The Significance of Stereopsis and Motion Parallax in Mobile Head Tracking Environments

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ABSTRACT

Despite 3D TVs and applications gaining popularity in recent years, 3D displays on mobile devices are rare. With low-cost head tracking solutions and first user interfaces available on smartphones [1], the question arises how effective the 3D impression through motion-parallax is and whether it is possible to achieve viable depth perception without binocular stereo cues. As motion parallax and stereopsis may be considered the most important depth cues [3], we developed an experiment comparing the user's depth perception utilizing head tracking with and without stereopsis.

Author Keywords

Perception, virtual environments, spatial user interfaces

ACM Classification Keywords

I.3.7. Computer Graphics: Three-Dimensional Graphics and Realism

EXPERIMENT

Since currently no mobile device allows both frame sequential stereo and motion parallax, a PC Display was occluded to a size of a 10inch tablet and used to render frame sequential stereo at 120Hz viewed through NVIDIA's 3D Vision 2 shutter glasses. The subject's head was tracked using a WorldViz PPT setup with 8 cameras and a infrared (IR) marker hat. The experiment was conducted with 11 participants who were tasked to use a mouse, for high precision, to position a marker in 2DOF beneath spheres of varying depths from 10cm behind the screen to 5cm in front of the screen in 2.5cm intervals.

The results from the experiment show that subjects are more accurate when stereo is enabled, which corresponds to the results of other studies in the field [4]. As illustrated in Figure 1, there was a significant difference between the active and inactive stereoscopic depth cues on the depth error distance ($F_{10}^{1} = 8.897,\ p < .05$), however the participants were still able to estimate the depth of the target within 5mm 98.12% of the time without stereoscopic cues, whereas 99.93% of the guesses with enabled stereo were within 5mm. Additionally, the scenes used were fairly simple to allow precise control

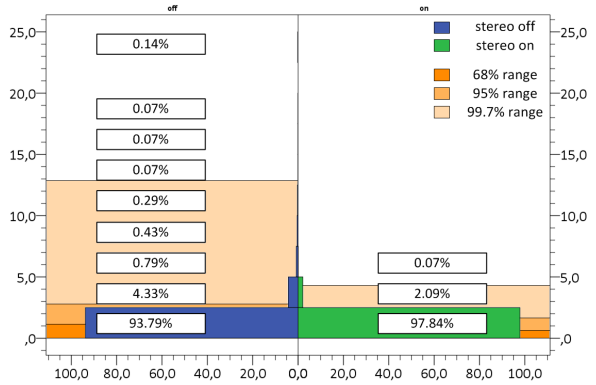

Figure 1. Results of the experiment: The x-axis shows the frequencies of the error distances measured in percent, the y-axis shows the measured error distances in mm. Frequencies are binned in 2.5mm intervals. The left side shows the results with disabled stereo, the right side with enabled stereo. Colored backgrounds indicate the deviation ranges.

of the experiment environment and avoid distraction by other depth cues. As shown by Hubona et al. [2], other depth cues like shadows could improve the accuracy further, potentially reducing the differences between the conditions.

Our results show that if the precision in 95% of the cases has to be below 1.54mm, stereoscopic cues are useful. However, if a precision below 2.56mm is enough, then monocular depth cues are viable. The results lead to the conclusion, that the depth perception gained from motion cues appears viable, especially for mobile applications.

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