A Study of Visual Augmentation by Projecting Images onto Eyelids

Hironobu Sakai, and Naoki Hashimoto

***Abstract*— In this research, we propose a method of visual augmentation by projecting images onto eyelids during the blackout period of blinking. Images are superimposed on the eyelids from a projector in synchronization with detecting the blinking. This method aims to realize more immersive and natural AR experiences without any field of view restrictions.**

I. Introduction

Recently, the research of Augmented Reality (AR) is actively promoted. Using a head-mounted display (HMD) is effective for it. One of the problem is that the display is placed in front of the eyes, which ristricts the field of view and strains the user's neck. On the other hand, spatial AR that projects images on the surrounding wall is also used, but it has the problem of restricting the places where it can be used.

In this research, we aim to realize AR that uses one's own eyelids as a screen instead of a display like an HMD.

II. Proposed Method

In this research, we propose a method of superimposing projected images on the normal visual observed from the outside world by projecting images onto the eyelids as a screen synchronized with the blinking. This eliminates the need to wear a screen in front of the eyes as in the past, and frees the user from restrictions imposed by the weight and field of view of the screen. In other words, AR with more natural and immersive experiences can be achieved.

Unlike previous research [1] that continuously projects images onto closed eyelids, our method projects images only at the moment of a blink, as shown in Fig. 1. The blink is detected by an optical sensor. This triggers a high-speed projector to project synchronized images onto the eyelids.

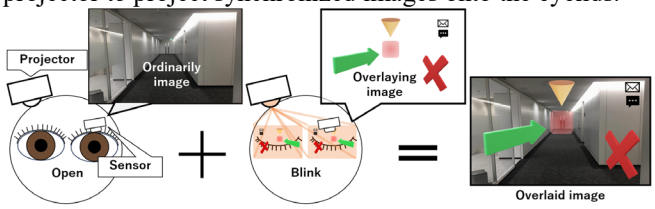

Figure 1. The image of the proposed method

A photo reflector consisting of an infrared LED and a phototransistor is used as a sensor for blink detection, and a microcontroller is used to read out the value. The sensor irradiates infrared onto the eyelids and detects differences in the amount of reflection due to changes in the skin caused by blinking. A smoothing filter is applied to the detected values using a microcontroller to reduce noise.

In the blinking motion, there is a period of time when the eyes are completely closed, which is called blackout. As shown in Fig. 2, the start and end of blackout are detected by setting threshold value for each of it. It is adjusted so that the LED placed in front of the eye is turned on for the blackout period which is detected and this is no longer visible.

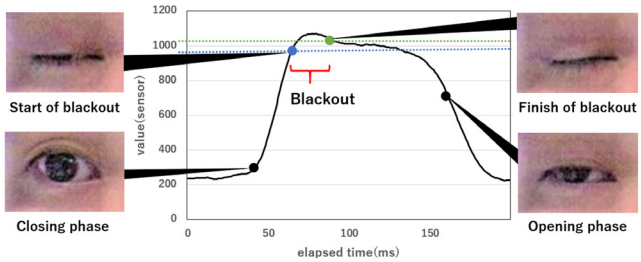

Figure 2. Blackout interval detection

III. Findings / Discussion

As a result of projecting red, blue, and green images at the moment of blinking, we were able to perceive each color. In addition, as shown in Fig. 3, when an image with green on the right side and blue on the left side was projected, we perceived the corresponding colors by changing one's gaze. However, in both cases, the color was perceived as blurred. This may be due to the light hitting the tissue inside the eyelid as it passed through the eyelid, or due to the diffusion of light caused by the focal distance adjustment limit of lens of ours.

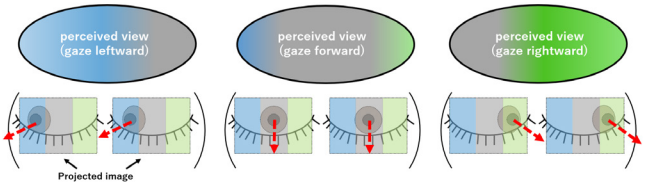

Figure 3. Color perception results

IV. Conclusion and Recommendations

In this study, we proposed a visual enhancement method by using eyelids as a screen and projecting images onto the eyelids during blinking, and conducted some preliminary studies. We found that the visual information that could be perceived differed depending on the projected image. In the future, we plan to increase the number of subjects and verify the significance of the visual enhancement.

References

[1] Goki Muramoto et al, "EIPD : Eyelid Image Projection Device", 25th Virtual Reality Society of Japan Conference, 3B3-7, 2020

* Research supported by JSPS KAKENHI Grant Number JP21K19789.

Hironobu Sakai is with the School of Informatics and Engineering, The University of Electro-Communications
(email: sakai@hashimoto.lab.uec.ac.jp).

Naoki Hashimoto is with the Graduate School of Informatics and Engineering, The University of Electro-Communications
(email: hashimoto@uec.ac.jp).