The effect of interocular separation on perceived depth from disparity in complex scenes

Karim Benzeroual, Sidrah R. Laldin, Laurie M. Wilcox, Robert S. Allison
{Karim, slaldin, Allison}@cse.yorku.ca, lwilcox@yorku.ca

Introduction:
The geometry of stereopsis makes straightforward predictions regarding the effect of increasing an observer’s simulated interocular distance, which can be simulated by changing the stereo cameras interaxial distance (IA), on perceived depth. Our aim is to characterize the effect of IA on perceived depth, and its dependence on scene complexity and screen size. The presence of multiple realistic depth cues has significant and complex effects on perceived depth from binocular disparity; effects that are not obvious from binocular geometry.

Hardware Configuration
- Two screen sizes (Four displays) were used
- Two Viera TC-P54VT25VT Series 54” 1080p 3DTV Plasma TVs and two Acer GD235HZ 23.6” 3D LCD monitors
- The viewing angle (36°) was kept constant by adjusting the viewing distance

Complex Scene Stimuli & Reference
- 4 poles were positioned in a studio set
- Each pole was identified by number (1, 2, 3, 4)
- Another scene was used as constant reference for depth and size judgements

Task:
- Subjects made 5 separate estimates of 3D depths in the display (indicated with red arrows)
- Magnitude estimation was used to make estimates of 3D distances in the scene (actors’ shoulders in the reference scene as the standard and assign it a depth of 100)

Predictions
- Predicted depth as a function of IA (Normalized data, convergence on middle pole)
- Predicted depth as a function of Convergence (Normalized data, IA = 50mm)
- Predicted bigger 3D distance estimation on large displays from geometric calculations

Experiment 1: Effect of IA and convergence
- The effect of IA and scene ‘convergence’ (point in the image with zero screen parallax). Convergence point was adjusted by horizontal image translation of one image relative to the other
- Five IAs: 3, 25, 50, 75 and 95mm
- Three convergence points: Front (Pole 1), Middle (Pole 2) and Far (Pole 3)
- Perceived depth for full cue stimuli as a function of IA

Experiment 2: Line Stimuli
- To quantify the influence of the monocular cues, we performed the same task using simple line stimuli
- IA and convergence points are the same as in Experiment 1
- Perceived depth for the bar (reduced-cue) stimuli as a function of IA

Full Cue vs. Reduced Cue Comparison
- To assess the effect of screen size, observers judged perceived depth, as in Experiment 1. Test and reference were presented in four combinations (small screen reference/large test and vice versa)
- Three IAs (25, 50, 75mm) and two convergence points (front, far)
- Surprisingly, presenting the reference on a different size screen resulted in similar magnitude estimates as when the reference and test screens were identical
- Overall when the large screen is used for both test and reference, more depth is reported than when the small screen is used

Conclusions
- The presence of multiple depth cues, even when largely consistent with stereoscopic depth information, have a significant effect on the amount of depth perceived via stereopsis
- The data obtained using full-cue stimuli show a much weaker effect of IA on perceived depth compared to the reduced-cue stimuli
- Viewers show a surprising tolerance to depth and scale distortions due to screen size or stereoscopic camera parameters
- Concerns about IA and depth distortions from stereo may not be as serious as believed, so long as the range of IAs used doesn’t create other geometric distortions
- These results have important implications for both basic vision and the stereoscopic 3D media industry; from them content maker can adjust acquisition parameters to obtain a desired S3D effect