Wearable Line-of-Sight Detection System Using Transparent Optical Sensors on Eyeglasses and Their Applications

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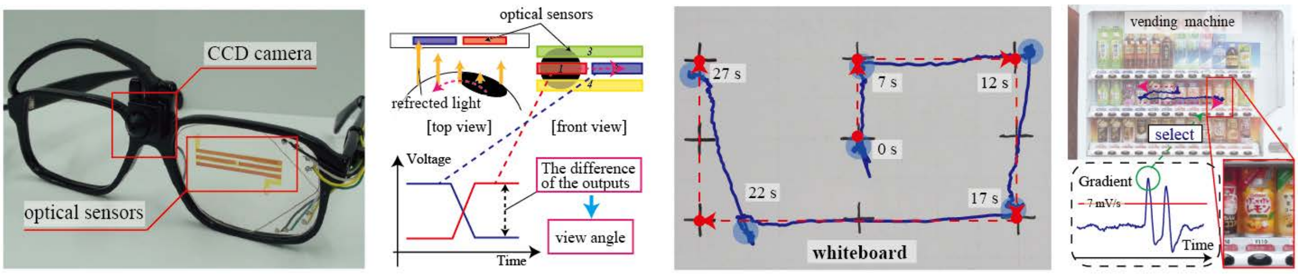

(a) (b) (c) (d)

Figure 1: (a) Line-of-Sight (LOS) detection system which has micro-fabricated transparent optical sensors on eyeglasses. (b) The optical sensors detect the light reflected from the eyeball. (c) The deduced LOS on a whiteboard. (d) The selection of the drink from the vending machine.

1. Introduction

The line-of-sight (LOS) detection system has various applications, such as in the field of communication technology, human-computer interaction, safety and security [1]. In early studies, using an external camera and infrared camera to detect the location and motion of the pupil is the mainstream method of detecting LOS. However, these methods involve several problems in that they restrict users' activities and expose them to physical and mental stress. With this in mind, a solution to enhance the practicality of the promising LOS detection applications, with systems that do not impose any restriction on users' activities nor expose them to any stress, is strongly demanded.

2. Our work

We demonstrate a line-of-sight detection system which has micro-fabricated transparent optical sensors on eyeglasses as photographed in Figure 1(a). Dye-sensitized photovoltaic cells are micro-patterned to be used as optical sensors. As shown in Figure 1(b), optical sensors on eyeglasses detect the reflection light from the eye, which is stronger from the white than the black, and can deduce the pupil position. The system has only 4 cells. Since this system is wearable and transparent, it neither limits users' activities nor blocks their sight. No external camera and no infrared camera are necessary to detect the pupil position, which contributes the simplicity and light weight of the system (60 g).

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3. Experiments

First, we developed the algorithm to detect the view angle using the output voltages of the cells in an analogue manner. The view angle was correlated to the output of the cells. Figure 1(c) shows the deduced trajectory of the LOS on a whiteboard. The averaged detection accuracy was 1.5 ° in the view angle. The results verified that the proposed cell design achieved highly accurate LOS detection in both the horizontal and vertical directions

Second, we deduced characteristic output signals of the cells when the user blinked as shown in Figure 1(d). Eye-blinking can be used as a trigger to initiate the LOS measurement, select objects, etc.

Finally, we successfully demonstrated applications of the user's LOS that was detected by the proposed system, which included selection of objects to express the user's intent and tracking the point of regards to deduce the user's interest. Figure 1(d) shows the attempt to select a product in the vending machine on a street. The system could be successfully used outside of the laboratory.

References

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