Experience Visual Impairment via Optical See-through Smart Glasses

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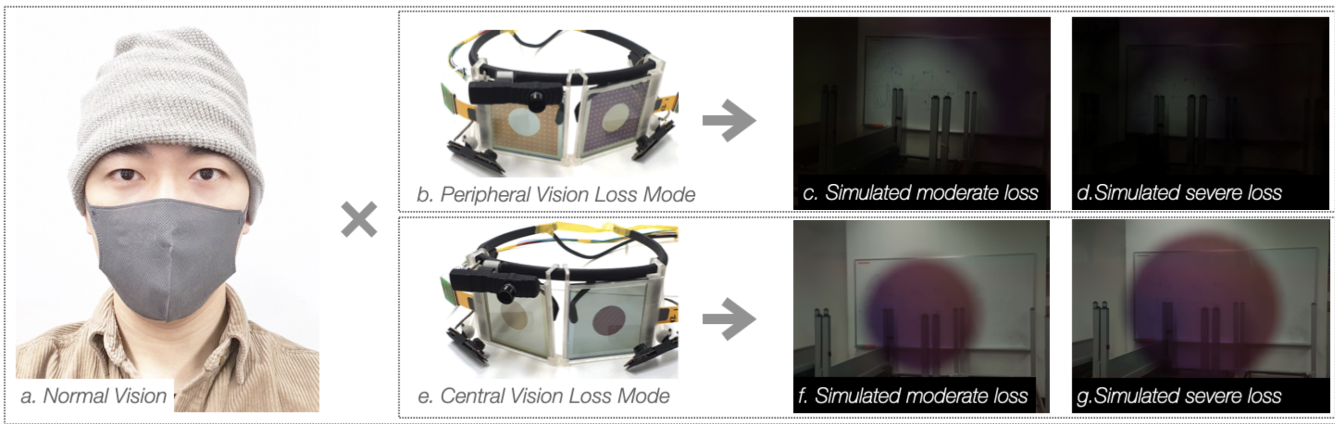

Figure 1: The optical see-through Visual Impairment Simulation Glasses Prototype a) for a user with normal vision b) demonstrates peripheral vision loss e) or central vision loss and c&d) modifies peripheral vision loss from moderate to severe or f&g) modifies central vision loss from moderate to severe.

ABSTRACT

As the population ages, many will acquire visual impairments. To improve design for these users, it is essential to build awareness of their perspective during everyday routines. Although several visual impairment simulation toolkits exist in both academia and as commercial products, analog, and static visual impairment simulation tools do not simulate effects with respect to the user's eye movements. Meanwhile, VR and video see-through-based AR simulation methods are constrained by smaller fields of view when compared with the natural human visual field and also suffer from vergence-accommodation conflict (VAC) which correlates with visual fatigue, headache, and dizziness. This demonstration enables an on-the-go, VAC-free, visually impaired experience by leveraging our optical see-through glasses. The FOV of our glasses is approximately 160 degrees, and participants can experience both losses of central vision and loss of peripheral vision at different severities.

CCS CONCEPTS

• **Hardware**; • **Human-centered computing** → **Accessibility systems and tools**;

KEYWORDS

visual impairment, experience transfer, eye tracking, visual perception, design assistance

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1 INTRODUCTION

As the global population progressively ages, the number of people with visual impairments will continue to grow. Individuals are likely to experience some degree of vision loss throughout their lives [1]. However, public facilities are designed assuming normal vision. To aid understanding of visual impairments, several simulations have been created such as analog glasses [2], static display-based solutions [4], and video see-through AR glasses [3]. However, simulation effects generated by analog glasses or static displays can not react to the user's eye movements, whereas HMD-based methods can rarely overcome vergence-accommodation conflicts. These HWDs often require significant computational power and have a significantly smaller field of view than the natural human visual field. In addition, HMD video see-through methods inherently have a lag when simulating visual impairements.

In this demonstration, we focus on simulating (1) central vision loss and (2) peripheral vision loss, which are two typical symptoms of aging-related macular degeneration (AMD) and open-angle glaucoma. To address the shortcomings of simulation approaches we present a new set of low-profile smart glasses that combines optical see-through displays with real-time eye-tracking to map the simulation effect to correspond to the user's gaze, which enables a more flexible and realistic simulation of visual impairment.

2 APPROACH

To build the visual impairment simulation device, we use two monochrome 2.9-inch (55mm x 55mm viewing area, 128 x 128 pixels) liquid crystal display panels[1] as our optical see-through lenses. These lenses are used for the generation of a semi-transparent layer in between the real world and the eyes, as illustrated in Figure 1b&e.

We designed the semi-transparent patterns to be shown on the LCDs to simulate loss of central vision and loss of peripheral vision. Loss of central vision is represented as a filled circle with a transparent peripheral field of view, see figure 1e. On the other hand, loss of peripheral vision is shown as a transparent circle with a filled peripheral. See figure 1b. The severity of the vision loss is controlled over the opacity and the size setting of the filled region. See figure 1c, d, f, and g. The hardware design is shown in figure 2. To allow others to replicate the hardware, we provide the 3D models of our device[2].

3 APPLICATION

Instant design check. After the simulation glasses are properly set up on the participant's head, the participant can experience their environment via the glasses' lenses, experimenting with reading signage, interacting with their smartphone, or having a conversation. The participants can also compare two pre-prepared posters. One is an ordinary poster that assumes the readers have normal vision; the other is specifically designed for readers with visually impairments, using bigger fonts and a low spatial frequency layout.

[1]JHD128128-G56BFW-G

[2]https://github.com/qzkiyoshi/visual-impairment-simulation-glasses

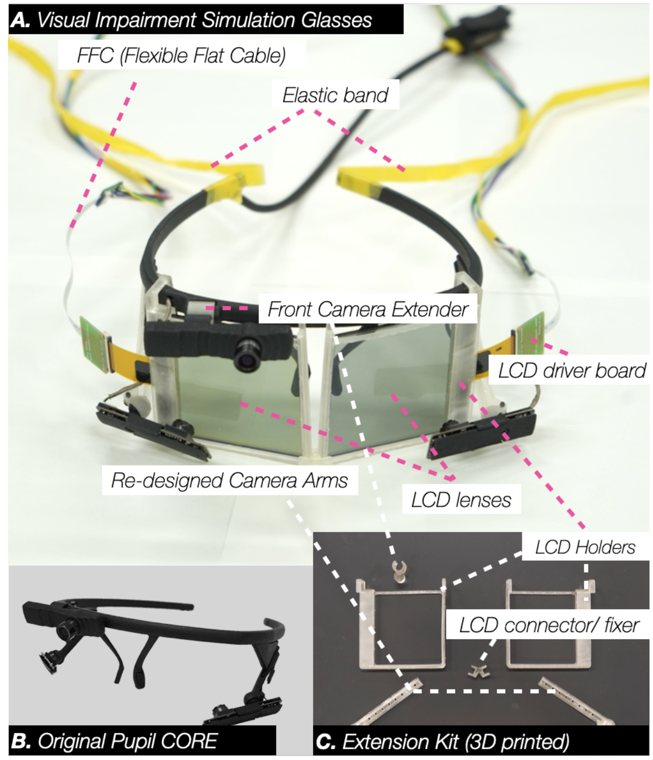

Figure 2: A. exhibits the assembled Visual Impairment Simulation Glasses with two extra elastic bands to fasten the device to the user's head minimizing undesired displacement. B. indicates the original Pupil CORE eye-tracker. C. shows the extension kit that we designed and 3D printed for modifying Pupil CORE into the simulation glasses.

Walking experience. Participants are encouraged to walk around the booth to experience the difference between normal vision and low vision while accompanied by the exhibitors.

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