Ocular Parallax in AR

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Motivation

Augmented reality (AR) is an enabling technology for many socially impactful outcomes, including more accurate breast and laparoscopic surgery (1,2) and safer manufacturing processes (3). Improving realism in AR will improve the perceived physical accuracy of these systems, integrate them more seamlessly with the natural world, improve ease-of-use, and thereby, potentially improve effectiveness.

Related Work

Recent work in VR rendering methods aims to improve realism of virtual scenes by mimicking natural visual cues in processing, especially those related to depth. For example, Cholewiak et. Al. implemented a depth- and color- dependent blur and showed it increased perceptual realism (4). Also, Kellnhofer et. Al. improved depth dependent displays by introducing motion parallax in addition to binocular disparity (5). Six degree of freedom (6DOF) rendering is also a standard tool in VR headsets and introduces the effects of head parallax into rendering (6). Recent unpublished research from Professor Wetzstein's lab has shown that ocular parallax, a third type of motion depth cue, is a noticeable effect in virtual reality. However, the effects of ocular parallax in augmented reality (AR) are unstudied. I would like to fill this literature gap by performing a simple psychophysical experiment to understand whether ocular parallax increases perceptual realism in AR.

Project Overview

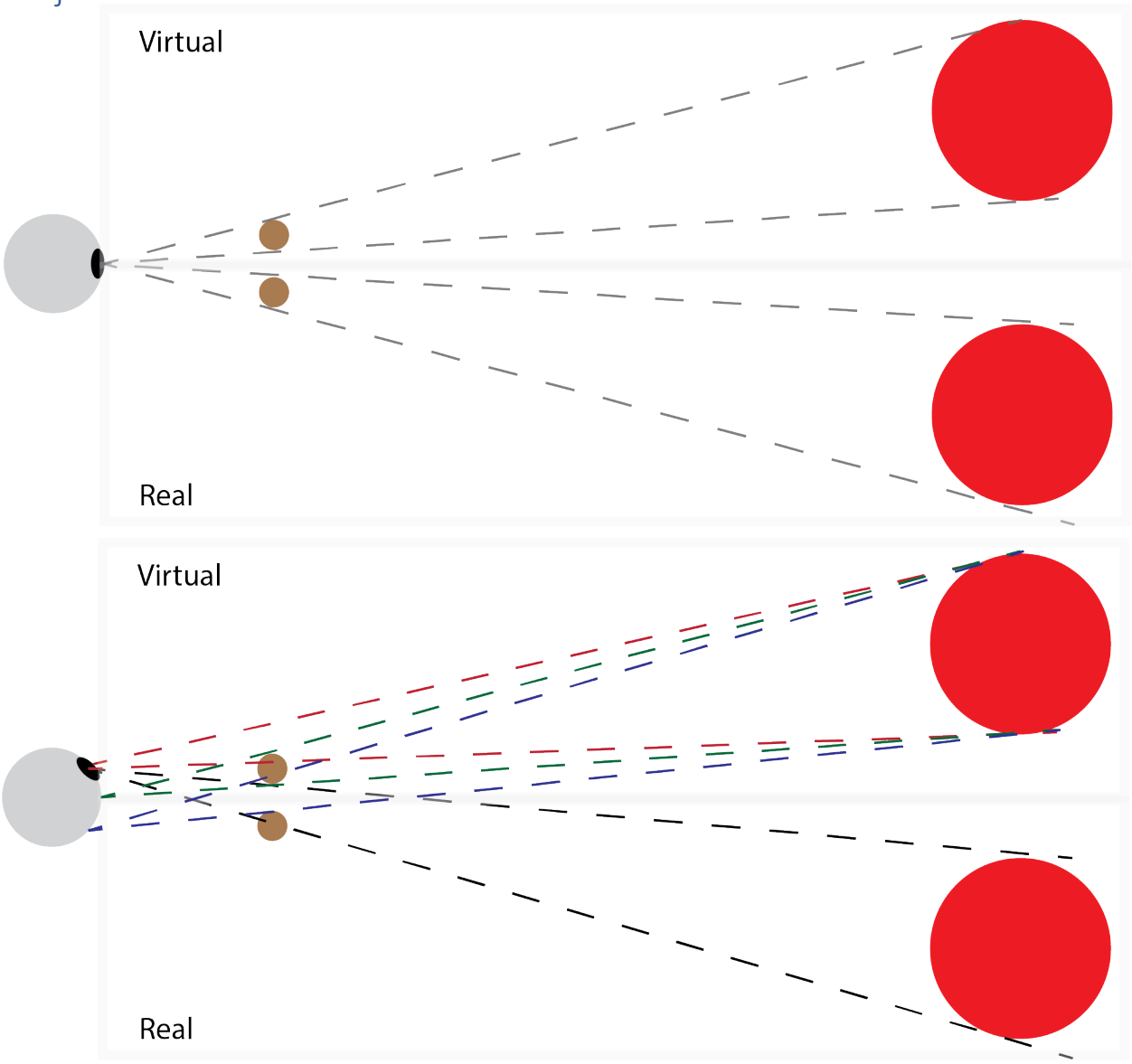

Fig. 1. Experimental setup. When the eye is facing forward, targets are aligned so the front target perfectly occludes the rear target. When the eye shifts, as seen in the "real" section, the rear target is only partially occluded. Three rendering methods are tested in the "virtual" section: one which correctly simulates ocular parallax (red), one which does nothing (green), and one which simulates the reverse mode (blue). Subjects will be asked which rendering mode most effectively shows the 3D structure of the scene.

Users will wear a Microsoft Hololens modified with pupil labs eye trackers. Then they will place their heads in a mount to keep them steady. 5.7 degrees right of them in the real world, there will be two physical disks at the distances 4D and 0.5D, perfectly occluding each other. The same thing will be rendered in AR, and these scenes will be shown side-by-side. Users will cycle through three modes in a random order: ocular parallax on, ocular parallax off, and ocular parallax reversed (see Fig. 1). They will

rank these modes from 1 to three based on how good they are at effectively showing the 3D structure of the scene. Data will be taken from at least 12 subjects and analyzed to understand if ocular parallax rendering increases realism in AR.

Milestones

Milestones: The completion of the experimental design, the assembling of the physical setup, the coding of the digital setup (in Unity/C#), the completion of experiments, the analysis of data, and the paper submission.

Timeline & Goals

The timeline is compressed due to paper submission to SIGGRAPH. I have completed experimental design, assembling the physical setup and the coding portion too.

By next Monday (18), I want to have a few human trials on the ocular parallax setup.

By the following Monday (25), I want to have 20 trials finished or until significance.

By March 1, I hope to have completed this study.

References

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(4) Steven A. Cholewiak, Gordon D. Love, Pratul P. Srinivasan, Ren Ng, and Martin S. Banks. 2017. Chromablur: Rendering Chromatic Eye Aberration Improves Accommodation and Realism. ACM Trans. Graph. (SIGGRAPH Asia) 36, 6 (2017), 210:1–210:12.

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(6) J. Thatte, J. Boin, H. Lakshman and B. Girod, "Depth augmented stereo panorama for cinematic virtual reality with head-motion parallax," 2016 IEEE International Conference on Multimedia and Expo (ICME), Seattle, WA, 2016, pp. 1-6. doi: 10.1109/ICME.2016.7552858