

Spatial Manipulation and Physical Interaction

UNIVERSITY OF MINNESOTA
Driven to Discover®

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Virtual Portals



Virtual Portals



(a)



(b)



(c)

Figure 1: A transitional environment: (a) the real laboratory, (b) the corresponding virtual 3D textured model of the laboratory, and (c) screenshot of a virtual portal. While the user moves through the transitional environment, she can see the actual virtual world through the portal.

Portals for Environment Transitions
(Steinicke et al. 2009)

Virtual Portals



Portal Reorientation in a CAVE
(Freitag et al. 2014)

Rick and Morty : Virtual Rick-ality



Change Blindness Illusions











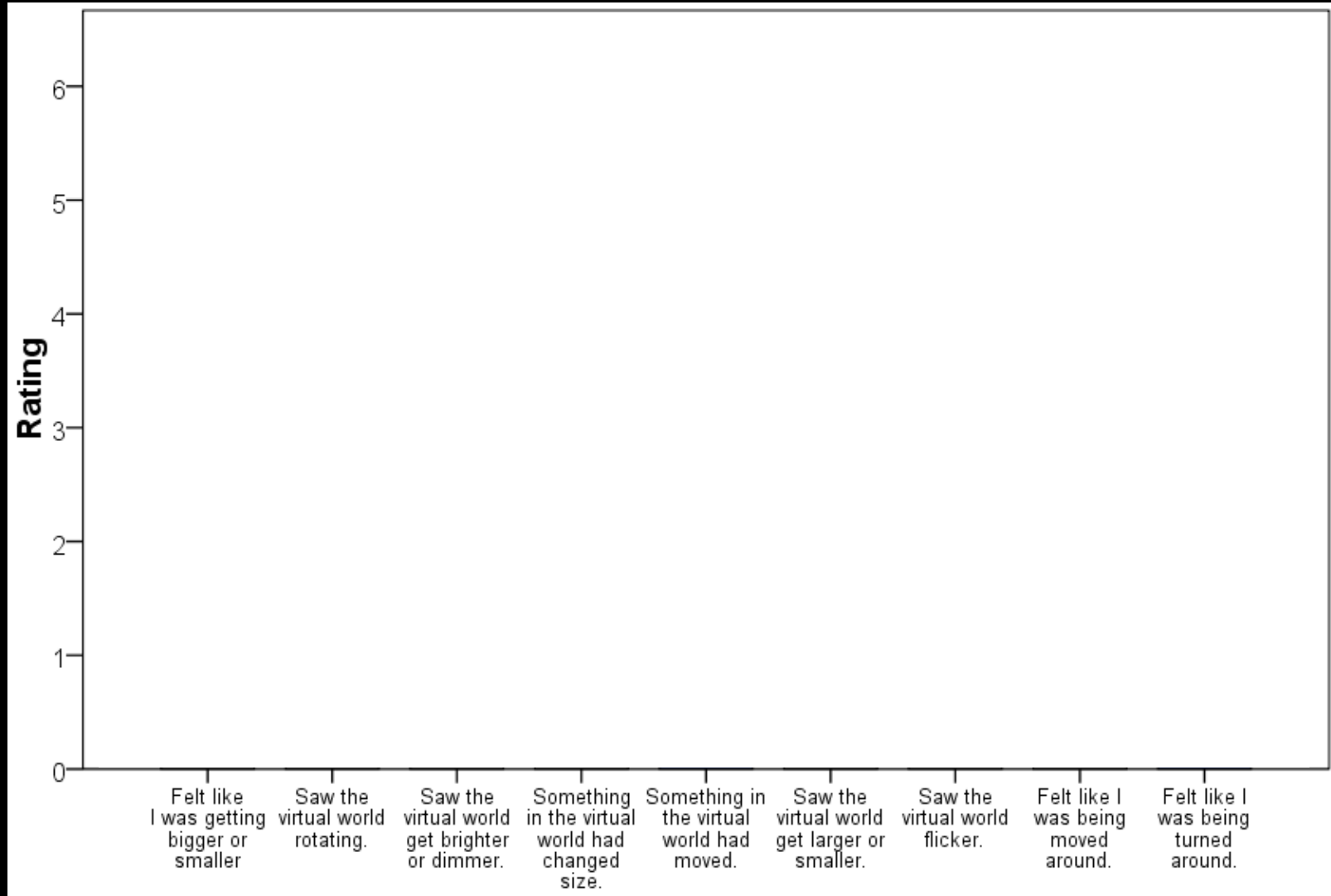








Embedded Questions

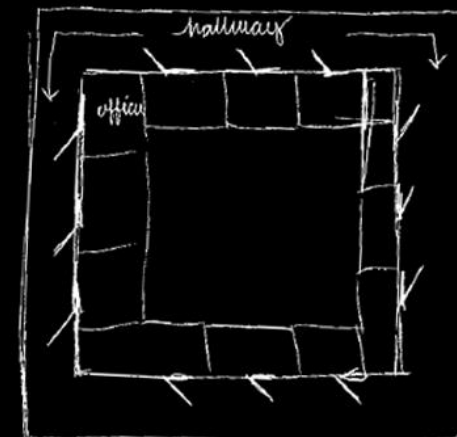
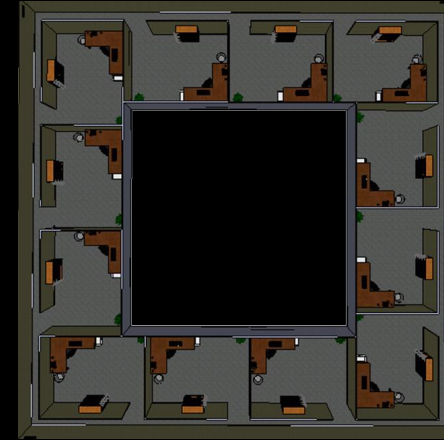


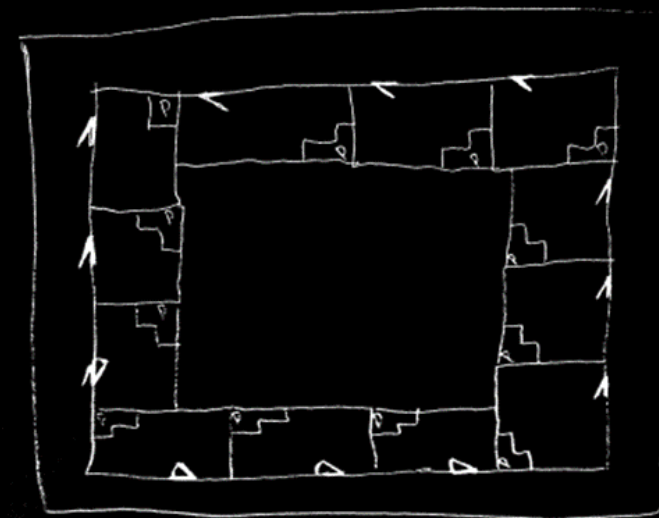
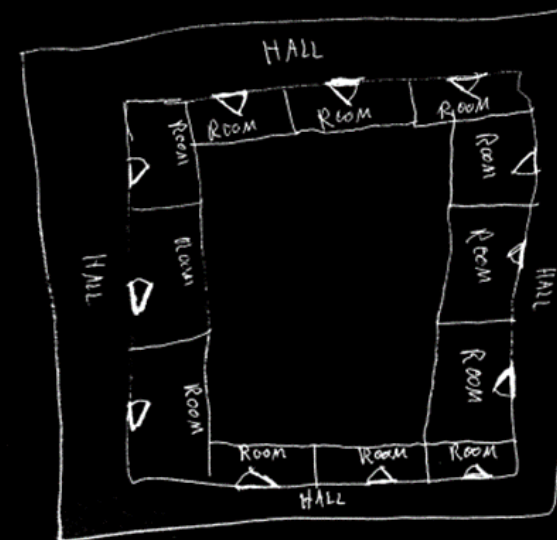
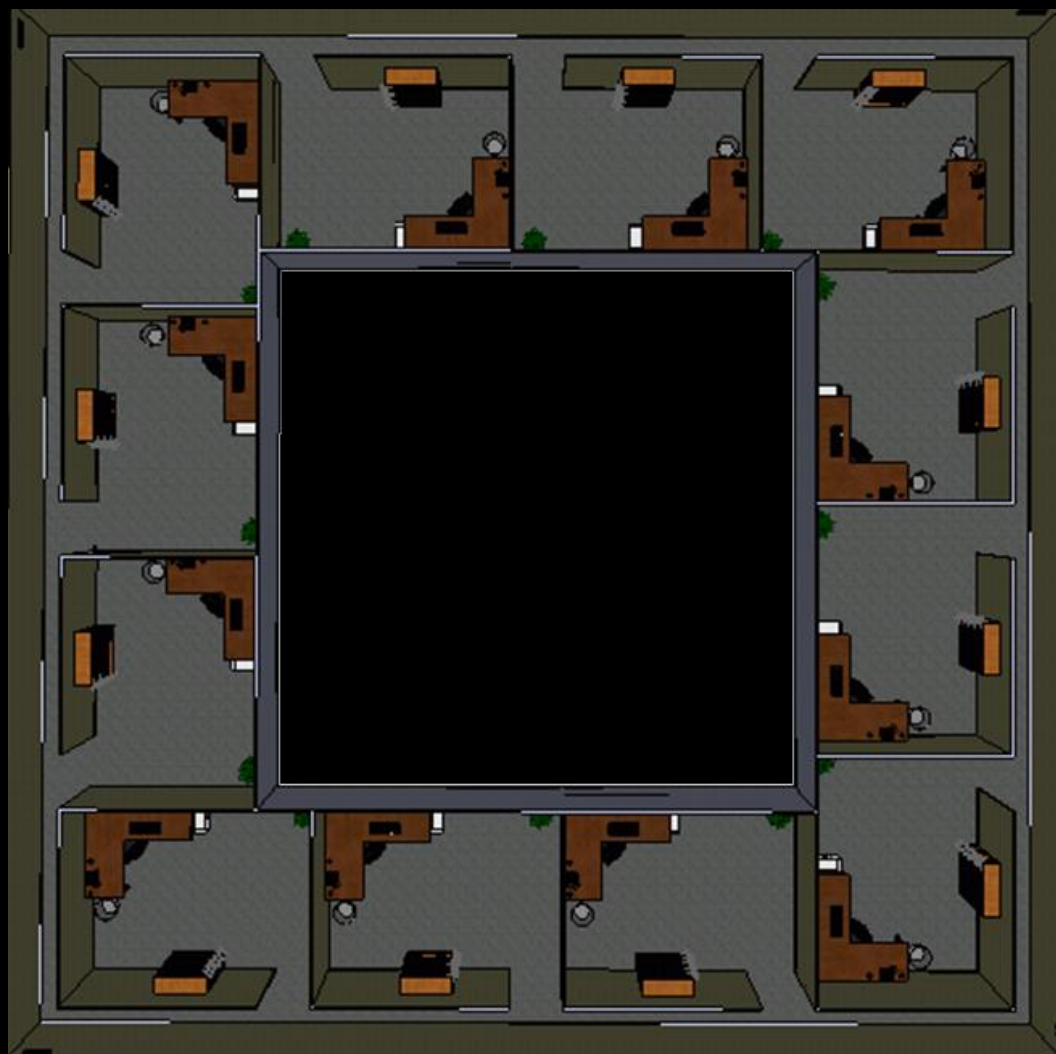
Evaluating Sketch Maps

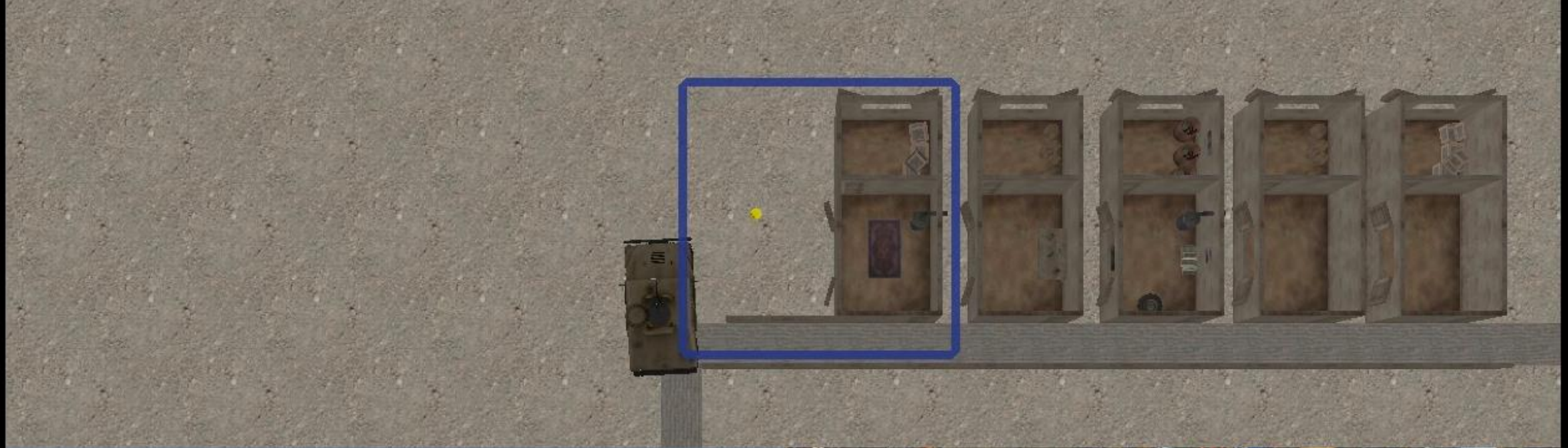
- Ratings from independent graders
- Must be blind to experiment conditions

How well does the sketch represent the same environment as the picture?

1 ←————→ 5
not at all very closely





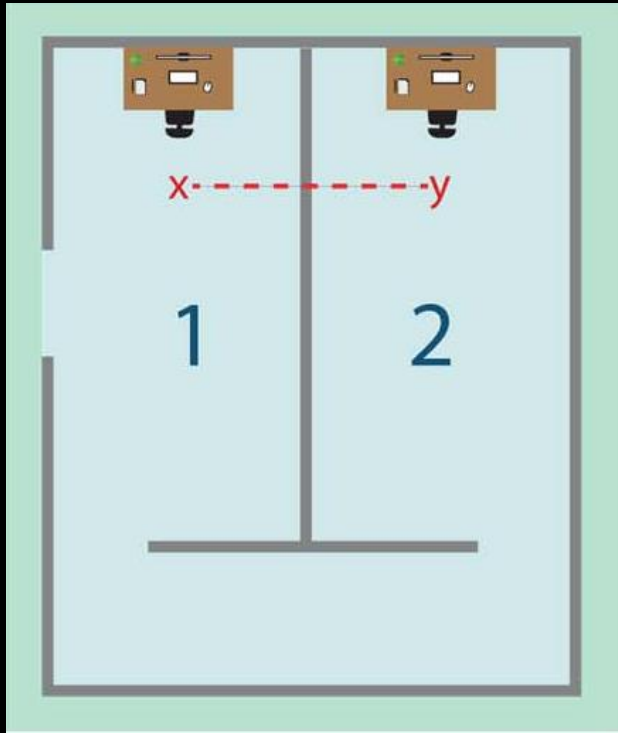


E. Suma, D. Krum, and M. Bolas. Redirection on Mixed Reality Walking Surfaces, PIVE 2011.

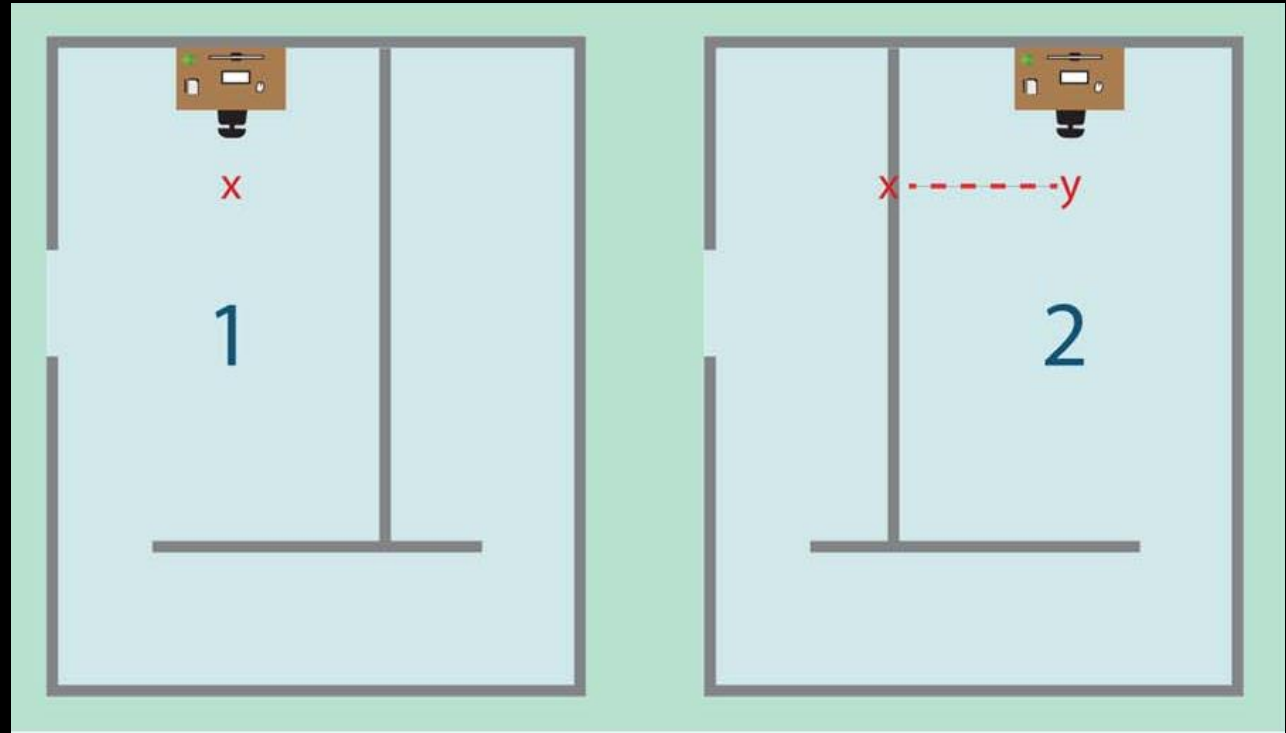
Impossible Spaces



Impossible Spaces

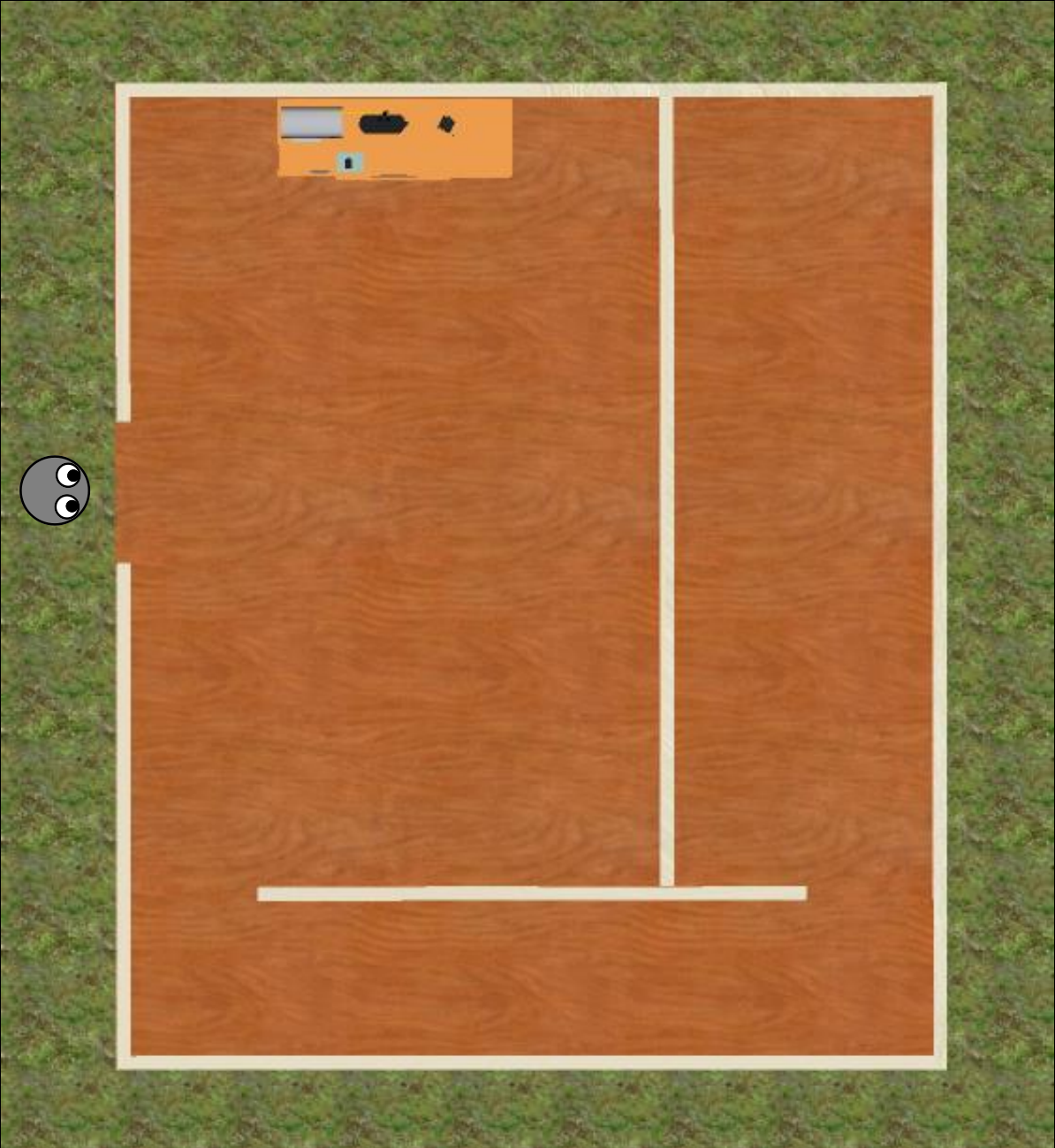


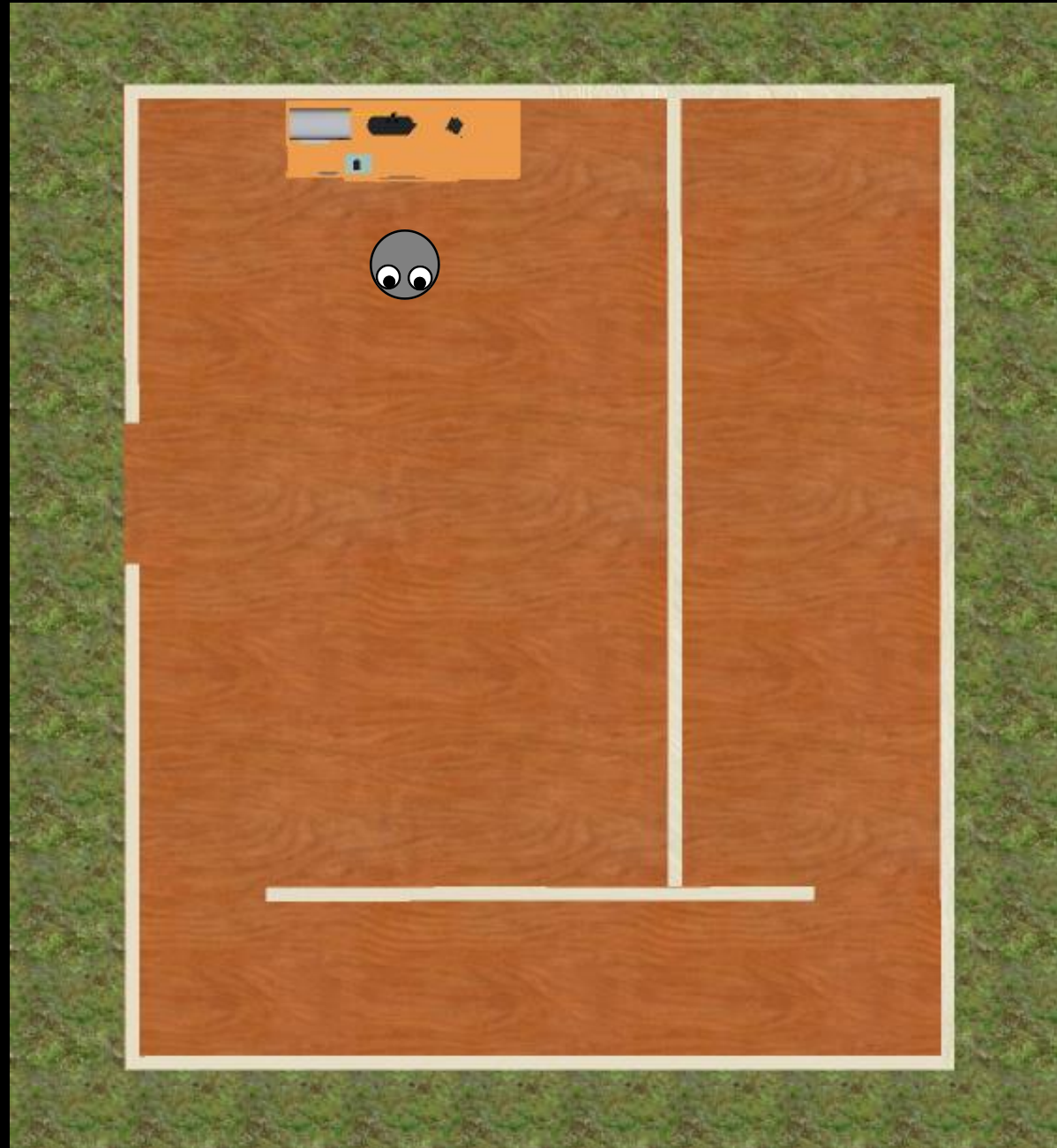
0% overlap between rooms

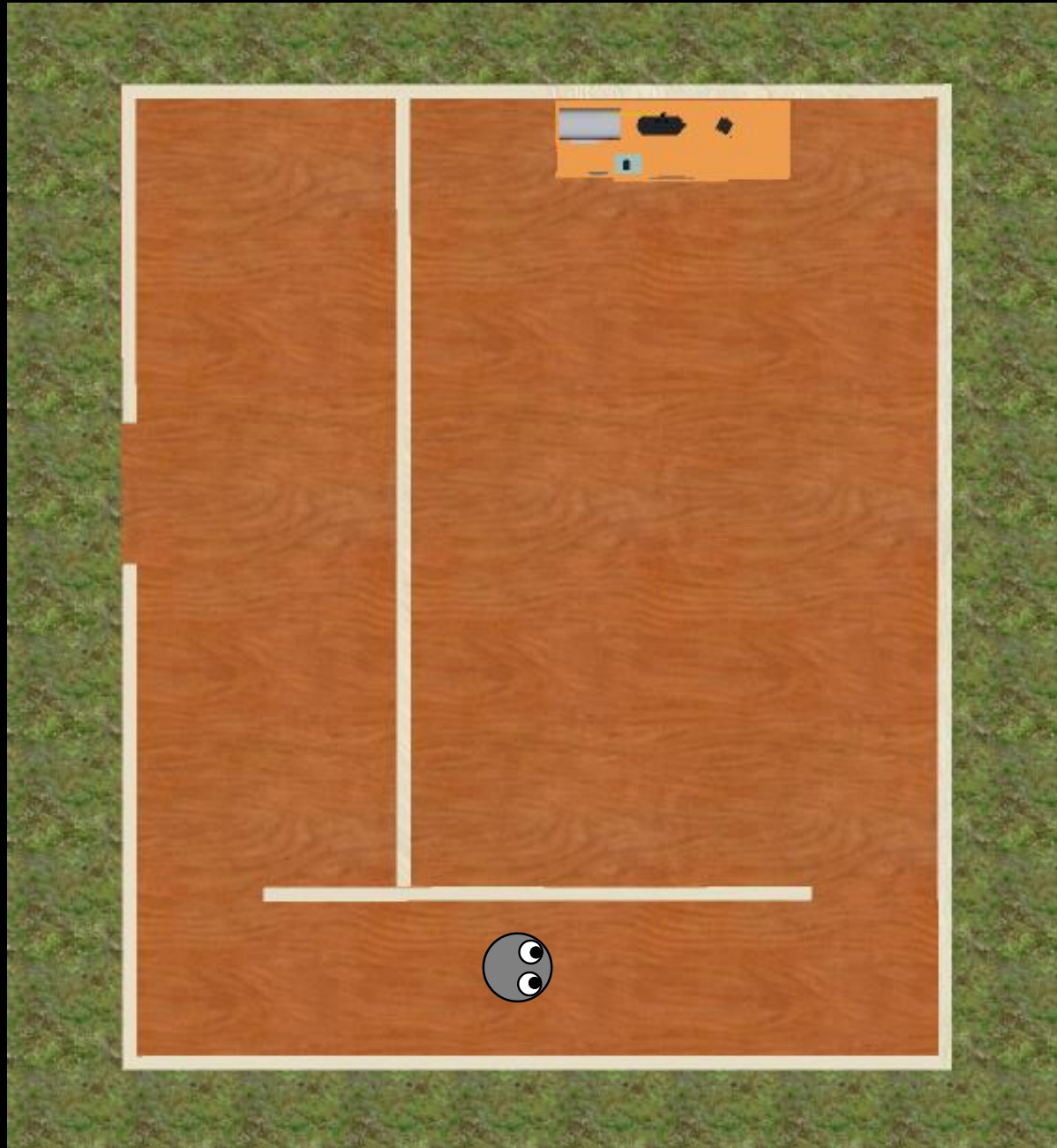


50% overlap between rooms

E. Suma, Z. Lipps, S. Finkelstein, D. Krum, and M. Bolas. Impossible Spaces: Maximizing Natural Walking in Virtual Environments with Self-Overlapping Architecture, IEEE TVCG 2012. **Best Paper Honorable Mention.**

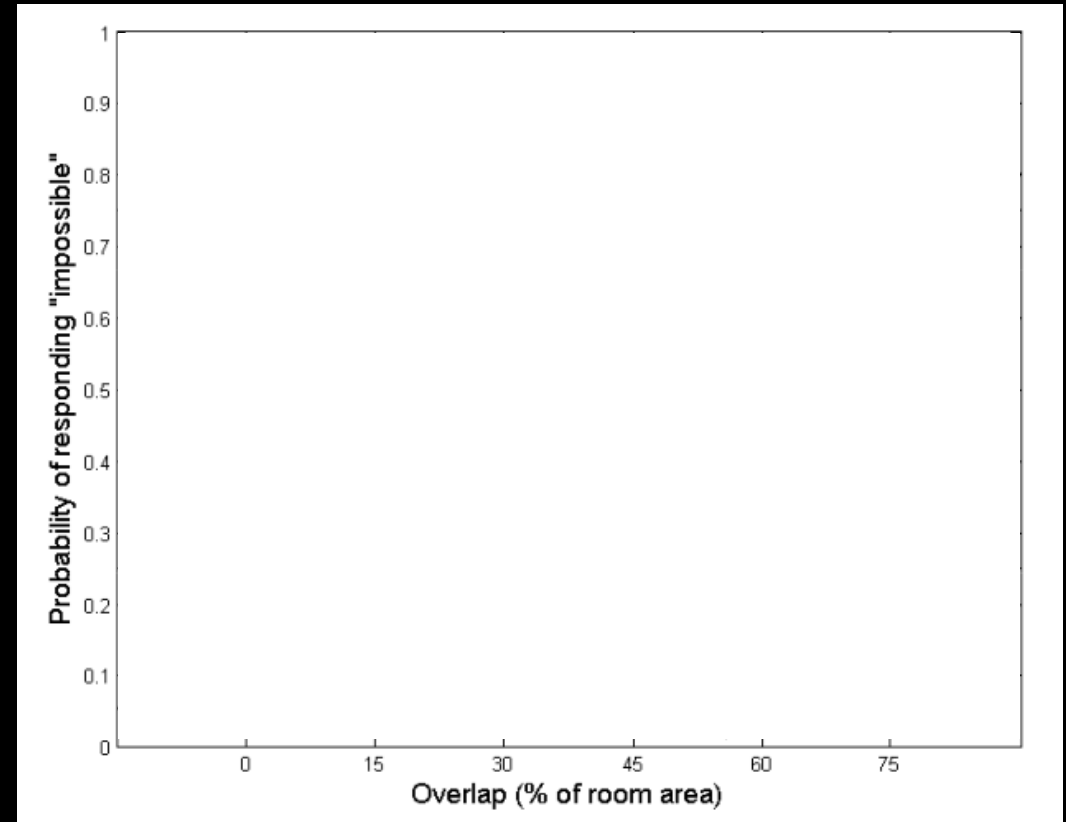






Detection of Impossible Spaces

- Two alternative forced choice task (2AFC)
- “Is this an **impossible** or **possible** space?”
- Compute pooled probability of response (forced choice, no neutral option)
- Fit a psychometric function (sigmoid)
- Detection threshold at 50%

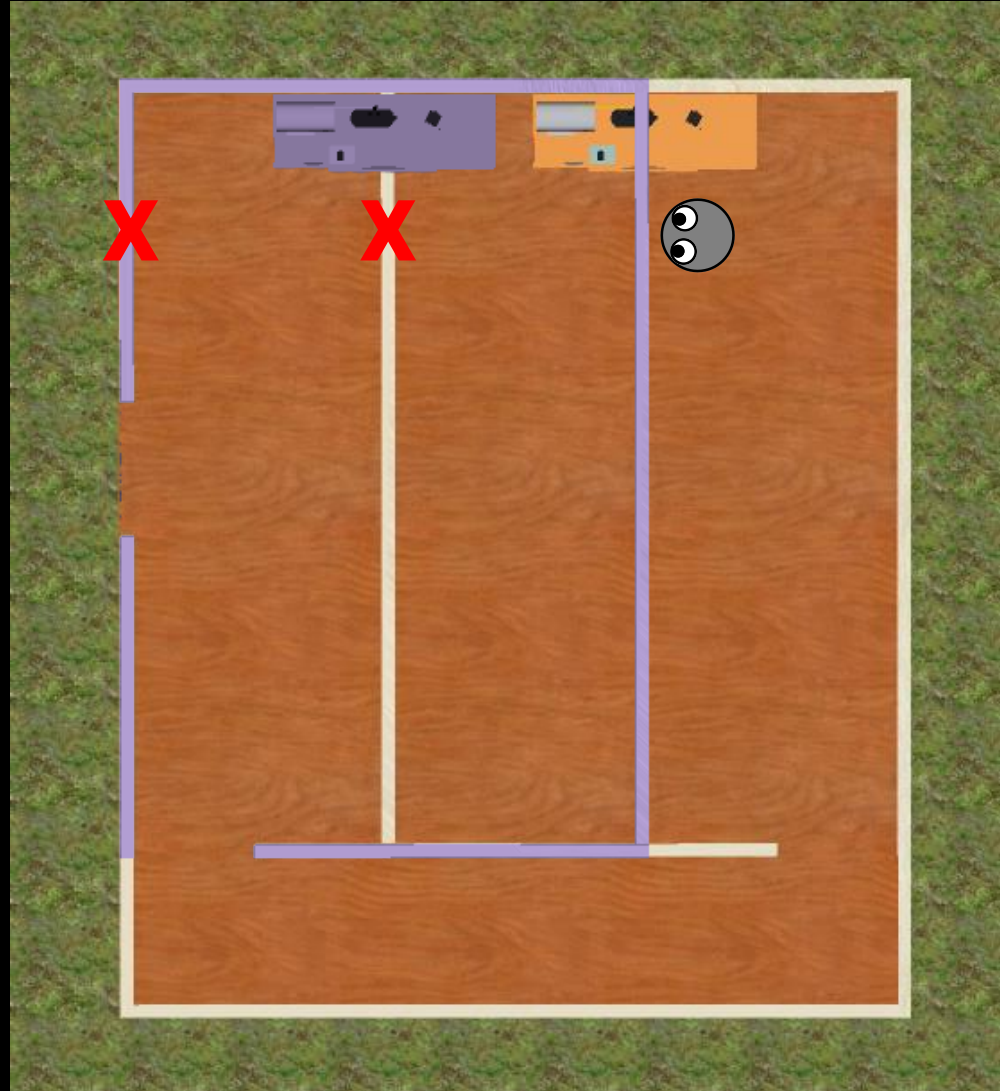


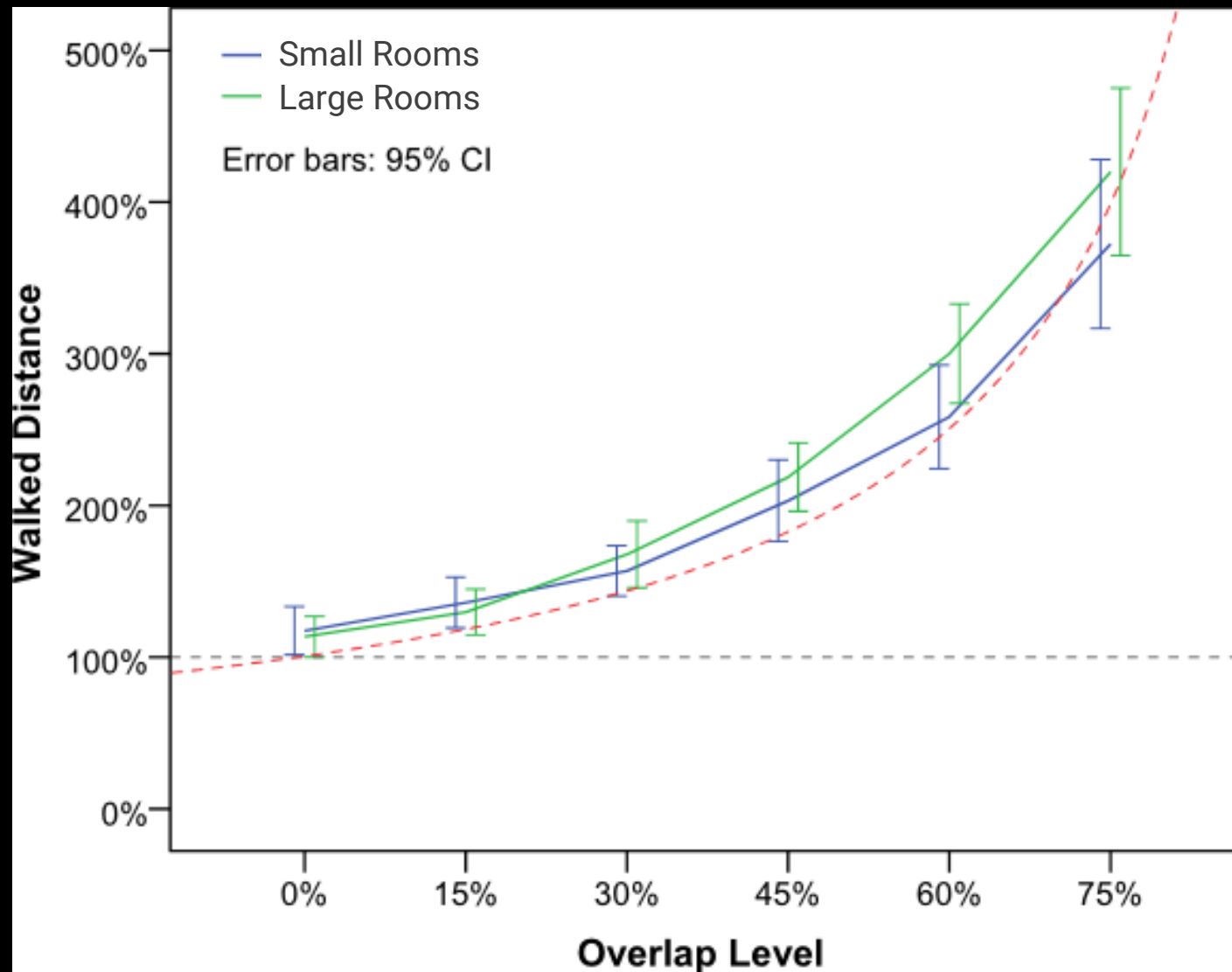
Distance Estimation

X



Distance Estimation





E. Suma, Z. Lipps, S. Finkelstein, D. Krum, and M. Bolas. Impossible Spaces: Maximizing Natural Walking in Virtual Environments with Self-Overlapping Architecture, IEEE TVCG 2012. **Best Paper Honorable Mention.**

Flexible Spaces





K. Vasylevska, H. Kaufmann, M. Bolas, and E. Suma. Flexible Spaces: Dynamic Layout Generation for Infinite Walking in Virtual Environments, IEEE 3DUI 2013.

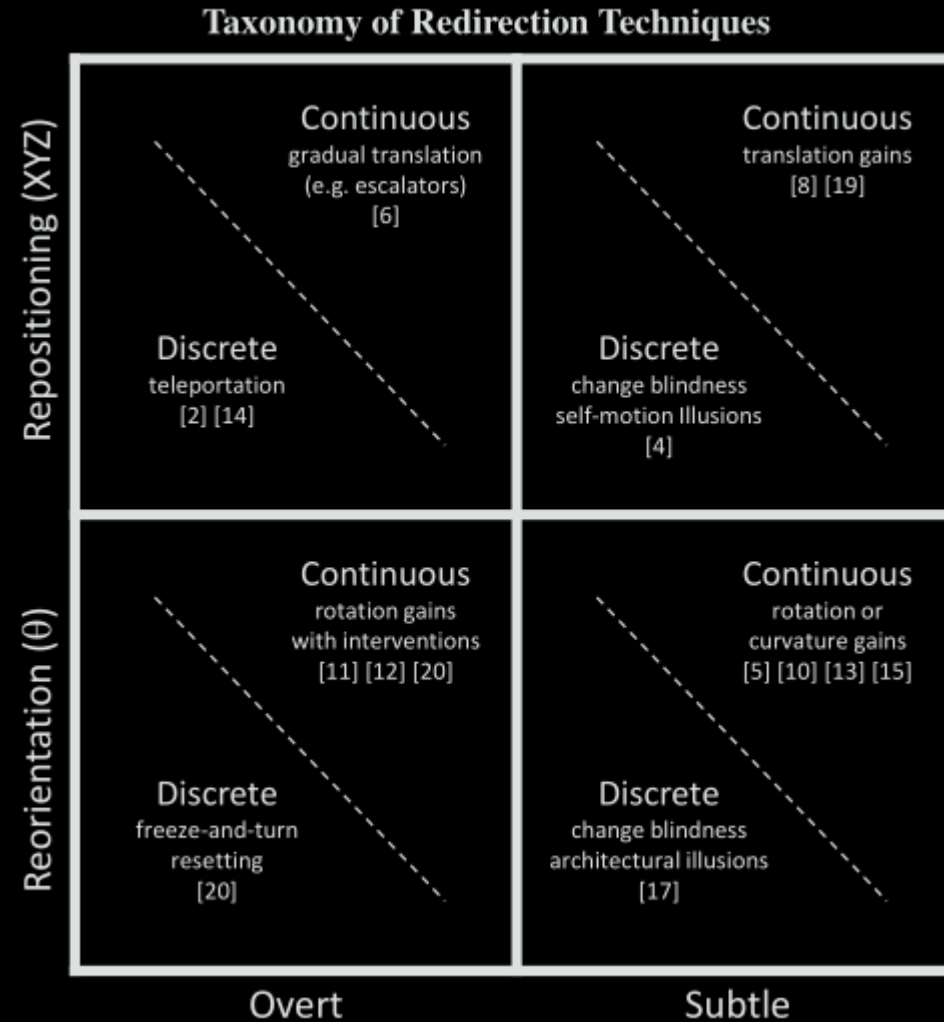
Summary

Virtual portals, change blindness, and impossible spaces are **spatial manipulation** techniques for redirecting users.



Commercial Implementations of Impossible Spaces

Redirection Taxonomy



Physical Interaction



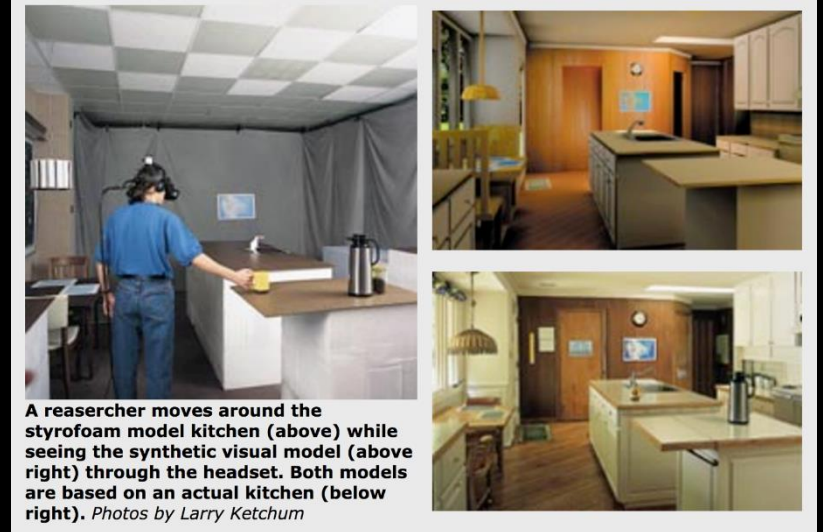
Image Credit: Ready Player One (2018)

UNC Virtual Kitchen (1992)

Seeing and Feeling

In virtual reality (VR) experiments, people wearing special headsets are able to "see" an environment. This is especially helpful in designing new environments, whether the floor plan of a building or the layout of a warship. A UNC research project not only allows you to "see" what an environment looks like but also what it "feels" like. Hybrid reality allows users to actually feel and bump into the objects seen in the virtual environment. Researchers hope to find out if virtual environments seem more real when users cannot walk through virtual walls or solid objects, as they have been able to do in most VR environments.

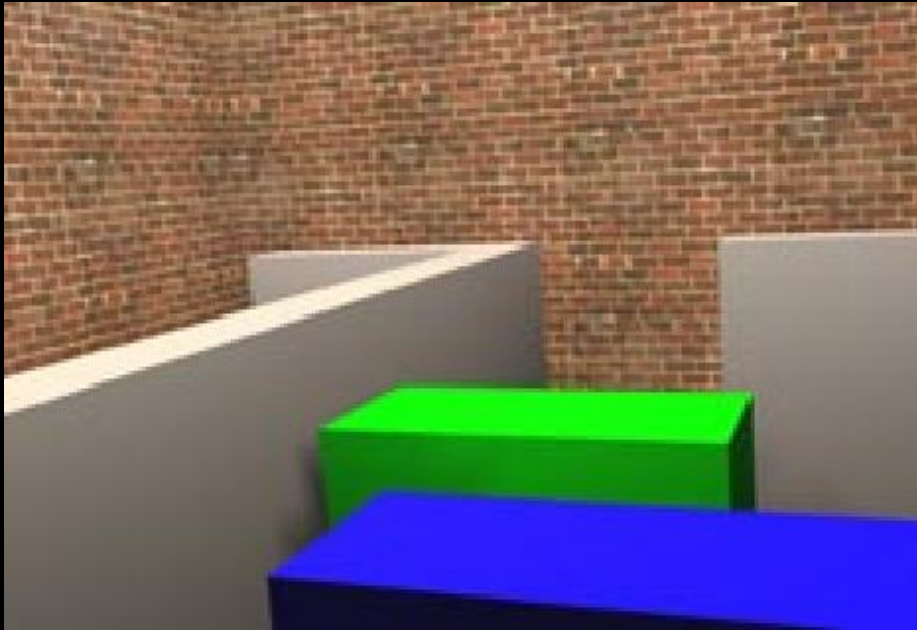
UNC researchers set up a model kitchen made of styrofoam, simulating countertops, work islands, a sink and other features of a kitchen. Wearing the VR headset, a user sees a synthetic visual kitchen, which replicates, with half-inch accuracy, an actual kitchen. However, the visual model and the styrofoam model have been carefully aligned so that when the user reaches out to touch something such as a countertop corner, the corner in the styrofoam model is where the visual information indicates it will be.



A researcher moves around the styrofoam model kitchen (above) while seeing the synthetic visual model (above right) through the headset. Both models are based on an actual kitchen (below right). Photos by Larry Ketchum

Passive haptics can enhance virtual reality with physical touch.

Passive Haptics Increases Presence



Insko, B. E., Meehan, M., Whitton, M., & Brooks, F. (2001). Passive haptics significantly enhances virtual environments.
Doctoral dissertation, University of North Carolina at Chapel Hill.

UNC Virtual Pit (2001)

Key Features

- Training room and pit room
- Physical walking
- Fast, accurate, room scale tracking
- Haptic feedback – feel edge of pit, walls
- Strong visual and 3D audio cues

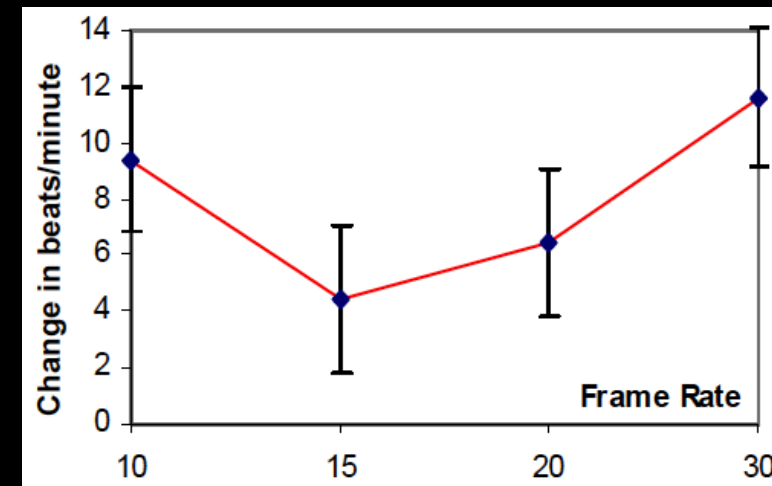
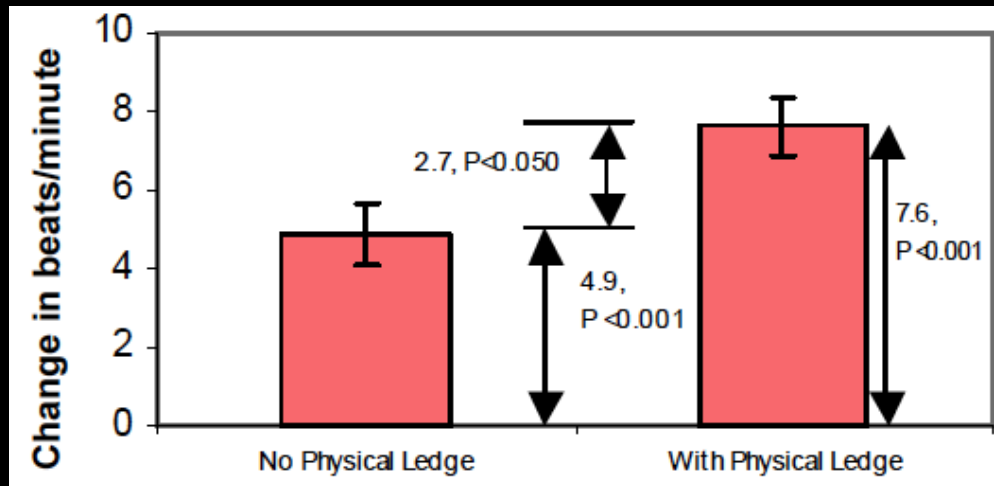
Task

- Carry object across pit
- Walk across or walk around
- Dropping virtual balls at targets in pit



http://wwwx.cs.unc.edu/Research/eve/walk_exp/

UNC Virtual Pit (2001)

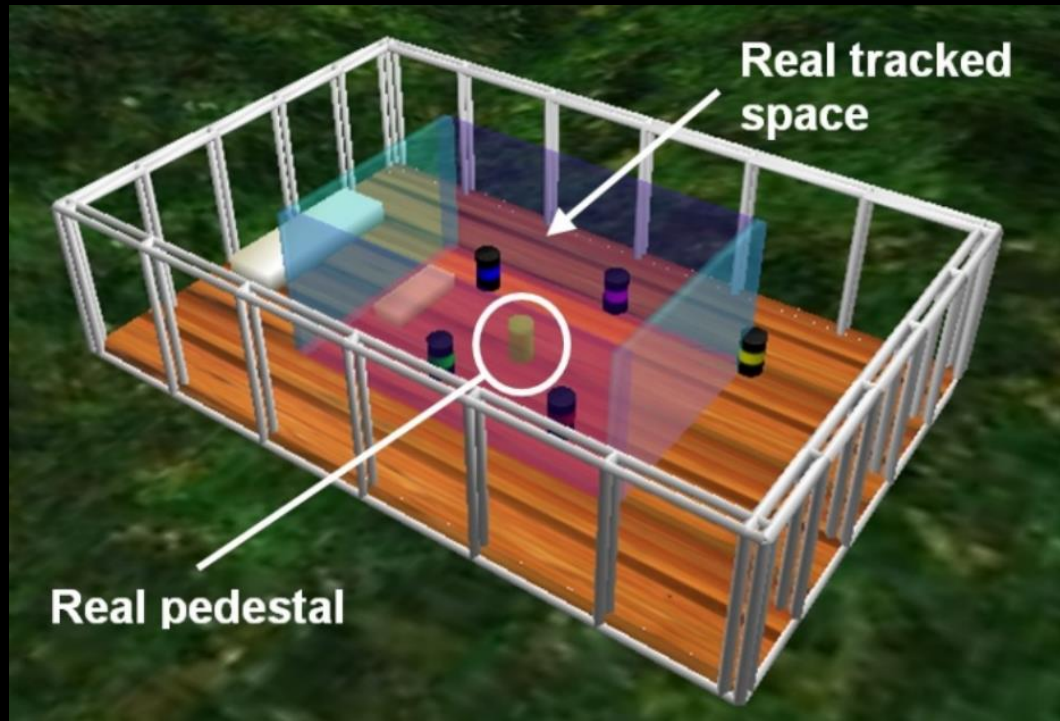


Participant's heart rates increased with passive haptics and increased framerate.

Richie's Plank Experience (2017)

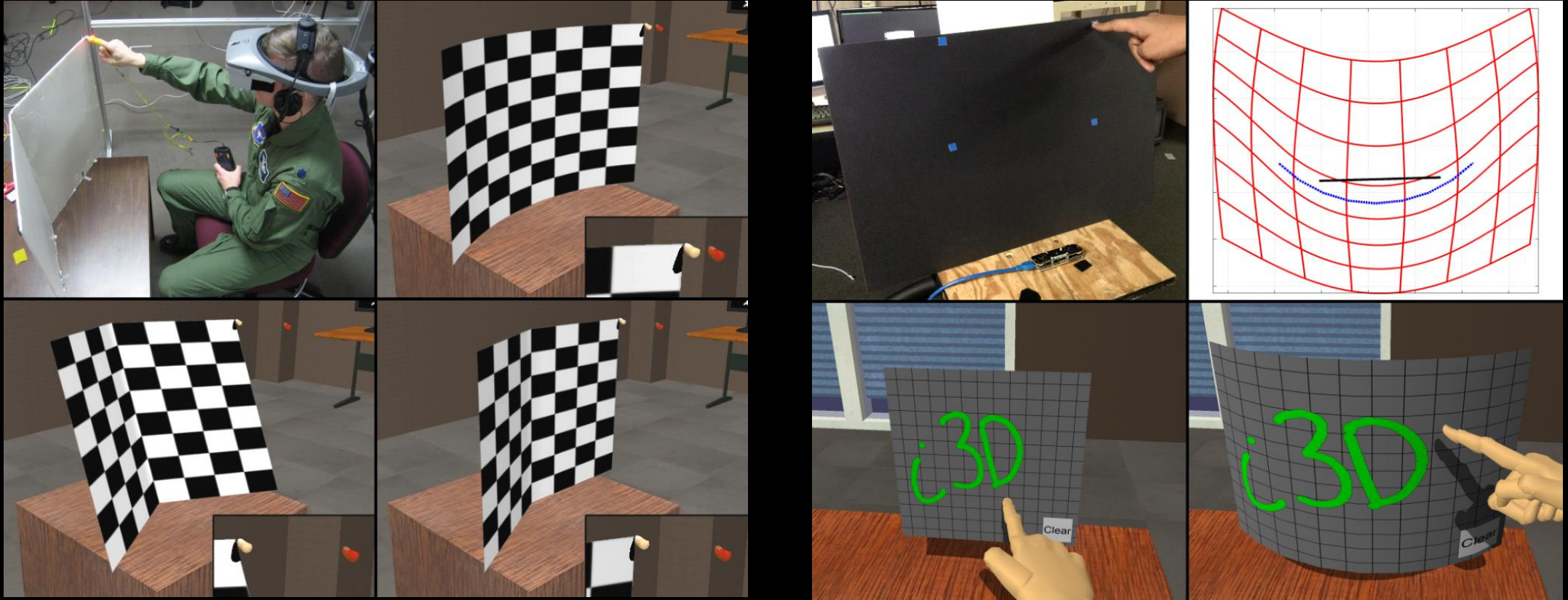


Redirection and Passive Haptics (2005)



L. Kohli, E. Burns, D. Miller, and H. Fuchs. Combining passive haptics with redirected walking, ICAT 2005.

Redirected Touching (2013)



Luv Kohli. Redirected Touching. Ph.D. Dissertation, University of North Carolina at Chapel Hill, 2013.

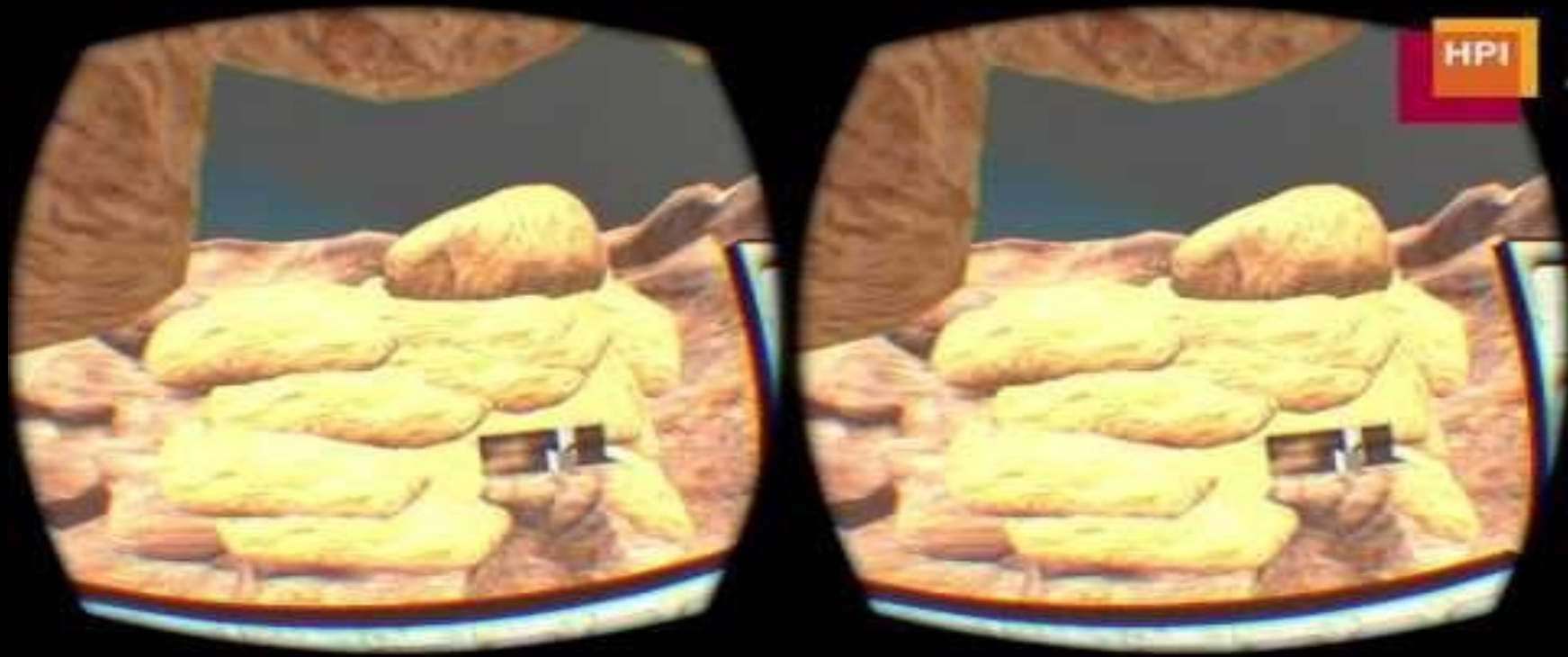
Haptic Retargeting (2016)



Sparse Haptic Proxy (2017)



TurkDeck (2015)



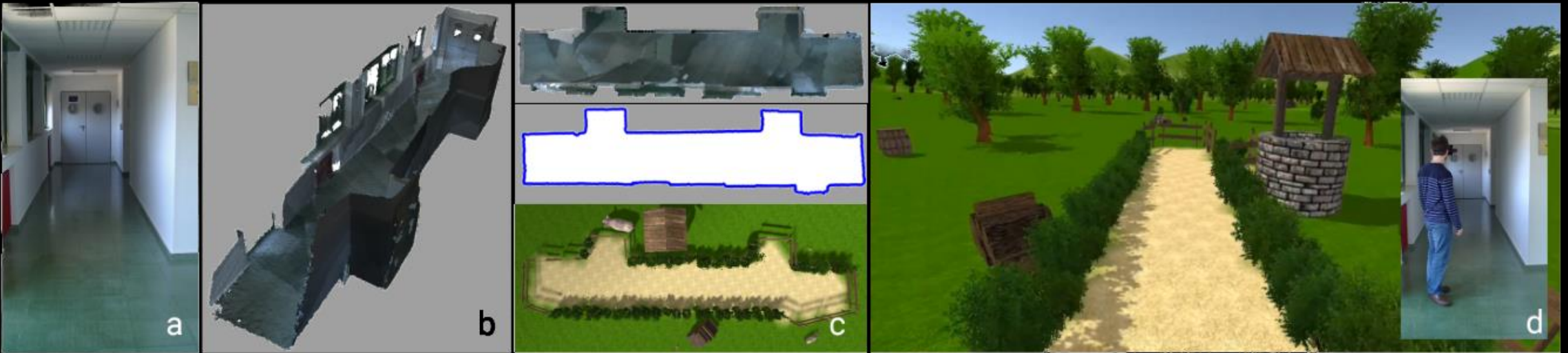
Mutual Human Actuation (2017)



iTurk (2018)



Procedural Generation (2016)



Sra, M., Garrido-Jurado, S., Schmandt, C. and Maes, P. Procedurally generated virtual reality from 3D reconstructed physical space, ACM VRST 2016.

Vroamer (2019)



DreamWalker (2019)



RealityCheck (2019)



Reminders

Complete the participation exercise on Canvas by **Friday, December 11.**

Remember that next week's classes will be held **synchronously!**