The contribution of the visual scene to disambiguation of optic flow with vestibular signals.

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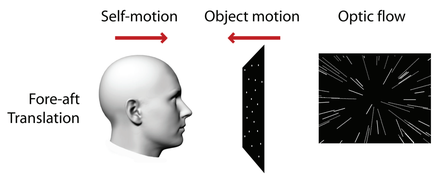
Introduction

Optic flow is generated by observer motion relative to stationary objects, by movement of objects relative to a stationary observer, and by a combination of these situations.

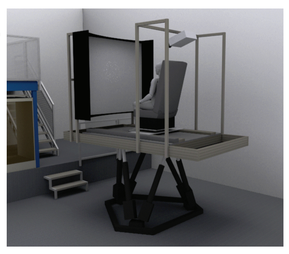
In this project we investigate speed discriminations for forward and backward linear translations:

- How do visual and vestibular cues disambiguate object motion and self–motion?
- What role does the visual scene play in optimal cue combination?



Materials and Methods

- All experiments were carried out on a Stewart Platform.
- All stimuli were 2 seconds in length and had a raised cosine velocity profile.
- Subjects were given both forward and backward linear translations.

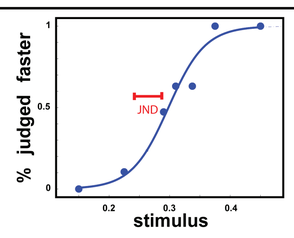


Task

Speed discrimination with two-interval-forced-choice task

Condition	Stimuli	Task
Vestibular σ^2_{vest}	Two physical movements	"Which was faster?"
Visual σ^2_{vis}	Two visual movements	"Which was faster?"
Self-motion σ^2_{self}	Two visual-vestibular movements	"Which was faster?"
Object motion (matching task) σ^2_{obj}	One visual-vestibular movement – visual speed varied	"Was visual faster or slower than vestibular?"

$$\sigma_x = JND_x / \sqrt{2}$$



All experimental conditions were run for two stereo visual scenes

Starfield

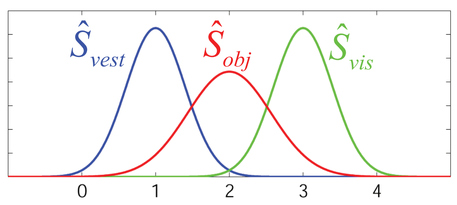
Ground Plane with Columns

Predictions

Object Motion

$$\hat{S}_{obj} = \hat{S}_{vis} - \hat{S}_{vest}$$

$$\sigma^2_{obj} = \sigma^2_{vis} + \sigma^2_{vest}$$

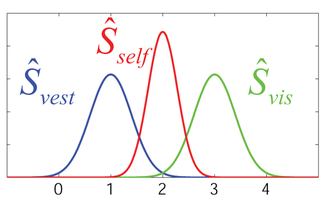


Self Motion

$$\hat{S}_{self} = \hat{S}_{vis} w_{vis} + \hat{S}_{vest} w_{vest}$$

If $\hat{S}_{obj} \approx 0$

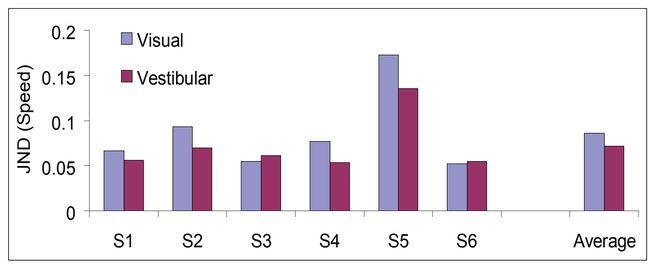
$$\sigma^2_{self} = \frac{\sigma^2_{vis}\,\sigma^2_{vest}}{\sigma^2_{vis} + \sigma^2_{vest}}$$



Results

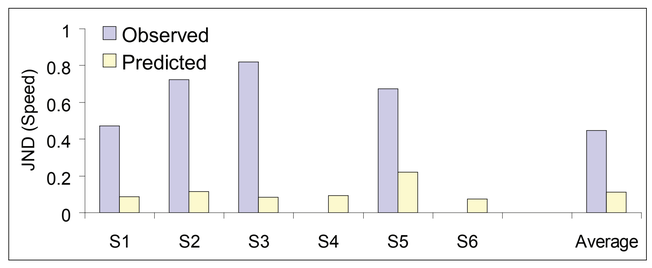
Starfield Experiment

Single Cue



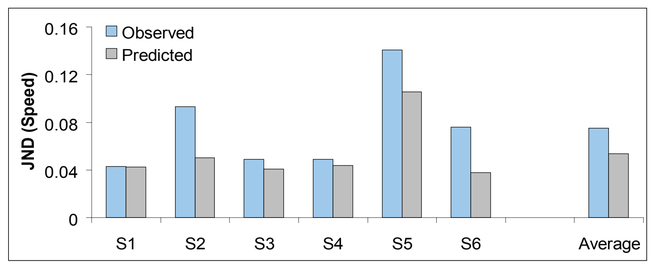
Object Motion

Observed greater than predicted



Self Motion

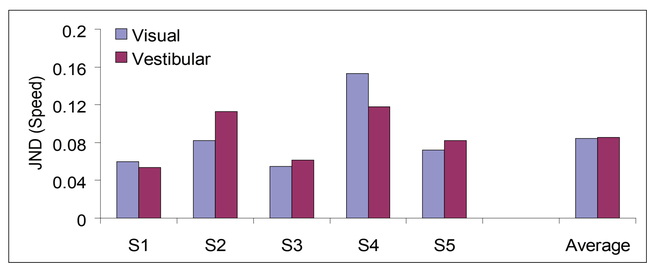
50% of observed near predicted



May need stronger Stationarity Assumption

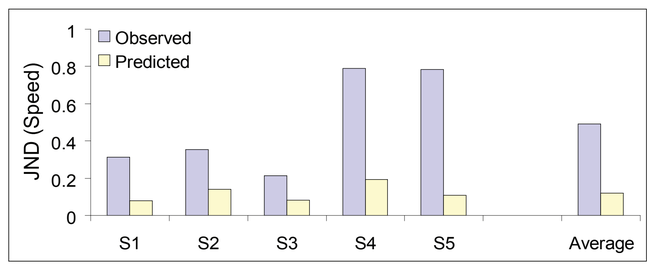
Ground Plane Experiment

Single Cue



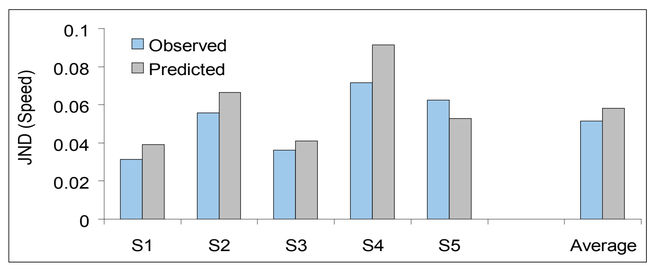
Object Motion

Observed greater than predicted



Self Motion

Observed near predicted



Conclusions

- Object motion: scale ambiguity makes matching difficult
- Self-motion: ground plane facilitates optimal combination

References

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Fetsch, C. R.; Wang, S. T.; Gu, Y.; DeAngelis, G. C. & Angelaki, D. E., Spatial reference frames of visual, vestibular, and multimodal heading signals in the dorsal subdivision of the medial superior temporal area, Journal Of Neuroscience, 2007, 27, 700-712

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