Visual Snapshots to Estimate Egocentric Orientation in Natural Environments

Max Kinateder & Emily A. Cooper
Dartmouth College

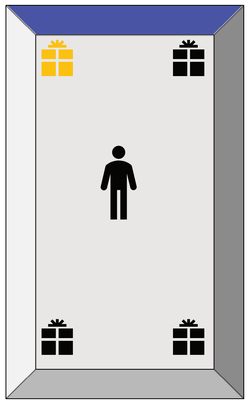
Problem Statement

Successful navigation requires perceiving orientation within the environment

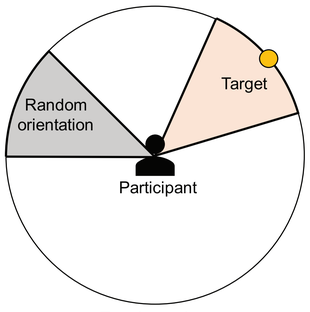
To recover absolute orientation people utilize environmental properties (landmarks and layout) differently depending on experience, context, and task [1-4]

Most studies use simplified indoor environments

Natural environments are usually far more complex and vary in amount of clutter and view similarity



Re-Orientation Task



Top-down view

1) Teleport into natural environment and show **Target**
2) **Disorient** in a starfield
3) Teleport back into natural environment at a random orientation
4) **Reorient** towards target location

VR System

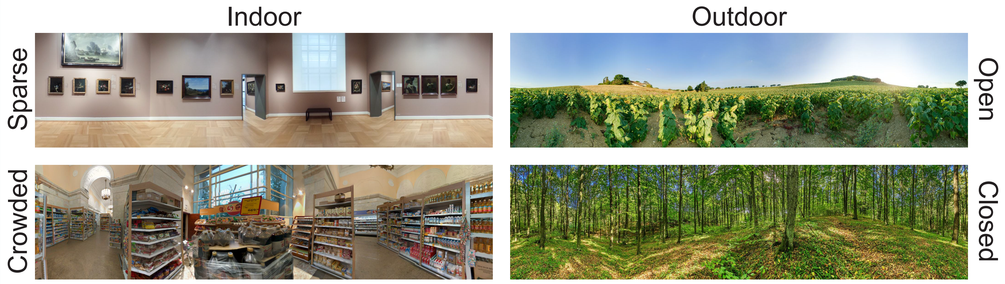
HMD: Rift CV1 (Oculus, Irvine CA); 110° diagonal FOV; resolution: 1080 x 1200 pixels per eye.

Rendering: Alienware Aurora (2017, Round Rock TX); 60 fps; generated in Unity 2017.3 (Unity Technologies, San Francisco CA).

Tracking: Head position and rotation tracked with 3 infrared sensors and built-in accelerometer

Responses: Oculus touch controller to record responses.

Stimuli & Conditions

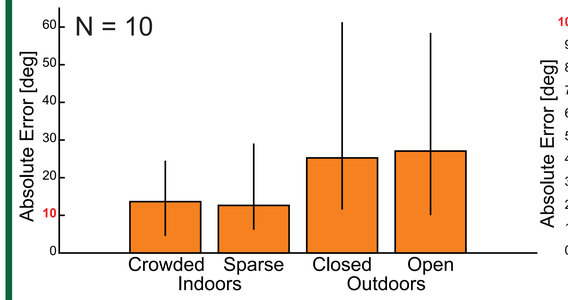


8 equirectangular images ("Photospheres")

Experiment 1: Snapshot view
Photospheres visible for 750 ms before participant starts responding

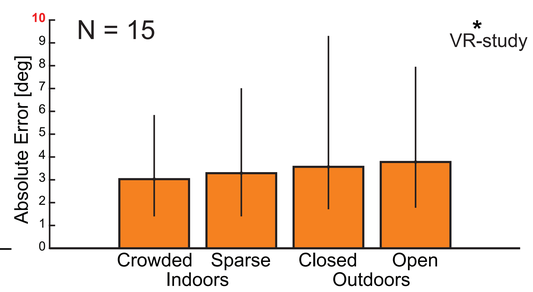
Experiment 2: Continuous feedback
Photosphere visible while participant responds

Snapshot View

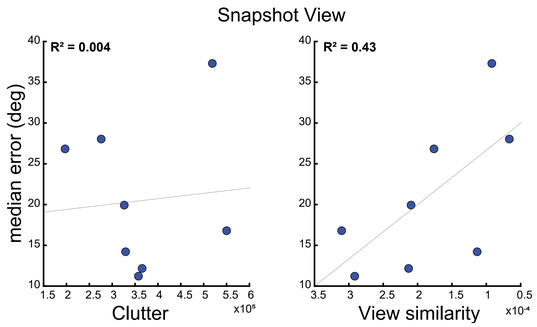


- Friedman test: $\chi^2(3) = 17.64$, $p < 0.001$
- all outdoor vs indoor $p < 0.05$

Continuous Feedback



- Friedman test: $\chi^2(3) = 7.08$, $p = 0.07$



Accuracy only explained by view similarity and not clutter during spatial re-orientation

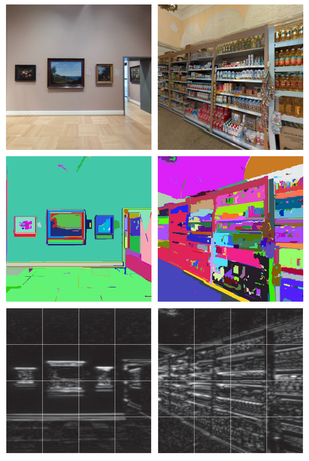
Accuracy is poor for outdoor environments with snapshot view, even though recognition of the target view is similar across environments. This may be explained by a higher similarity in different orientation views.

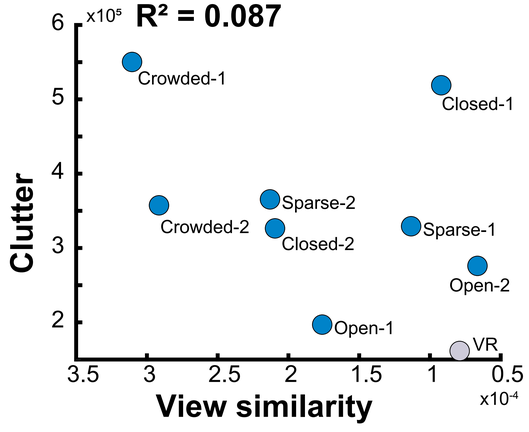
Image Analysis

Segment photospheres into 8 equally spaced, overlapping views

Scale invariant clutter: Average number of image segments across views [5]

View similarity: Variance of view GIST (spatial envelope) [6]





Discussion

Impaired visual acuity or field of view may hamper access to environmental properties

How do visually impaired navigators utilize landmark and layout information?

References

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5. Bravo, M.J. and H. Farid, A scale invariant measure of clutter. Journal of Vision, 2008. 8(1): p. 23-23.
6. Siagian, C. and L. Itti, Rapid biologically-inspired scene classification using features shared with visual attention. Ieee Transactions on Pattern Analysis and Machine Intelligence, 2007. 29(2): p. 300-312.

 Contact: max.kinateder@dartmouth.edu