# AUGMENTED REALITY FOR MARITIME NAVIGATION ASSISTANCE

Paper done by Julia Hertel and Frank Steinicke

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Frederico Vieira nº mec : 98518

Ricardo Antunes nº mec: 98275

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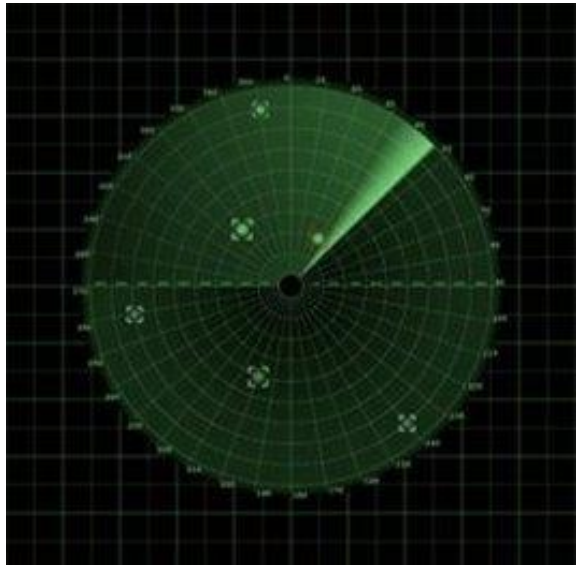
# Motivation

- It is the 1st experiment that studies depth perception in outdoor environments
- Interesting topic
- May improve navigation assistance interfaces



# Introduction:

- This work consist of carrying out an experiment to improve maritime navigation.

- It was intended to change:
  - 2D Radar;
  - The concentration on driving;
  - The focus on some critical moments

# Objectives

- Two fundamental questions:
  - 1. How accurate do persons perceive large egocentric distances in outdoor environments using OST AR?
  - 2.How are different design attributes influencing the depth perception?


# Experiences

- One to investigate perception of depth, accuracy and influence of different attributes design has.

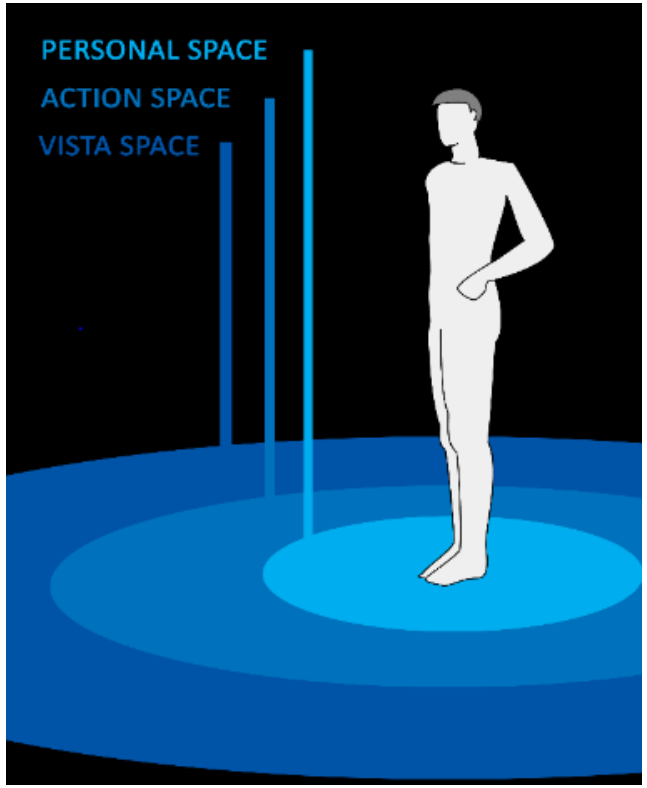
- Study on a boat to verify the validity of the first results

# BACKGROUND

# ASSESSING DEPTH PERCEPTION:

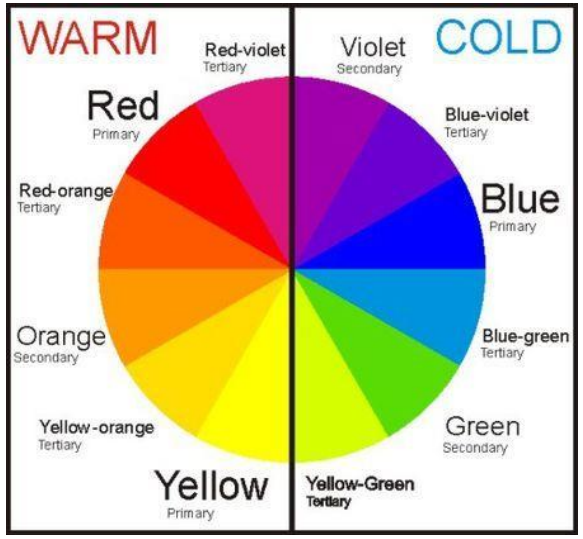
# Depth Cues in Vista Space

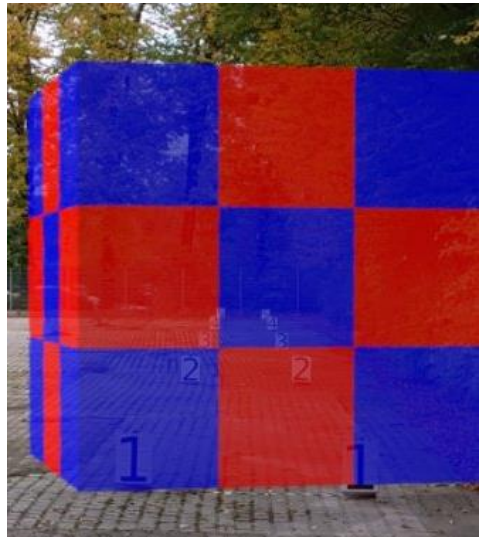
- According to Cutting the egocentric space around a person can be divided into three bands:
  - 1. Personal space (0-2m)
  - 2. Action space (2-30m)
  - 3. View space (30m-infinite)



# The Influence of Visual Attributes in AR

- In general, cold colors are perceived further away than warm colors.
- Objects with high luminosity are perceived closer than objects with low luminosity.
- The texture gradient influences the depth perceived by the human visual system.

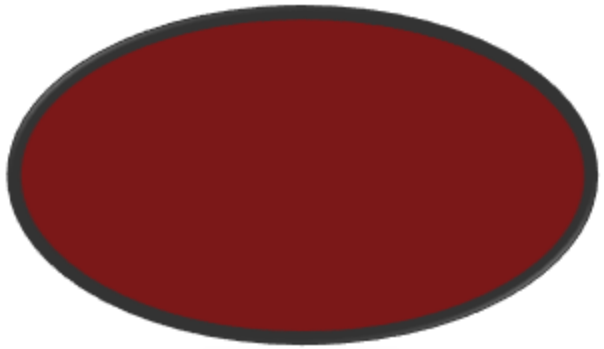


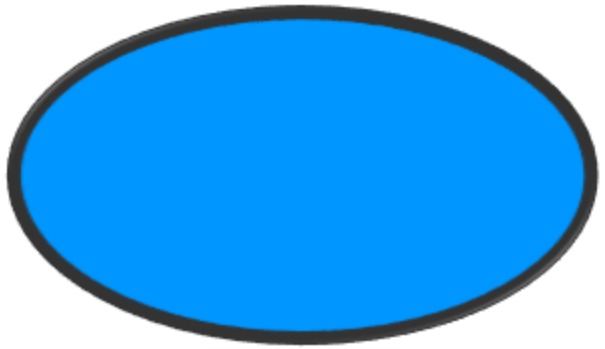



# PERCEPTUAL EXPERIMENT

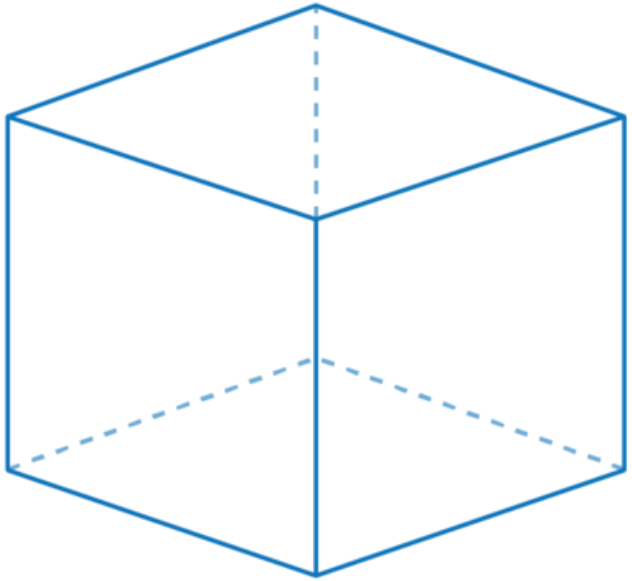
# Overview

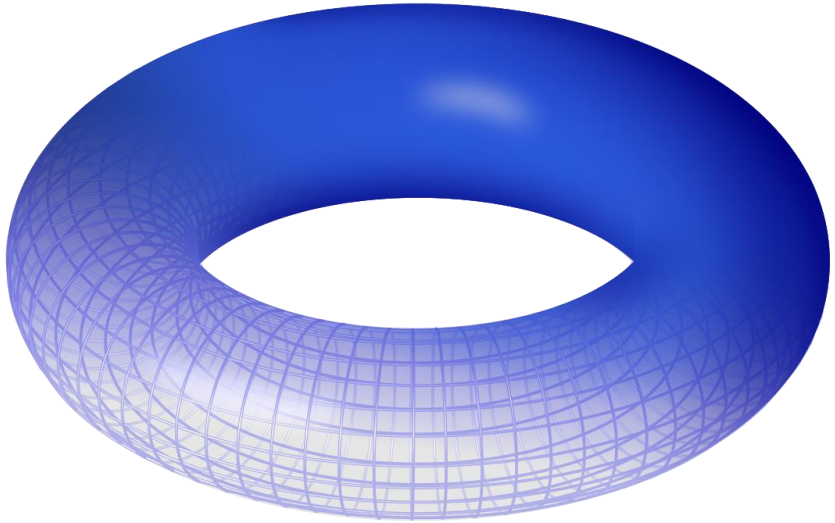
- In line with previous research:
  - (i) coloring;
  - (ii) shape;
  - (iii) relation to the floor;





# Overview





# Table – Experimental Design

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

# Hypotheses

H1: Virtual objects will be perceived farther away in action space (15 and 30m) and closer in vista space (45, 60, and 75m).

H2: The matching task error will increase with an increasing target distance.

H3: The object's coloration will influence on the matching task error.

H4: A torus shape will decrease the matching task accuracy compared to cube-shaped object.

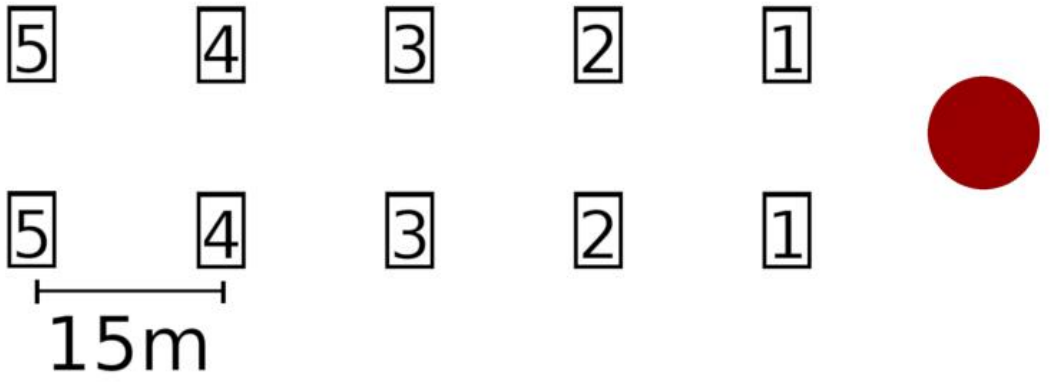
H5: The relation to floor will influence the matching task error.

# Setup

- Headset Microsoft HoloLens 21
- 3D engine Unity2
- Microsoft Mixed Reality Toolkit (version 2.4)
- Microsoft Xbox One controller
- Noise-cancelling headphones
- Empty parking lot with a length of 80m.

# Implementation

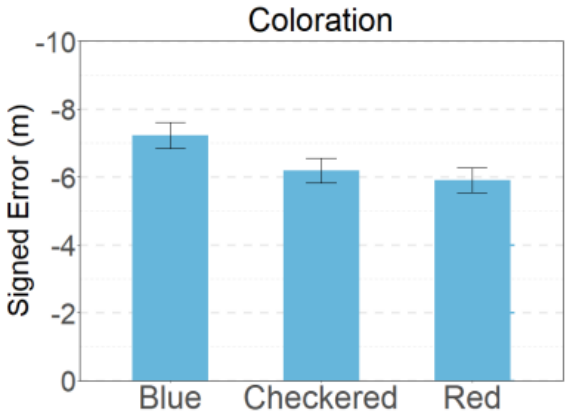
- Participants performed the task by translating the virtual objects to the desired position using the controller's joystick.

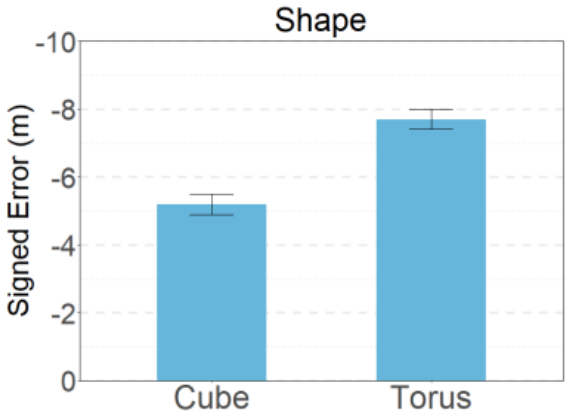


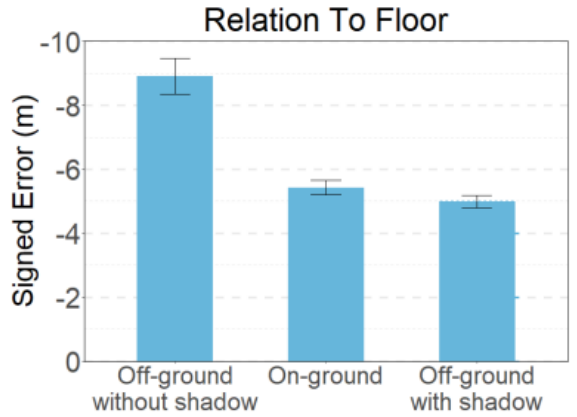

# Experimental Task and Procedure

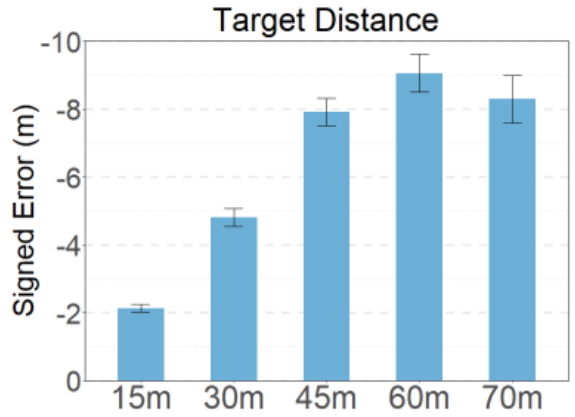
- 3 blocks trials with 90 conditions
- 270 trials with 5 training trials
- 15 participants

# Results

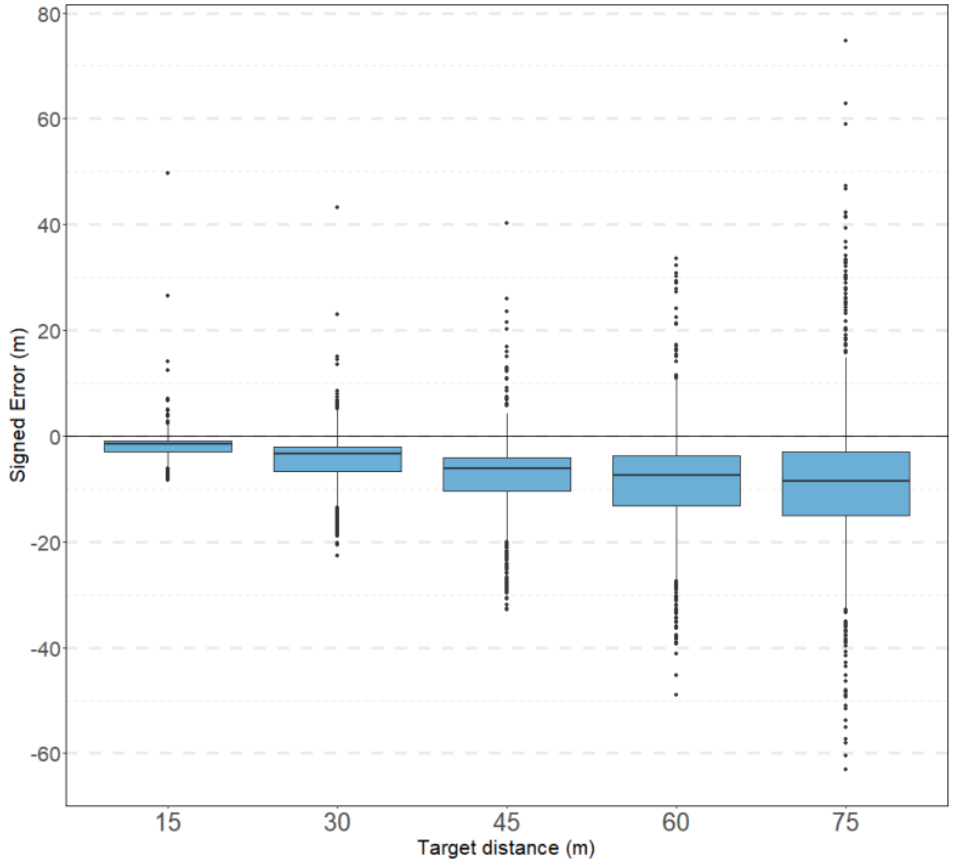

Coloration
Signed Error (m)
-10
-8
-6
-4
-2
0
Blue
Checkered
Red

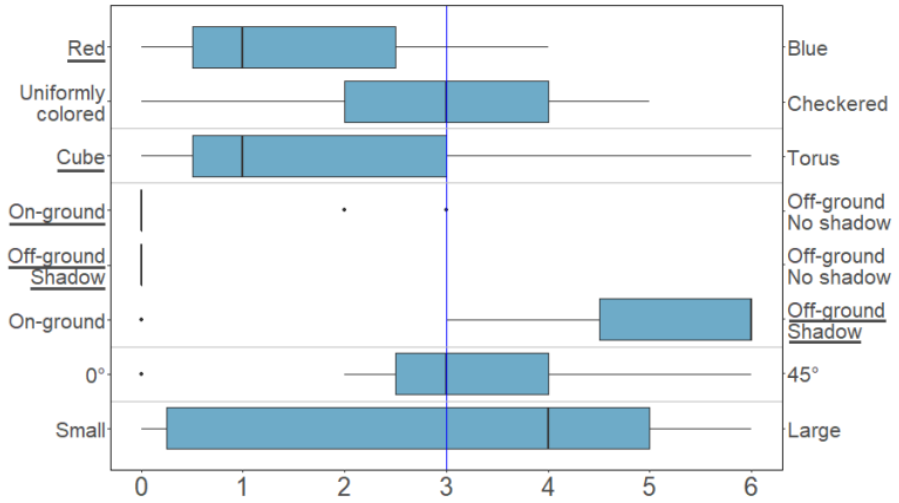

Shape
Signed Error (m)
-10
-8
-6
-4
-2
0
Cube
Torus

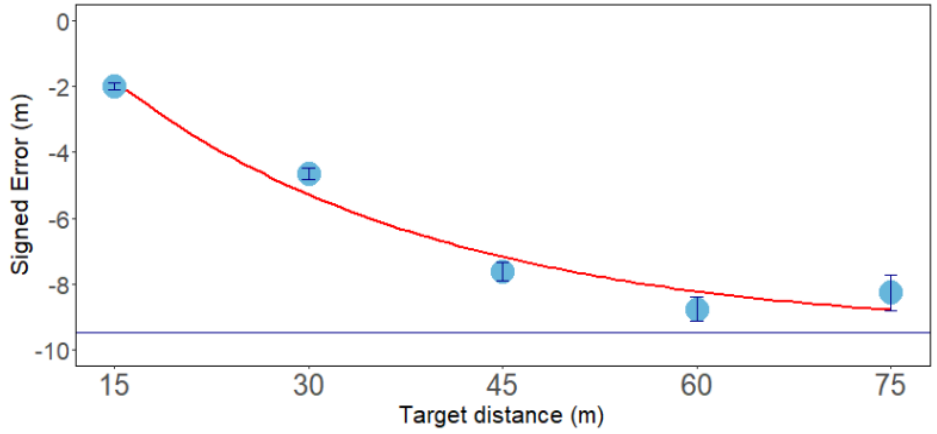

Relation To Floor
Signed Error (m)
-10
-8
-6
-4
-2
0
Off-ground without shadow
On-ground
Off-ground with shadow


Target Distance
Signed Error (m)
-10
-8
-6
-4
-2
0
15m
30m
45m
60m
70m

# Results


Signed Error (m)
80
60
40
20
0
-20
-40
-60
15
30
45
60
75
Target distance (m)

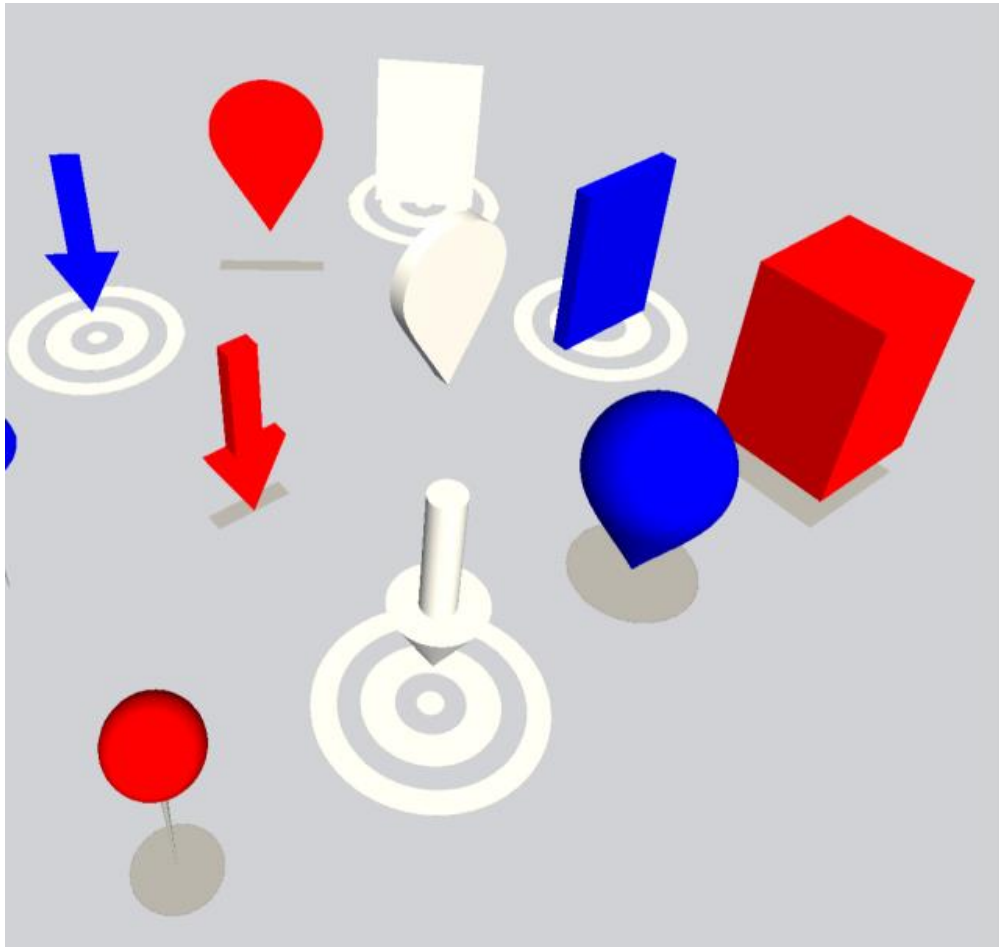

Red
Uniformly colored
Cube
On-ground
Off-ground Shadow
On-ground
0°
Small
Blue
Checkered
Torus
Off-ground No shadow
Off-ground No shadow
Off-ground Shadow
45°
Large
0
1
2
3
4
5
6


Signed Error (m)
0
-2
-4
-6
-8
-10
15
30
45
60
75
Target distance (m)

# Pilot Study

- Study carried out on a boat;

- Objective:
  - user to move the 3D objects with different colors and try to distinguish them



# Pilot Study- Results

- Participant reported that blue objects were more difficult to see and locate than red ones.
- This time we also included white objects. As expected, these performed even better than the reds.

# CONCLUSION