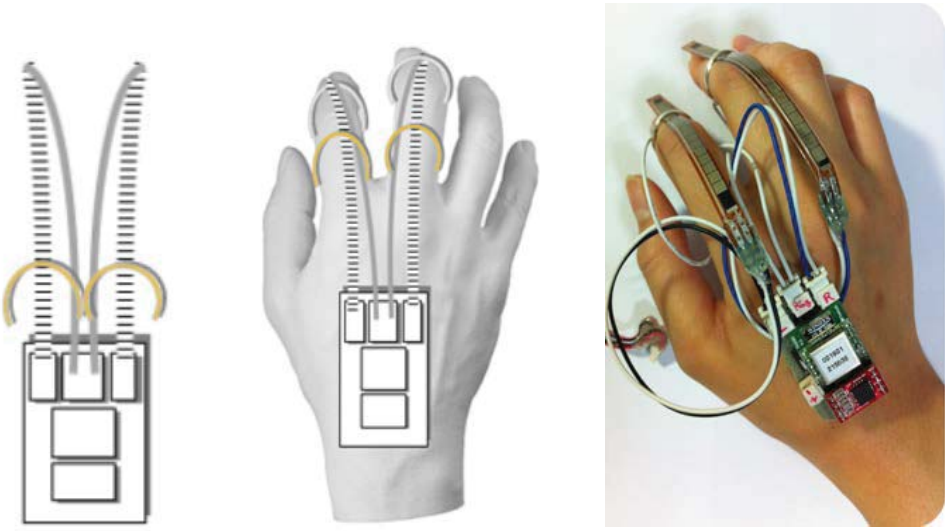


Fig. 8. Finished product.

racy errors compared to the standard mouse. In case of using wearable mouse, an accelerometer is used when the cursor move up and down. Thats why an accuracy of wearable mouse in the mouse trajectory is better because there do not exist friction between the mouse and mouse pad and between the users arm and the desk. The friction in y-axis is bigger than the friction in x-axis because the right arm, used to move the mouse, lies on y-axis in Fig. 7. Therefore, there is less x-axis error. On the other hand, the y-axis trajectory of standard mouse oscillates severely. This result shows us that wearable mouse with accelerometer instead of photo sensor has more accuracy. And click using flexible bend sensor is operated successfully.

6 Conclusion and Further Work

This paper proposes a wearable and flexible hand exoskeleton with a new concept and design, which can be used as a wearable computer mouse in our daily life. In experiments, the proposed device was used as a computer mouse and the results were compared with a standard mouse. While the standard mouse is simple and useful to click and move mouse point, there exist several inconvenient disadvantages such as limited space and non-operation on transparent or uneven surface and impossibility to use keyboard and mouse at the same time. In the case of using a wearable mouse, most of the problems in using a standard mouse were solved. Moreover, the experiments demonstrated that a wearable mouse had better accuracy than a standard mouse.

The proposed wearable device can be applied in domain of various game, art and construction design. Although there are a lot of merits of wearable mouse, flexible sensor is a little bit long and the board on the hand is also a little bit big. Thus, our further work is to reduce board's size and to replace flexible bend type with a more comfortable type.

Acknowledgements

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