Can 3D Shape be Estimated from Focus Cues Alone?

Rachel A. Albert[1], Abdullah Bulbul[1], Rahul Narain[2], James F. O'Brien[1,2], Martin S. Banks[1,3]

[1]Vision Science Graduate Group, UC Berkeley, [2]Department of Computer Science, UC Berkeley, [3]School of Optometry, UC Berkeley

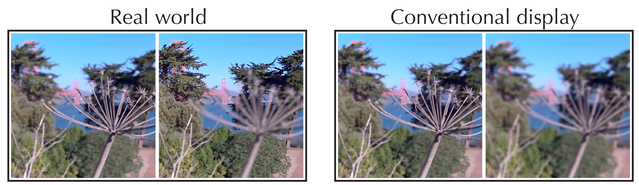
Vision Science
University of California at Berkeley

Motivation

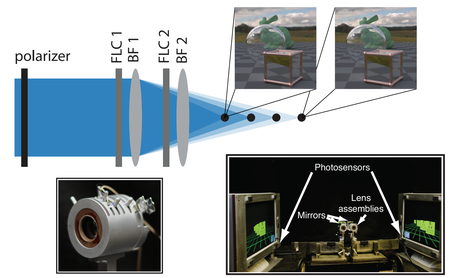
Focus cues (blur & accommodation) are generally considered coarse, ordinal cues.[1]

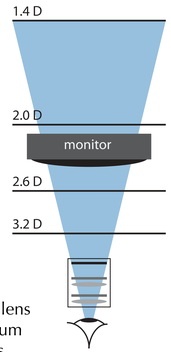
However, this may be due to improper stimulus presentation techniques.

Change in accommodation



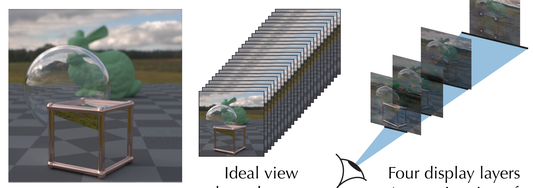
Volumetric display



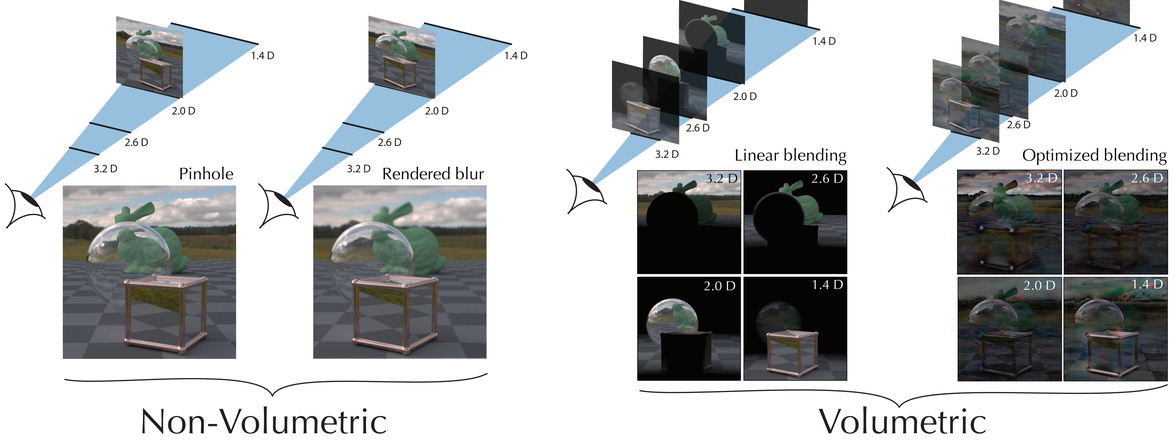


High-speed switchable lens (Love et. al).[2] Above: schematic of lens with four focal states. Right: top view of the lens. Viewing frustum in blue, horizontal lines show focal distances of four lens states.

Optimization technique



Rendering and presentation techniques



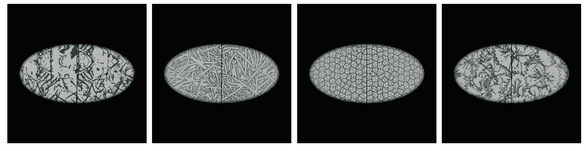
Experiment

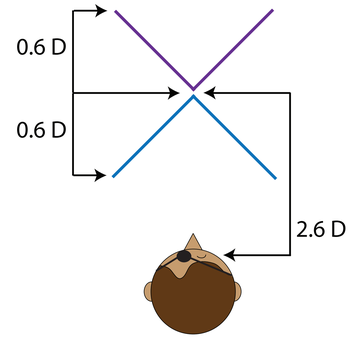
Four subjects were asked to judge the shape of a hinge (convex or concave). Rendered blur and optimized stimuli were generated using a simulated aperture equal to the subject's measured pupil size under experimental conditions.

Hinges were presented monocularly (removing disparity cue) and textured in screen space (removing texture cue).

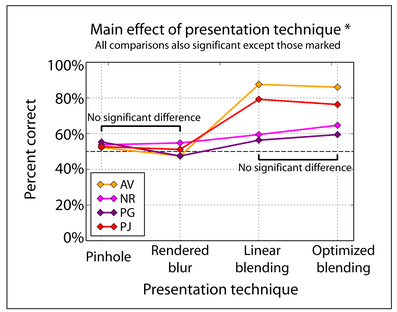
Stimulus duration: 0.3 s, 3 s, or 5 s
Vertex distance: 2.6 Diopters
Hinge angle: 70° or 90°

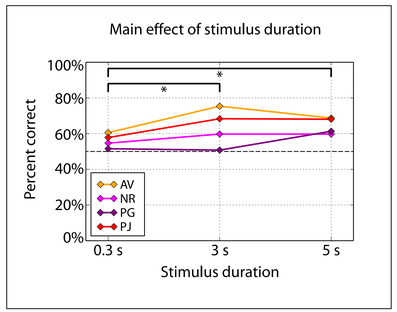
Sample stimuli:

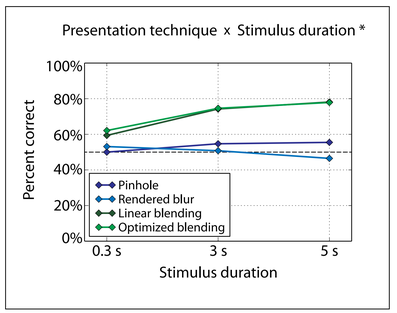




Results







A single multi-factor ANOVA was perfomed. Subjects showed significantly better performance under volumetric conditions compared to non-volumetric conditions. Increased stimulus duration resulted in significantly better performance for volumetric conditions only.

References

[1] Mather, G., & Smith, D. R. (2002). Blur discrimination and its relation to blur-mediated depth perception. *Perception*, 31(10), 1211-1220.

[2] Love, G. D., Hoffman, D. M., Hands, P. J., Gao, J., Kirby, A. K., & Banks, M. S. (2009). High-speed switchable lens enables the development of a volumetric stereoscopic display. *Optics Express*, 17(18), 15716-15725.

Poster contact: RachelAlbert@Berkeley.edu