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Augmented Reality for Maritime Navigation Assistance – Egocentric Depth Perception in Large Distance Outdoor Environments

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Human-Computer-Interaction
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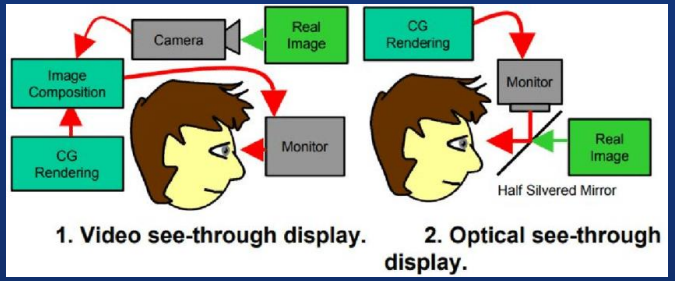
Paper Selection

Why did we choose this paper?

- Unusual and interesting topic
- AR on outdoor environment

Introduction

- Advances in OST AR (Optical See-Through AR)
- The goal of this work is to investigate how OST AR can be used in maritime contexts
- Interpret information visualized in 2D as 3D
- Understand how users perceive egocentric distances in OST AR



PROBLEM VS SOLUTION

PROBLEM

How accurate do persons perceive large egocentric distances in outdoor environments using OST AR and how diferente designs infuence?

SOLUTION

Perceptual matching task experimente onshore and a pilot user study on a maritime environment

Open-loop and Closed-loop

Open-loop

Experiment were participant do not get visual feedback while performing the task

Closed-loop

Used on this experimente, where real target objects are placed at defined distances and participants are asked to move a virtual object

Overestimation and Underestimation

Overestimation

Participant perceive the virtual object's egocentric distance larger than it was intended to be rendered

Underestimation

Participant perceive the virtual object's egocentric distance closer than it was intended to be rendered

Depth Cues in Vista Space

Occlusion 

Shadows 

Relative height 

Familiar size 

 Relative size

 Perspective convergence

 Texture gradient

 Atmospheric perspective

Background

2006, SWAN

Perceptual matching task experiment to measure egocentric depth judgments in distances from 5 to 45m in a halfway setting, using OST HMD.

2017, DIAZ

Found a decreasing error when a cube was rotated with the users head and showed that rendering a drop shadow improves the accuracy by 90%

Perceptual Experiment Overview

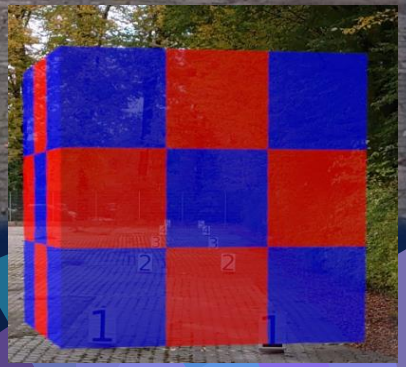


Table 1: Experimental Design

	Variable name	Levels / Values / Unit
Independent variables	Coloration	Red Blue Checkered
	Shape	Torus Cube
	Relation to floor	On-ground Off-ground without shadow Off-ground with shadow
	Target distance	15m, 30m, 45m, 60m, 75m
Random factors	Initial depth Yaw rotation Size	2 - 90m -45°- 45° 0.75m - 1.25m
Dependent variable	Signed error	m

Hypotheses

H1

Virtual objects will be farther away in (15-30m) and closer in(45, 60 a 75m)

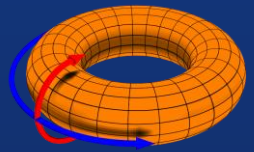
H2

Bigger distance = Bigger task error

H3

Object’s coloration influence task error

H4



Torus shape decrease matching task accuracy

H5

Relation to floor influence matching task error

Experiment

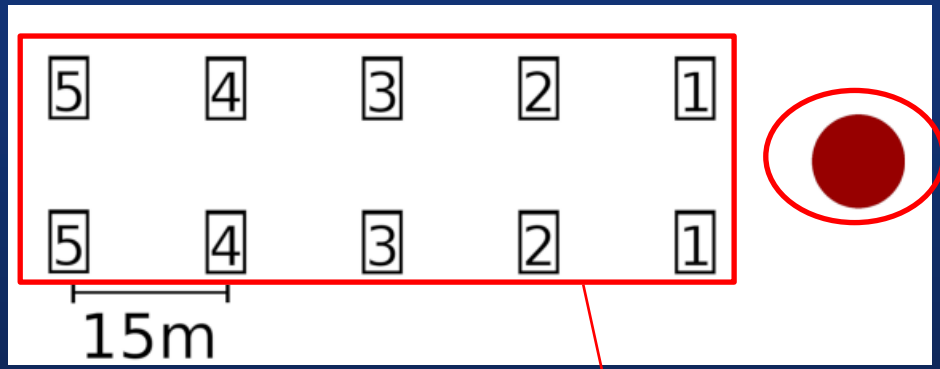
Setup

- HoloLens 2
- Microsoft Xbox Controller
- 3D engine unity e Microsoft Mixed reality Toolkit
- The environment lighting was measured (1120lx to 4547lx (M = 2724.7, SD = 1025.1))
- Noise-cancelling

Task

- The participants had to align virtual objects with real-world target objects

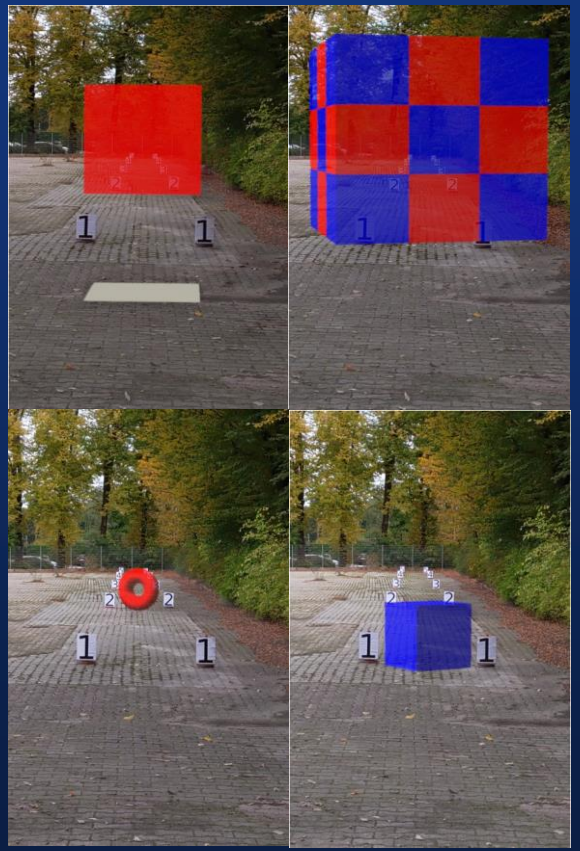
Implementation and calibration



Experiment Task and Procedure

Participants

- The participants completed three blocks of trials
- 270 experiment trials were preceded
- Target(1-5)
- Participants answered questionaires
- 15 participants (5 female, 10 male)
- Eye disorder



Results

Data from 15 participants, 270 trials, 4050 data points

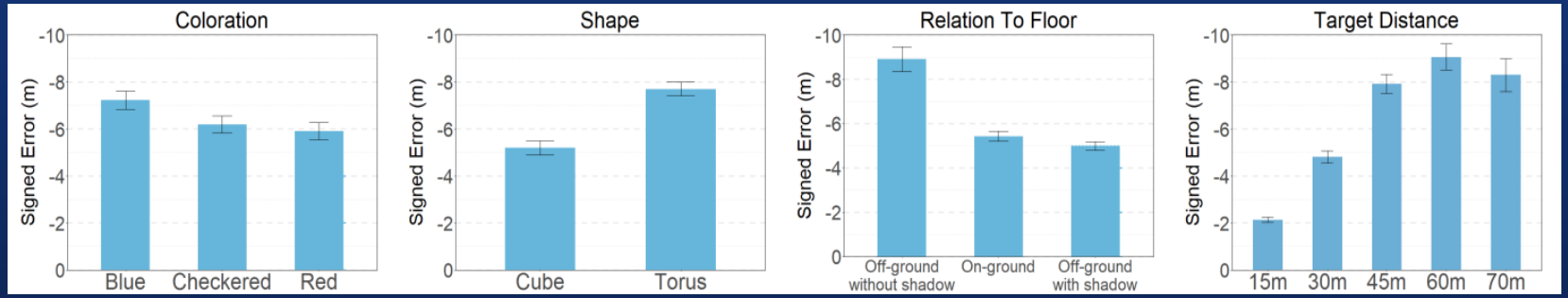


Fig 1: Mean signed errors measured in the perceptual matching task, grouped by the visual factors.

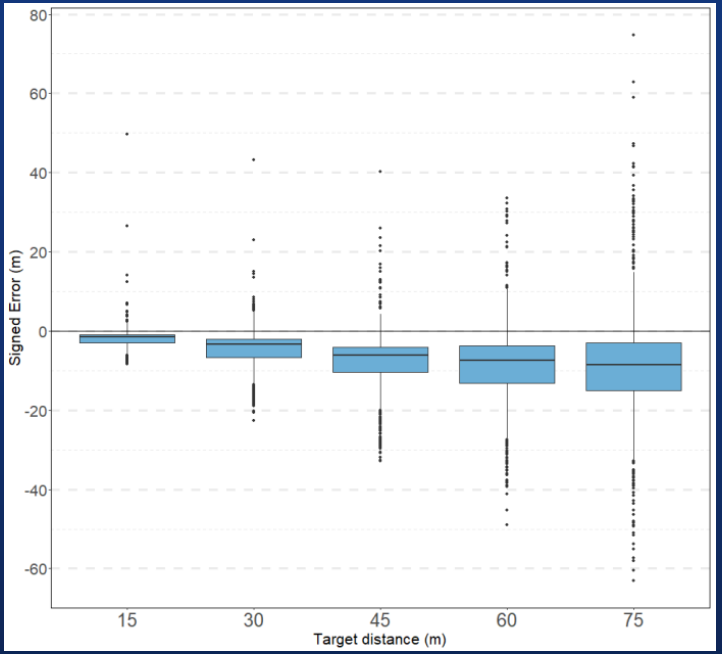


Fig 2: This visualization shows the high variance of error

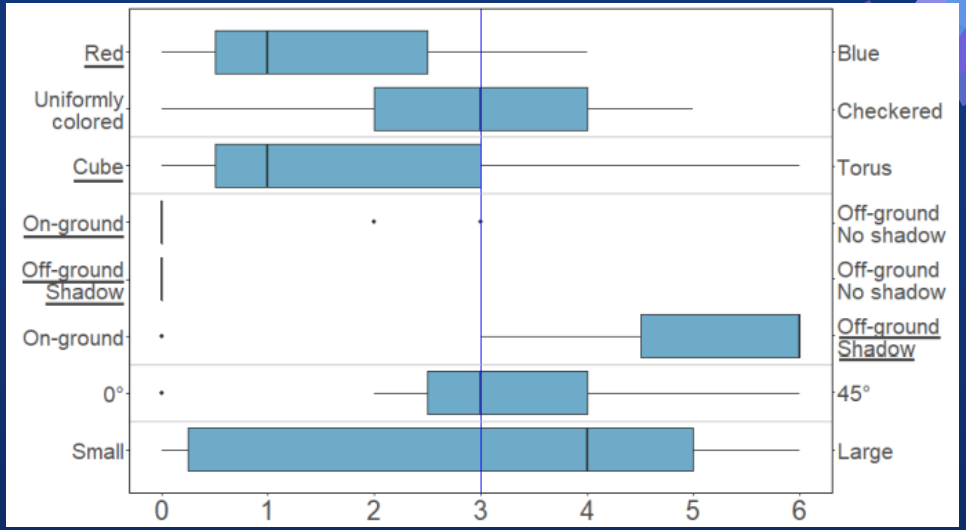


Fig 3: Subjective feedback collected in the matching task experiment.

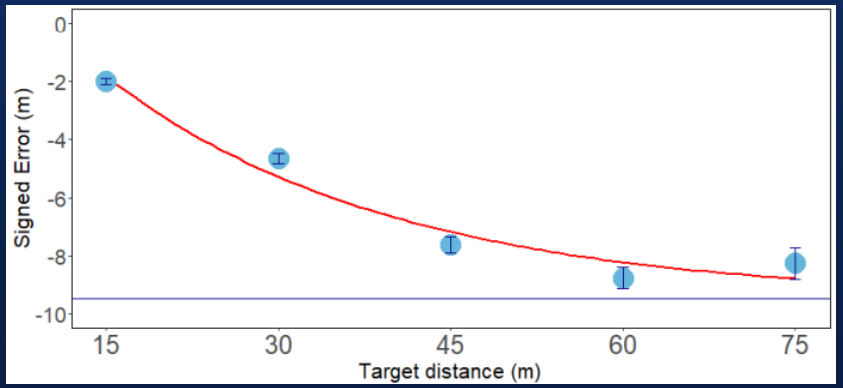
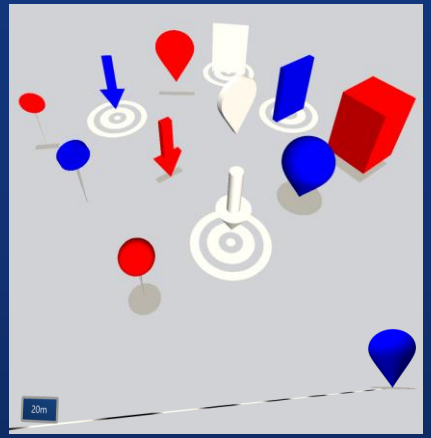


Fig 4: The blue points represent the error means per distance with the standard errors.



Pilot Study

Setup

- Microsoft HoloLens 2
- Builted HoloLens application
- Xbox controller

Task

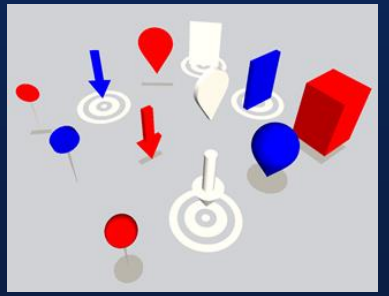
- Explore all objects and visual attributes
- Pick positions in the environment and try to place diferente objects there as accurately as possible

Results and discussion

Pilot study experiment

Regarding the color, the feedback collected aligned with the previous observations:

- Blue objects were harder to see
- 3D objects appear more appropriate
- Difficulties with objects without a relation to the floor
- Better visibility of the larger target circles
- Visualization and distance number helped



Conclusion

- Obtained valuable insights about depth perception in outdoor
- Overestimation of depth in all tested distances
- Higher accuracy with drop shadows and bright and warm colors
- Some limitations and open questions
- Necessity to investigate using other techniques

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THANKS

Do you have any questions?

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