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Seeing our Blind Spots: Smart Glasses-based Simulation to Increase Design Students' Awareness of Visual Impairment

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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, especially for design students. In this paper, we enable an on-the-go, VAC-free, visually impaired experience by leveraging our optical see-through glasses. Our evaluation indicates that our approach can significantly and effectively reduce visual acuity and visual field without causing typical motion sickness symptoms such as headaches and or visual fatigue. Questionnaires and qualitative feedback also showed how the glasses helped to increase participants' awareness of visual impairment.
Keywords: gaze detection, gaze synchronization, eye tracking

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. However, public facilities are designed assuming normal vision. To aid the understanding of visual impairments, several simulations have been created such as analog glasses, static display-based solutions, and video see-through AR glasses [1]. To help designers gain some basic understanding of the access barriers, several simulators have been developed utilizing a number of different techniques.

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

2. Our Approach: Simulating Visual Impairments by Transparent LCD with real-time eye tracking

In this paper, we focus on the simulation of open-angle glaucoma and age-related macular degeneration (AMD). We used two monochrome 2.9-inch (55 mm x 55 mm viewing area, 128 x 128 pixels) liquid crystal display panels as our optical see-through lenses, which were inspired by Hiroi et al. and Ma et al. [2], for the generation of a semi-transparent layer in between the real world and our eyes. The LCD modules ensure the generated visual impaired effects cover the majority of a person's most natural visual field like ordinary optical glasses. Although wearing glasses will reduce parts of our visual field, in particular one's peripheral vision, GAUTHIER et al. suggests we have the ability to fast adapt to that narrowed visual field and react as usual.

3. Conclusion

In this paper, we introduced the first optical see-through (OST) visual impairment simulation glasses with real-time eye tracking. These glasses enabled significantly reduced visual acuity and visual field without causing typical motion sickness symptoms such as headaches and or visual fatigue. By experiencing these OST visual impairment simulation glasses to do daily routines, the wearers showed significantly increased awareness and empathy for the visually impaired experience.

4. Discussion

Our experimental results show that our method can statistically and significantly reduce visual acuity and field of vision, which are the key factors when defining visually impaired levels. While relevant works highlighted how static filters and superimposed black occlusions on standard spectacles have been reported as unrealistic by individuals with both glaucoma and AMD.

In the next step, we plan to evaluate if our visual impairment simulation glasses can provide a sufficiently good approximation for peripheral and central vision loss modeling of the accuracy and efficiency loss in standard vision tests.

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