Visual perception challenges for holographic displays

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Abstract

Our long term aim is to contribute to the understanding what requirements the human visual system, eye movement behaviour, and the visual perception process has for the new generation of three dimensional (3D) holographic displays. A lot of research has been performed to date on the evaluation and optimisation of stereo displays. These work by giving slightly different images of a 3D scene to the viewer's left and right eyes. Through a visual perceptual process called stereopsis, the viewer perceives a scene with depth. However, these stereo displays are not true 3D displays since they can not give any more depth information about the scene if the viewer moves their head, eyes or accommodation (focal) plane.

Holographic displays use diffracted light to form an image which appears to be floating in the air. A viewer can perceive the image without using any special eyewear. Head and eye movements will give new perspectives of the scene. Holographic displays have the potential to display a true 3D scene to a viewer. However, designing, building, and evaluating holographic displays is challenging.

In this talk, I will concentrate on describing the challenges of evaluating holographic displays from a visual perception point of view. I will give a brief summary of digital holography, studies in visual perception of depth, and methods used in evaluating stereo displays. Then, I will proceed to describe the evaluation and visual perception challenges for holographic displays. These include, for example,
- Laser issues (safety) vs. using LEDs (blurring)
- Noise caused by the camera (dc, twin, speckle)
- Noise caused by the display (dc, speckle)
- Small camera sensor size (a small field of view, reduced stereo parallax, reduced motion parallax)
- Small display size (same problems as above)
- Large display pixel size (small angle of diffraction)
- Digital holographic displays typically only show the amplitude or phase (but not both) of a digital hologram

I will conclude my talk by outlining an experimental procedure I have designed for evaluating the holographic display built in the Department of Computer Science.

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