Ocular Parallax and Depth Perception in VR and AR

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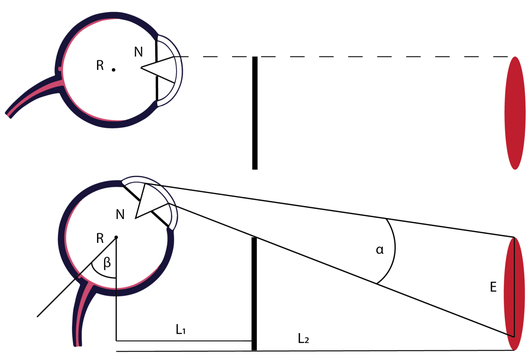
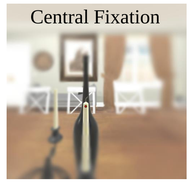
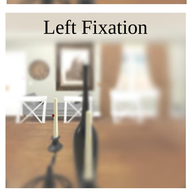
Motivation

- Modeling the HVS → Realistic VR/AR
- E.g. DOF rendering [1], motion parallax [2]
- Ocular parallax (OP) never used in VR/AR!

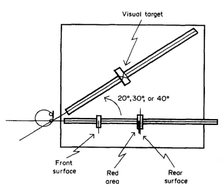






Related Work

- OP first discovered late 19th century [3]
- OP noticeable despite radial VA decrease [4]
- Gaze contingent rendering feasible, helpful [5]



References

[1] Rokita, *Generating depth of-field effects in virtual reality applications.* IEEE CGA. 1996.
[2] Kellnhofer, *Motion parallax in stereo 3D: Model and applications.* ACM TOG. 2016.
[3] Brewster, *On the Law of Visible Position in Single and Binocular Vision, ...* Proc. Royal Society of Edinburgh. 1845.
[4] Bingham, *Optical flow from eye movement with head immobilized:"Ocular occlusion" beyond the nose.* J Vision Research. 1993.
[5] Padmanaban, *Optimizing virtual reality for all users through gaze-contingent and adaptive focus displays.* PNAS. 2017.

Rendering Ocular Parallax

OP model

$$\alpha = \tan^{-1}\left[\frac{E + y\sin\beta}{L_2 - y\cos\beta}\right] - \tan^{-1}\left[\frac{y\sin\beta}{L_2 - y\cos\beta}\right]$$

$$E_p = \frac{(L_2 - L_1)y\sin\beta}{L_1 - y\cos\beta}$$

Transformation Matrices

clipping is applied later to account for asymmetric frustum

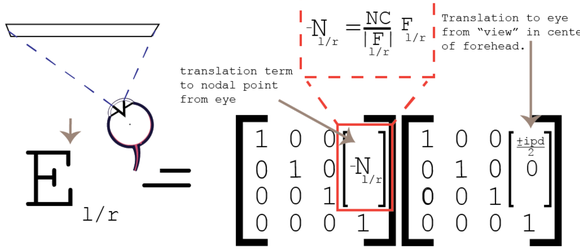
F = fixation point (from eye trackers)

$F_{l/r} = F \pm (ipd/2, 0, 0)$

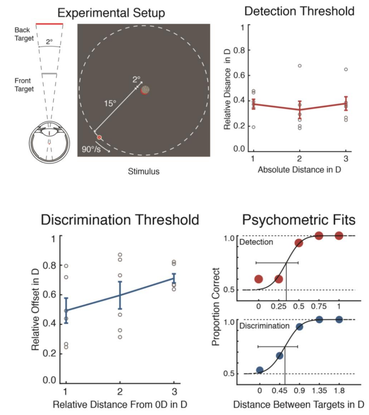
$$N_{l/r} = \frac{NC}{|F|} F_{l/r}$$

Translation to eye from "view" in center of forehead.

translation term to nodal point from eye

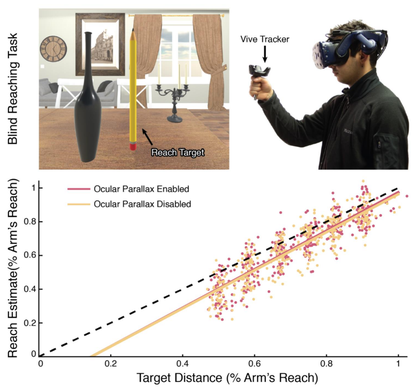


Q: How sensitive are people to OP?



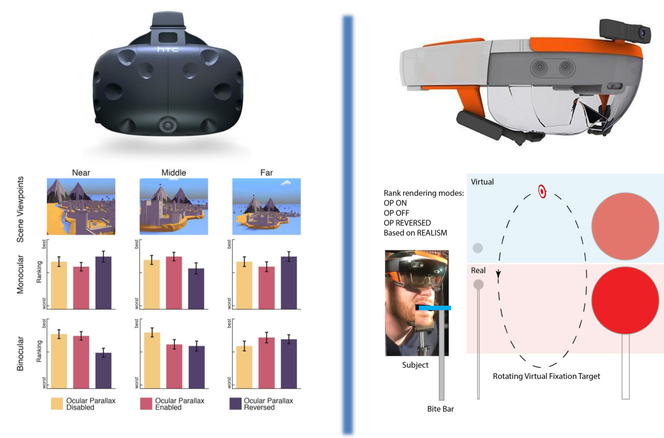
A: Surprisingly so!

Q: Does it help depth perception?



A:Most likely not.

Q: Does it help AR/VR realism?



A: Not with current tech.