Perceived Depth Perception In A Virtual Environment Using A Head Mounted Display

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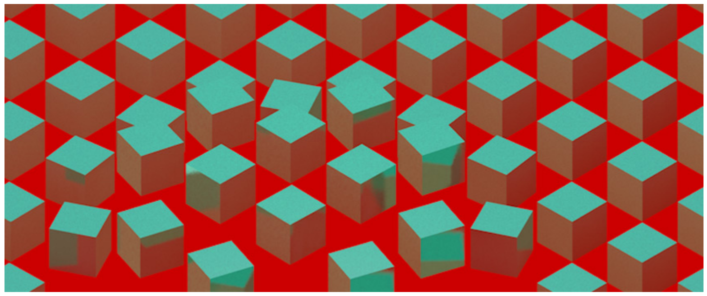

Figure 1: *BTH 2015, Karlskrona, SE.*

Abstract

In order to better understand how binocular depth cues can be recreated in a virtual environment, using the method of rendering a scene from two slightly different positions, a small scale experiment was constructed in which the users where presented with a scene containing a series of cubes and asked to judge the distance. During the experiment the distance between the virtual cameras was either increased or decreased and the user was then asked again to estimate the distance. While the test group was small, there where some indications that a wider distance between the cameras led to the user perceiving the cubes as being closer, and a decrease in the distance between the cameras to the user perceiving the cubes as being further away.

CR Categories: I.3.3 [Computer Graphics]: Three-Dimensional Graphics and Realism—Virtual Reality H.5.1 [Information Interfaces and Presentation]: Artificial, augmented, and virtual realities—;

Keywords: Virtual Reality, 3D, Depth Perception

1 INTRODUCTION

//////////////////////////////// The purpose of this paper is to investigate how humans perceive depth in a virtual 3D enviroment, more specifically how the distance between the two virtual cameras can influence the users perception of depth. On a pragmatic level, this could be applied to help alleviate the scale issues experienced by some users, where objects appear too small. The ability to manipulate the users perception without changing the actual geometry of a scene could also be used for example in a multiplayer horror game, where the player upon observing something scary gets a slight increase in the distance between their virtual cameras, causing the entire scene to feel smaller without effecting actual gameplay or the scene for any other player.

To do this an experiment was set up using the Occulus rift HMD and unity.

- title, author, and affiliation information
- abstract
- CR categories *
- keywords *
- body of the content
- bibliography

2 RELATED WORK

In order to perceive an object and ascertain its position relative to the observers own, the brain uses multiple sources of information (hereafter referred to as "cues"). The brain takes advantage of the physiological state of the eyes being approximately six inches apart on the human head, which serves as the basis for most binocular cues. For example, this causes the observation of a nearby object to be projected with two slightly different images on the retina as result of the two slightly different viewing angles. When these two images are merged in the striate cortex, the brain interprets the discrepancy (the binocular disparity) of the two images as a cue for depth. Thus two objects at different distances from the observer will have different amounts of such binocular disparity that signals their different locations in depth Ocular convergence is another binocular cue of depth. The binocular disparity in stereopsis, only works on objects that are relatively close to the observer, approximately within 30 order to perceive depth at longer distances, monocular cues (ones that does not require both eyes) are used. Examples of these cues are (1) differences in shadows and light on the object, (2) objects occluding or hiding one another (occlusion), (3) linear perspective, (4) relative size of similar objects on different distances,

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(5) the accommodation of the lens of the eye, (6) aerial perspective, (7) loss of detail with distance and (8) the relative motion of objects, also referred to as motion perspective or motion parallax (Gibson). Rigid objects (attached to the ground) at different distances from the observer will be perceived to move differently in relation to each other. This differential motion of the objects, arising when an observer fixes his or her gaze, is called motion parallax or optical flow Panerai).

To summarize, here are the basic page specifications:

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Table 1: *A simple table.*

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3700	octal
11111000000	binary
1984	decimal

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15 Contact Information

If you have questions or suggestions regarding this document, please contact Jesper Blidkvist at “Jesper.Blidkvist@live.se”.

Acknowledgements

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References

AGARWAL, S., MIERLE, K., AND OTHERS. Ceres solver. https://code.google.com/p/ceres-solver/.

ANONYMOUS, 1976. Planes of the head. http://www.planesofthehead.com/.

FEDKIW, R., STAM, J., AND JENSEN, H. W. 2001. Visual simulation of smoke. In *Proceedings of SIGGRAPH 2001*, ACM Press / ACM SIGGRAPH, E. Fiume, Ed., Computer Graphics Proceedings, Annual Conference Series, ACM, 15–22.

JOBSON, D. J., RAHMAN, Z., AND WOODELL, G. A. 1995. Retinex image processing: Improved fidelity to direct visual observation. In *Proceedings of the IS&T Fourth Color Imaging Conference: Color Science, Systems, and Applications*, vol. 4, The Society for Imaging Science and Technology, 124–125.

KARTCH, D. 2000. *Efficient Rendering and Compression for Full-Parallax Computer-Generated Holographic Stereograms*. PhD thesis, Cornell University.

LANDIS, H., 2002. Global illumination in production. ACM SIGGRAPH 2002 Course #16 Notes, July.

LEVOY, M., PULLI, K., CURLESS, B., RUSINKIEWICZ, S., KOLLER, D., PEREIRA, L., GINZTON, M., ANDERSON, S., DAVIS, J., GINSBERG, J., SHADE, J., AND FULK, D. 2000. The digital michelangelo project. In *Proceedings of SIGGRAPH 2000*, ACM Press / ACM SIGGRAPH, New York, K. Akeley, Ed., Computer Graphics Proceedings, Annual Conference Series, ACM, 131–144.

PARK, S. W., LINSEN, L., KREYLOS, O., OWENS, J. D., AND HAMANN, B. 2006. Discrete sibson interpolation. *IEEE Transactions on Visualization and Computer Graphics 12*, 2 (Mar./Apr.), 243–253.

PARKE, F. I., AND WATERS, K. 1996. *Computer Facial Animation*. A. K. Peters.

PELLACINI, F., VIDIMČE, K., LEFOHN, A., MOHR, A., LEONE, M., AND WARREN, J. 2005. Lpics: a hybrid hardware-accelerated relighting engine for computer cinematography. *ACM Transactions on Graphics 24*, 3 (Aug.), 464–470.

SAKO, Y., AND FUJIMURA, K. 2000. Shape similarity by homotropic deformation. *The Visual Computer 16*, 1, 47–61.

YEE, Y. L. H. 2000. *Spatiotemporal sensistivity and visual attention for efficient rendering of dynamic environments*. Master’s thesis, Cornell University.