Dementia Eyes: Perceiving Dementia with Augmented Reality

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Figure 1: Dementia Eyes being tested by participants in our physical setup as they perform various tasks while (a) walking and (b) seated. We validated the system based on feedback from medical doctors experiencing the symptoms (c) as well as nurses being guided through the experience (d)

ABSTRACT

Dementia is a global health crisis, of which there is a need to understand the patients' perception towards improving their quality of life. We propose Dementia Eyes, a mobile AR experience that simulates common visual symptoms of senile dementia based on the known pathology and caregivers' actual experience with patients. Leveraging an iPhone and a Head-Mounted Display (HMD), we developed a real-time application which allows users to see the world from the perspective of an Alzheimer's type of dementia (AD) patient. The experience was validated by professional medical workers in Japan, and the result advocates for the efficacy of the empathy we intended to bring to them.

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KEYWORDS

Augmented Reality, senile dementia, empathy training

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1 INTRODUCTION

Dementia is a worldwide public health priority which affects 50 million people[1]. The question of how to make the last stage of dementia patient's life quality has come to the spotlight. In 2014, Rebeca I. García-Betances et al. [García-Betances et al. 2014] conducted a study on using virtual reality (VR) for cognitive rehabilitation and concluded that "VR-based cognitive rehabilitation systems are capable of achieving the expected training goals for people affected by age-related cognitive impairments". While the prevalence of VR technology in the medical field has been ongoing, AR is still

[1]https://www.who.int/news-room/fact-sheets/detail/dementia

remaining new. Consequently, we propose Dementia Eyes, a mobile AR experience to see the world through a dementia patient's eyes in real-time.

2 DESIGN AND IMPLEMENTATION

2.1 Technical Implementation and Symptom Simulation

While visual symptoms are usually not directly caused by dementia, they do happen to up to 60% of the AD dementia patients[Cronin-Golomb et al. 1991]. Since the correlation between visual impairment and the risk of dementia has also been proven [Paik et al. 2020], we put forward the hypothesis that simulating visual impairment in AR will allow the user to physically experience and visually perceive dementia. We created the following six symptoms on the prototype AR application which was developed using Unity 2021.1.3[2] and shown in Figure 2. The symptoms were first collected from literature, then verified by medical professionals as shown in Figure 1. The AR effects are achieved via a post-processing filter placed over a stereoscopic rendering of the camera.

2.1.1 Delayed Pupillary Light Response. AD-related neurodegeneration has an effect on the pupillary light response [Chougule et al. 2019]; visually this phenomenon can be interpreted as the decreased speed of darkness and lightness adaptation.

2.1.2 Vision Field Defects. As Paolo Brusini [Brusini 2007] pointed out that the age coefficients used in many existing vision field devices underestimated the sensibility change due to age in the elderly, vision field defects is a common health issue for them, and the loss of peripheral vision was visualised in this prototype.

2.1.3 Decrease in Color Sensitivity. It has been found that patients with AD have difficulty distinguishing between blue and green [Cronin-Golomb et al. 1991].

2.1.4 Impaired Depth Perception. Depth perception can be explained as the visual ability to identify distance with objects and the capability of three-dimensional perception; disorder occur to the visuo-spatial function is due to focal cortical lesions that involve the parietal and temporal lobes, which is associated with decreased glucose metabolism in the posterior cerebral cortex–a major reason for cognitive declination [Mittenberg 1994].

2.1.5 Decreased Visual Acuity. It has been proven by Neil S. Gittings and James L. Fozard [Gittings and Fozard 1986] that visual acuity decreases by aging regardless of visual pathologies; since most degenerative dementia patients belong to the aging population, a decreased visual acuity effect was added to the experience.

2.1.6 Visual Motion Sensitivity. According to Trick and Silverman[Trick and Silverman 1991], motion thresholds related to visual motion sensitivity increase significantly for patients of senile dementia of Alzheimer's type compared to the healthy elderly.

[2]https://unity.com/

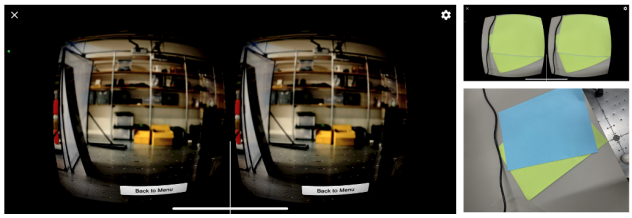

Figure 2: Symptoms viewed through the AR Stereoscopic View

2.2 User Experience

For the SIGGRAPH Asia demonstration, a mock hospital environment will be setup for the thorough patient experience. The participant will get to choose to experience a single symptom, combination of several, or all at once. They will then be asked to perform a series of tasks including 1) toilet selection, 2) sitting down on a chair, 3) figure identification, 4) letter reading, and 5) color identification. These tasks were generated from actual cognitive diagnosis tests on dementia patients, as well as common obstacles according to medical workers.

3 CONCLUSION AND FUTURE WORKS

The result from our test with professional medical workers is indicative in the prototype's impact in leading to empathy of non-patients towards dementia patients. In the future, this work has the potential to be included in a dementia care training program for nurses.

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