Ego-Motion from Optic Flow:
Evidence for a Matched Filter Mechanism

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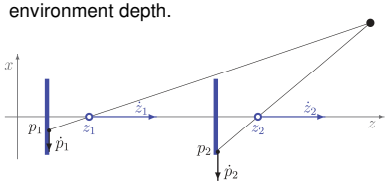
Göttingen Neurobiology Meeting • Poster No

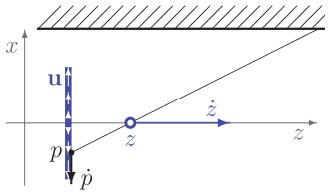
T24—1C

Ego-Acceleration from Optic Flow

When going fast on a wide street, or slow on a narrow street, optic flow may be the same. Despite this ambiguity for speed and object distance, the rate of ego-motion change („acceleration rate“) can be extracted from the image irrespective of environment depth.

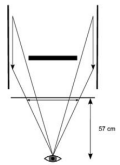


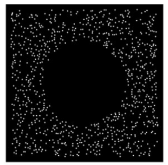
$$\rho := \frac{\ddot{z}}{\dot{z}} = \frac{\ddot{p}}{\dot{p}} - 2\frac{\dot{p}}{p}$$



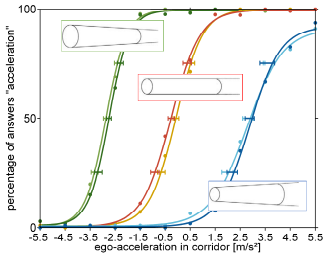
If, however, ego-motion speed is judged by a matched filter procedure (i.e. by comparing optic flow with an expected flow pattern), ego-acceleration and narrowing of the environment should be confused.

Previous Study (Festl et al., *Journal of Vision* 2012)



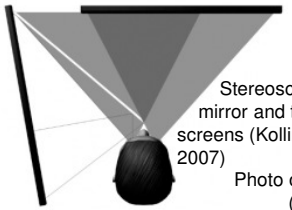


Subjects watch dynamic random dot display of 3 second flight through narrowing, straight, or widening corridor (end of corridor occluded by black disk). Dot lifetime was either 83 or 1000 ms. 12 ego-acceleration levels were presented and subjects answered Y/N to the question „was ego-motion accelerating?“.



Subjects overstimate ego-acceleration in narrowing corridors and underestimate ego-acceleration in widening corridors. Further analysis shows overall quantitative agreement with matched filter model.

Does Stereoscopic Depth Information Help?



Stereoscope with one mirror and two display screens (Kollin & Hollander 2007)

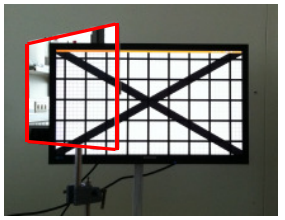
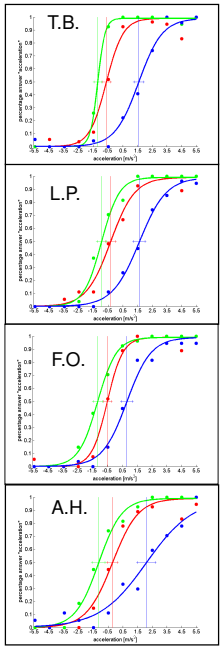
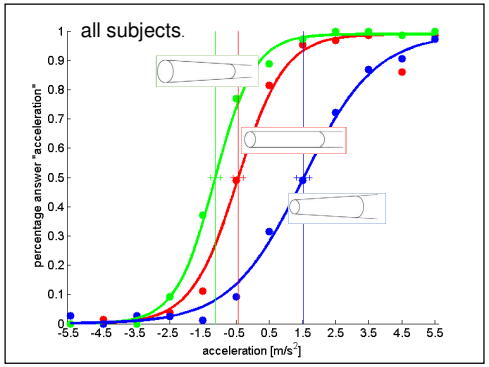


Photo of stereoscope (Hannig, 2012)





- Under stereoscopic viewing, the confusion of ego-acceleration and corridor narrowing is reduced, but not to zero.
- Independent stereoscopic depth cues thus seem to help interpret optic flow.
- Acceleration rate information, although available in the image is neglected.
- A computational algorithm needs to be developed for the integration of optic flow and stereo cues in ego-motion perception.

References

- Festl F, Recktenwald F, Yuan C, Mallot HA (2012) Detection of linear ego-acceleration from optic flow. *Journal of Vision*, 12(7):10,1-12
- Hannig MD (2012) *Entwicklung und Validierung eines spiegelstereoskopischen Virtual-Reality Aufbaus.* Diplomarbeit in Bioinformatik, Fakultät für Mathematik und Naturwissenschaften, Univ. Tübingen.
- J. Kollin und A. Hollander. (2007) Re-engineering the wheatstone stereoscope. *SPIE Newsroom.* doi: 10.1117/2.1200702.0673.

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