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VR World Congress 4/12/2017

In AR and VR, we are obsessed  
with creating a rich sense of **reality!**

# Your VR Living Room



# Work



# Communication



Is chasing reality the best strategy?

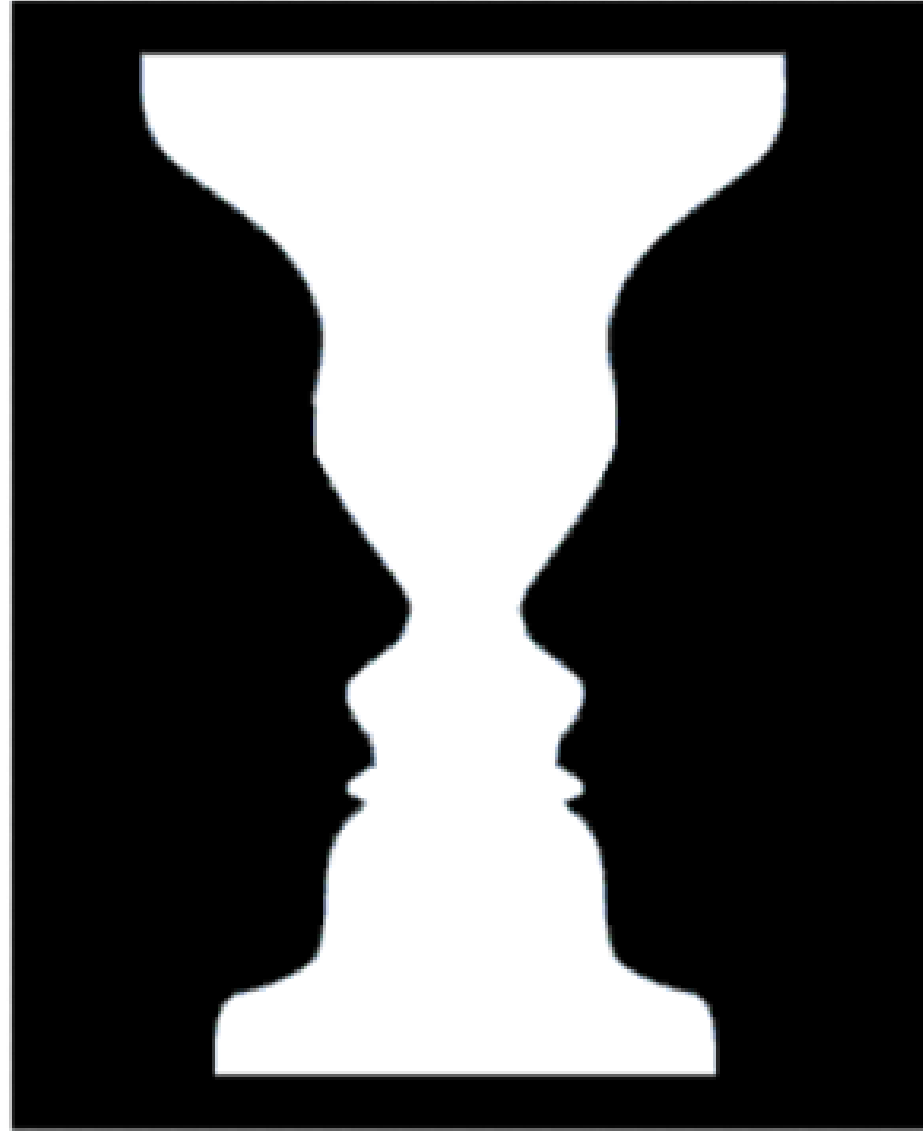
The 'world' is a framed and malleable construct that the user creates in their mind.

*Mark Bolas, 2012*

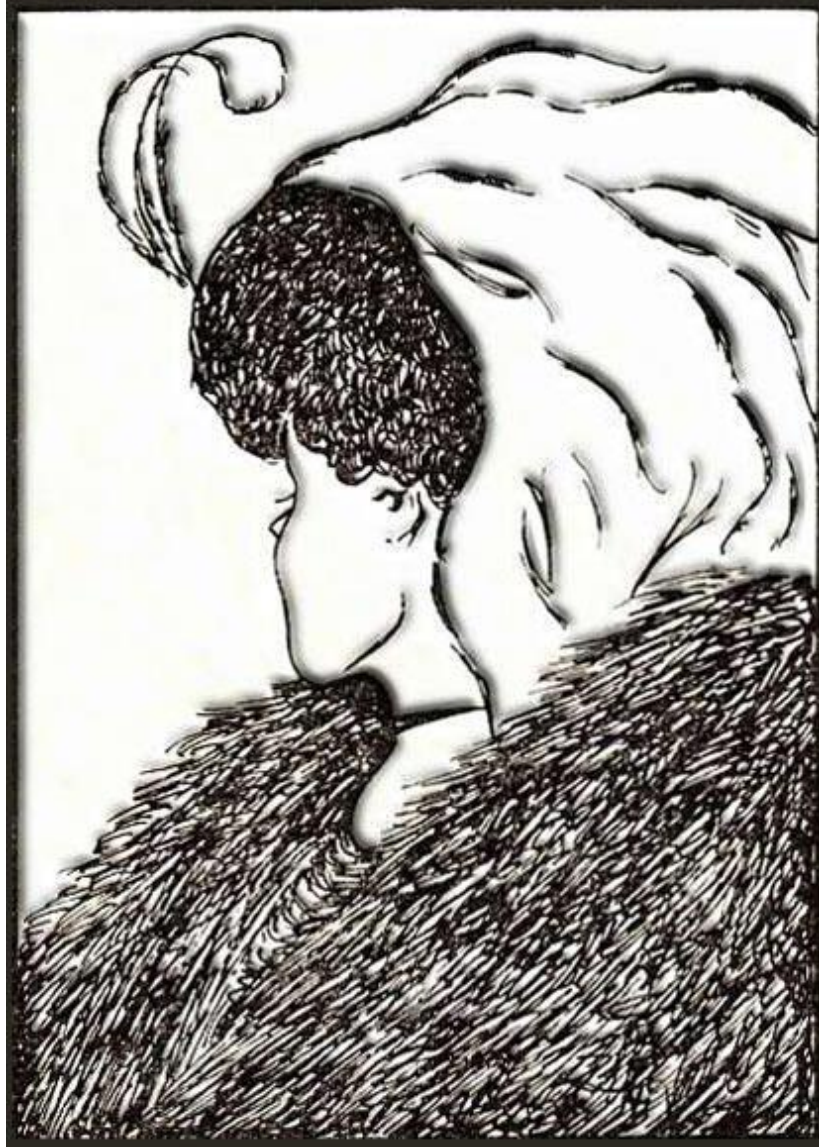
What is “real” vs. what we  
“perceive as real” is not  
necessarily the same!



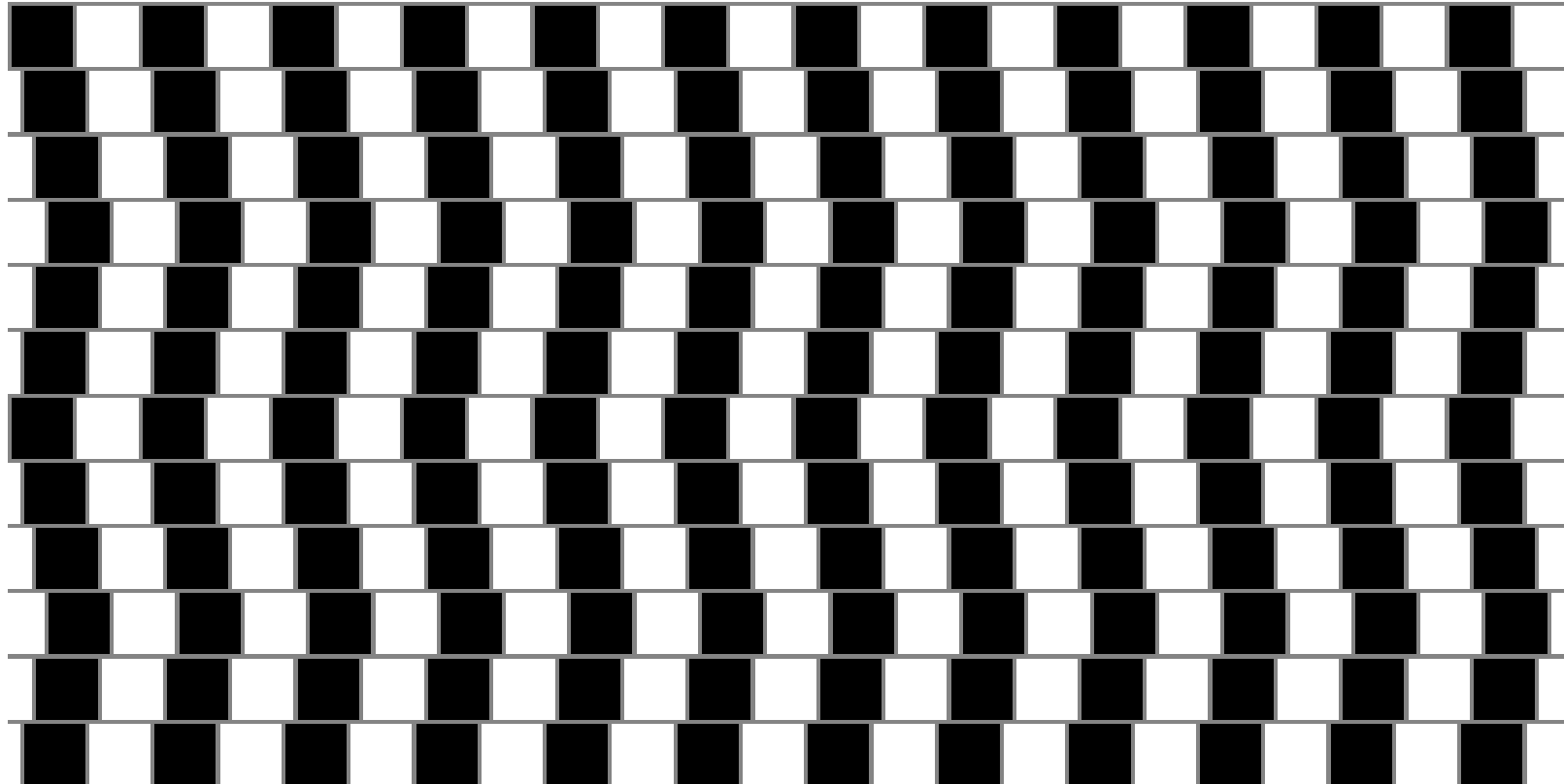
# Faces or vase?



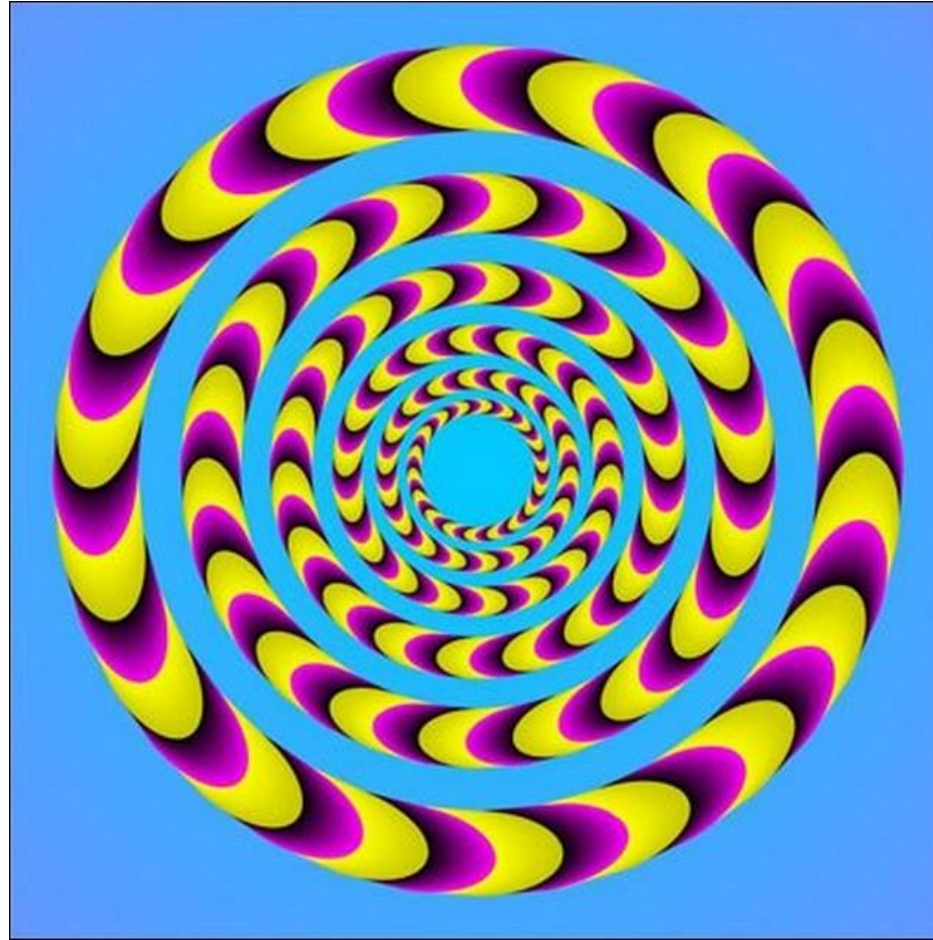
Young or old?



# Straight or crooked?



# Moving or static?



# Perception

the neurophysiological processes, including memory, by which an organism becomes aware of and interprets external stimuli

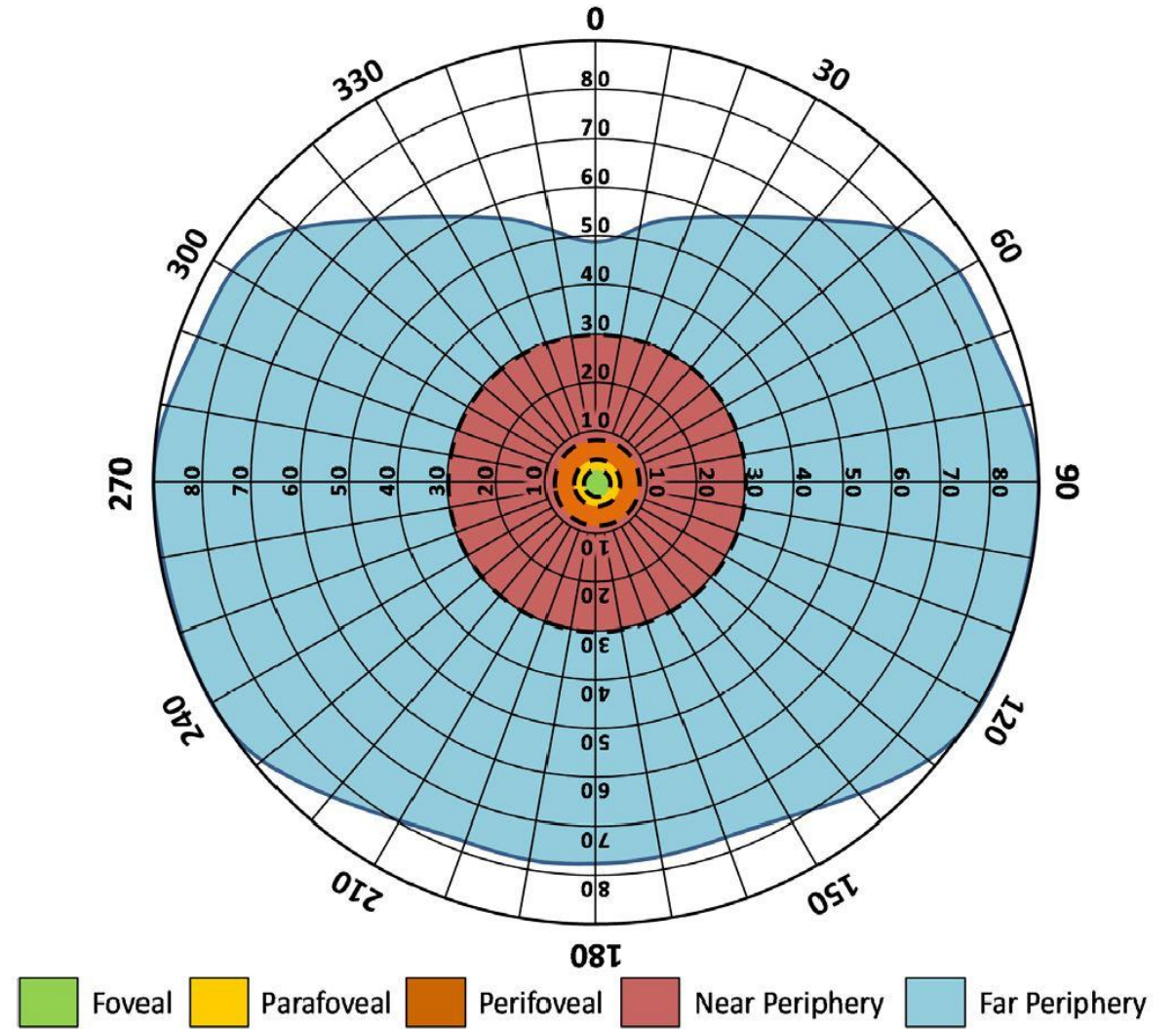
Insisting on “as real as possible” designs can lead to sub-optimal AR/VR experience.

Think about AR/VR interfaces as perceptual illusions that give the user the perception of reality!

# Example #1

Sparse Peripheral Displays

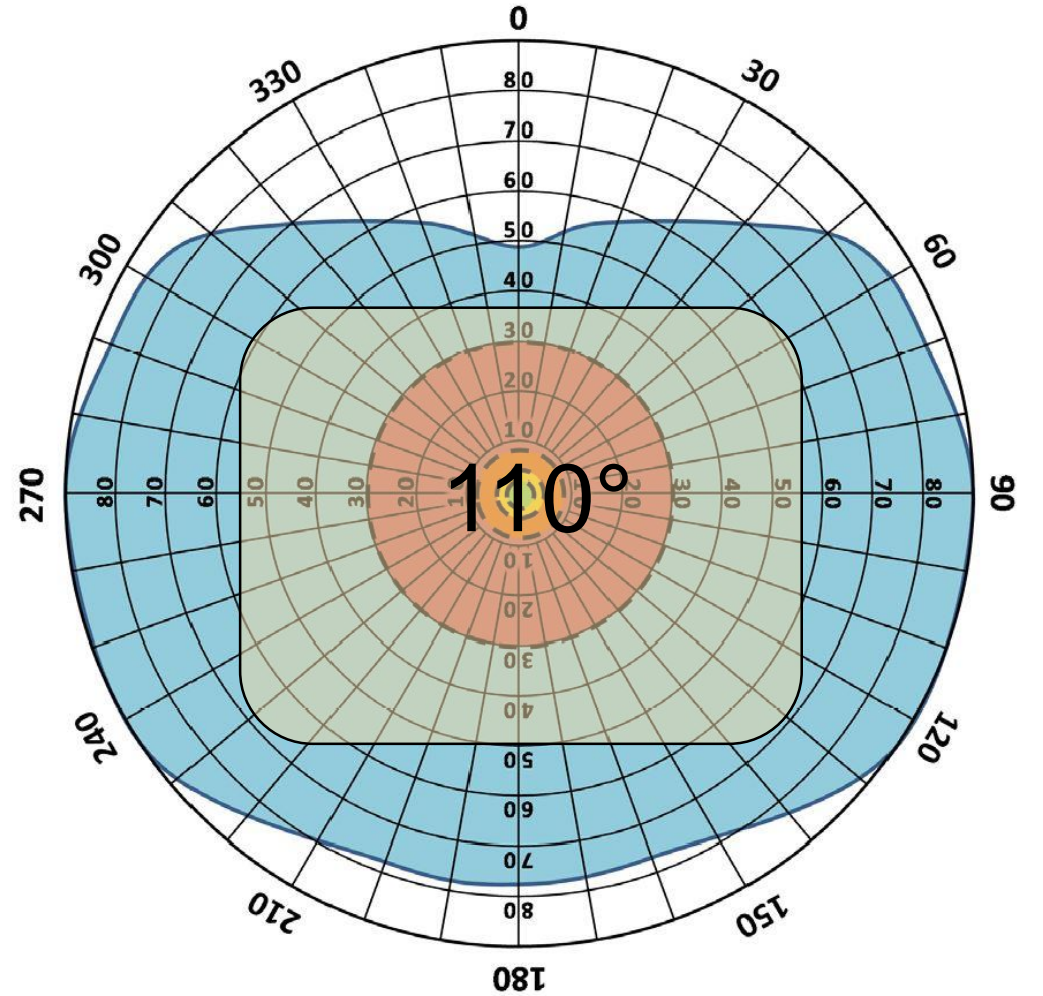
# Human FOV



Regions within the human binocular field of view. Adapted from Taylor [39], Boring et al. [3], and Strasburger et al. [36].



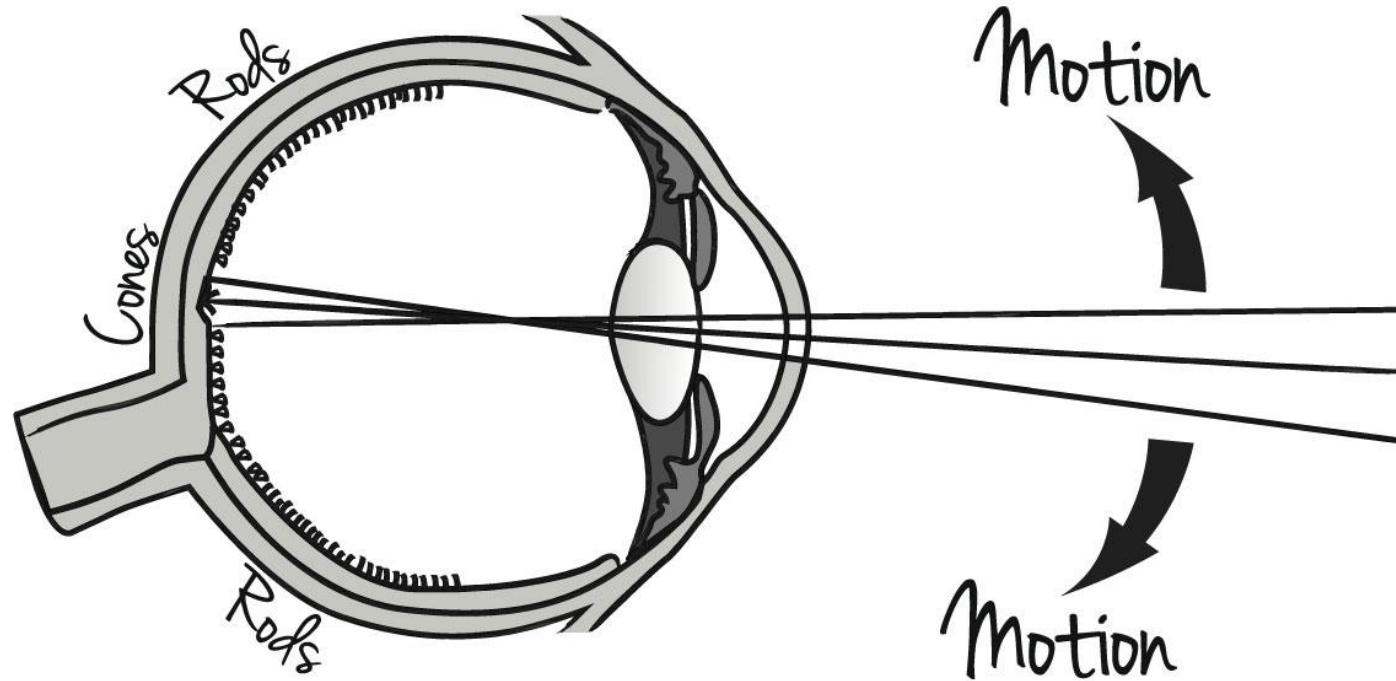
# VR FOV



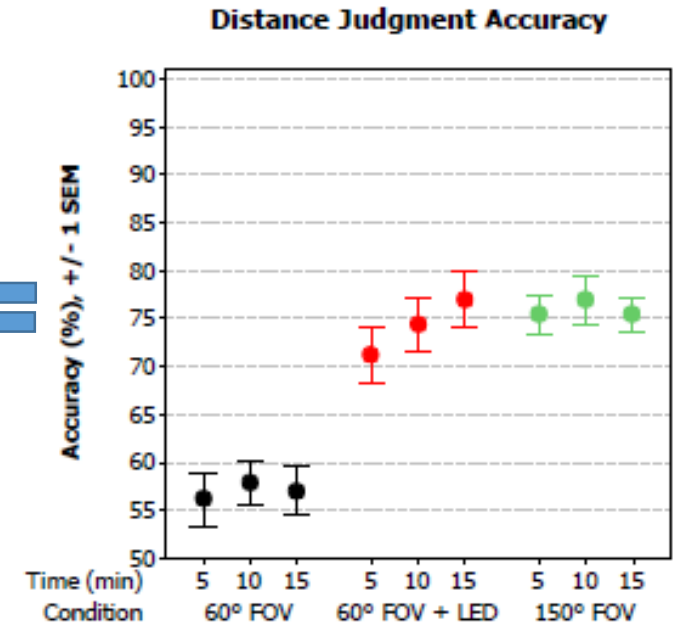
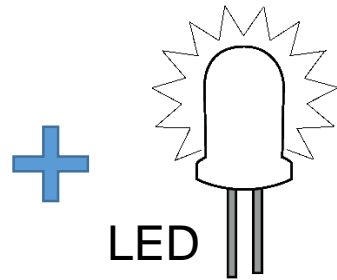
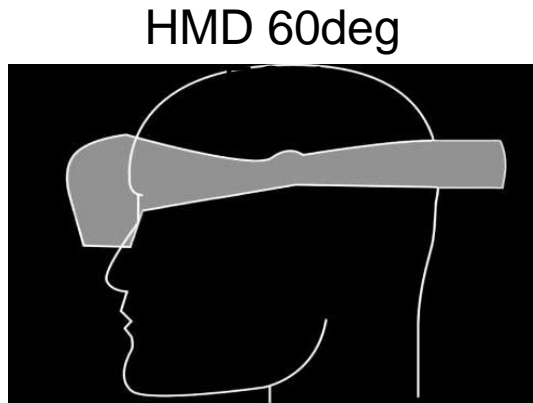
Legend: Foveal (Yellow), Parafoveal (Orange), Perifoveal (Red), Near Periphery (Light Blue), Far Periphery (Dark Blue)

Regions within the human binocular field of view. Adapted from Taylor [39], Boring et al. [3], and Strasburger et al. [36].

However, the periphery does not need to be the same as the focus!

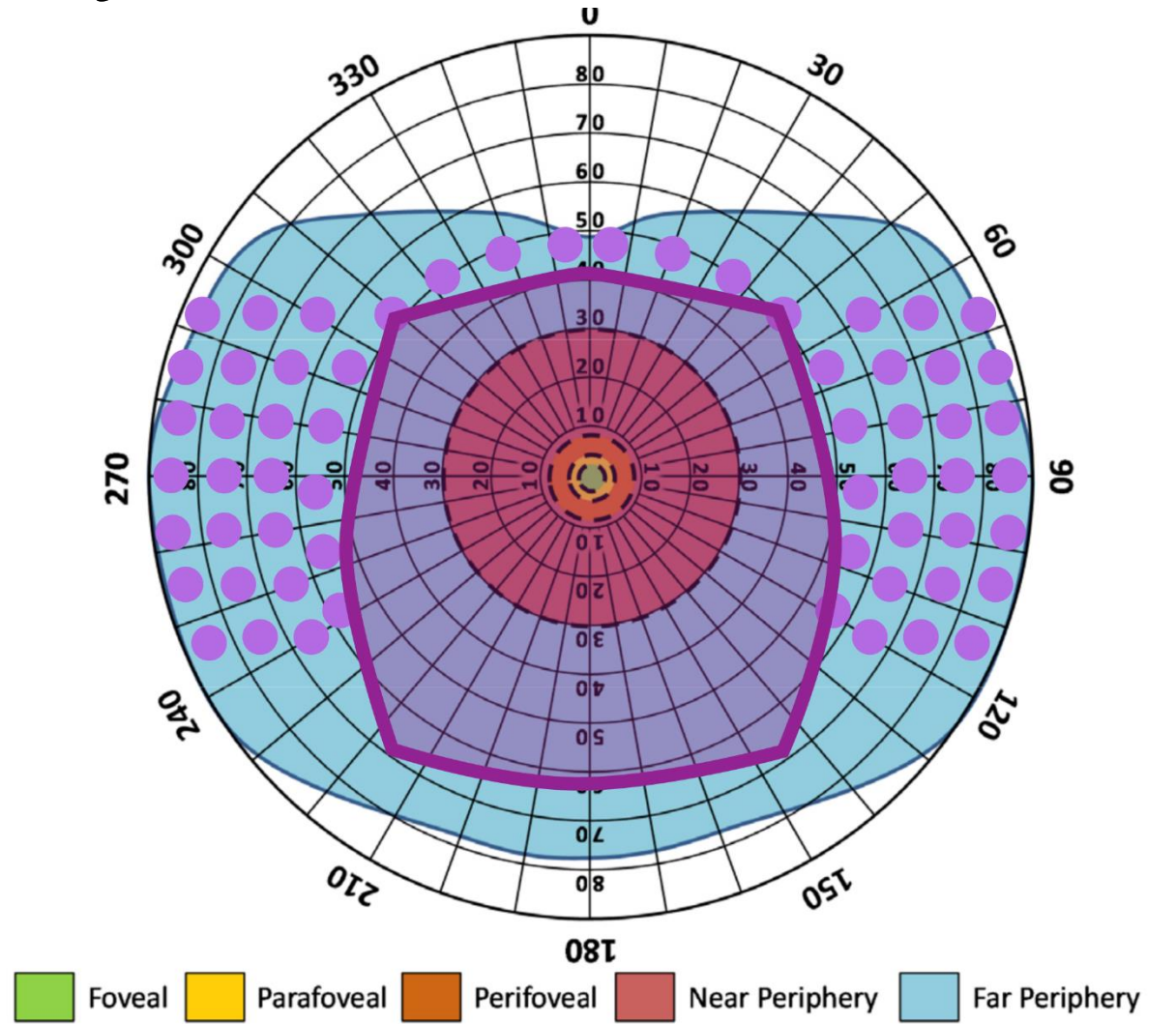


# Illuminated Periphery = Better Perception of Distance in VR



A. Jones, E. Swan, S. Ellis, M. Bolas. Symposium on Applied Perception in Graphics and Visualization 2011.

# Sparse Peripheral Displays

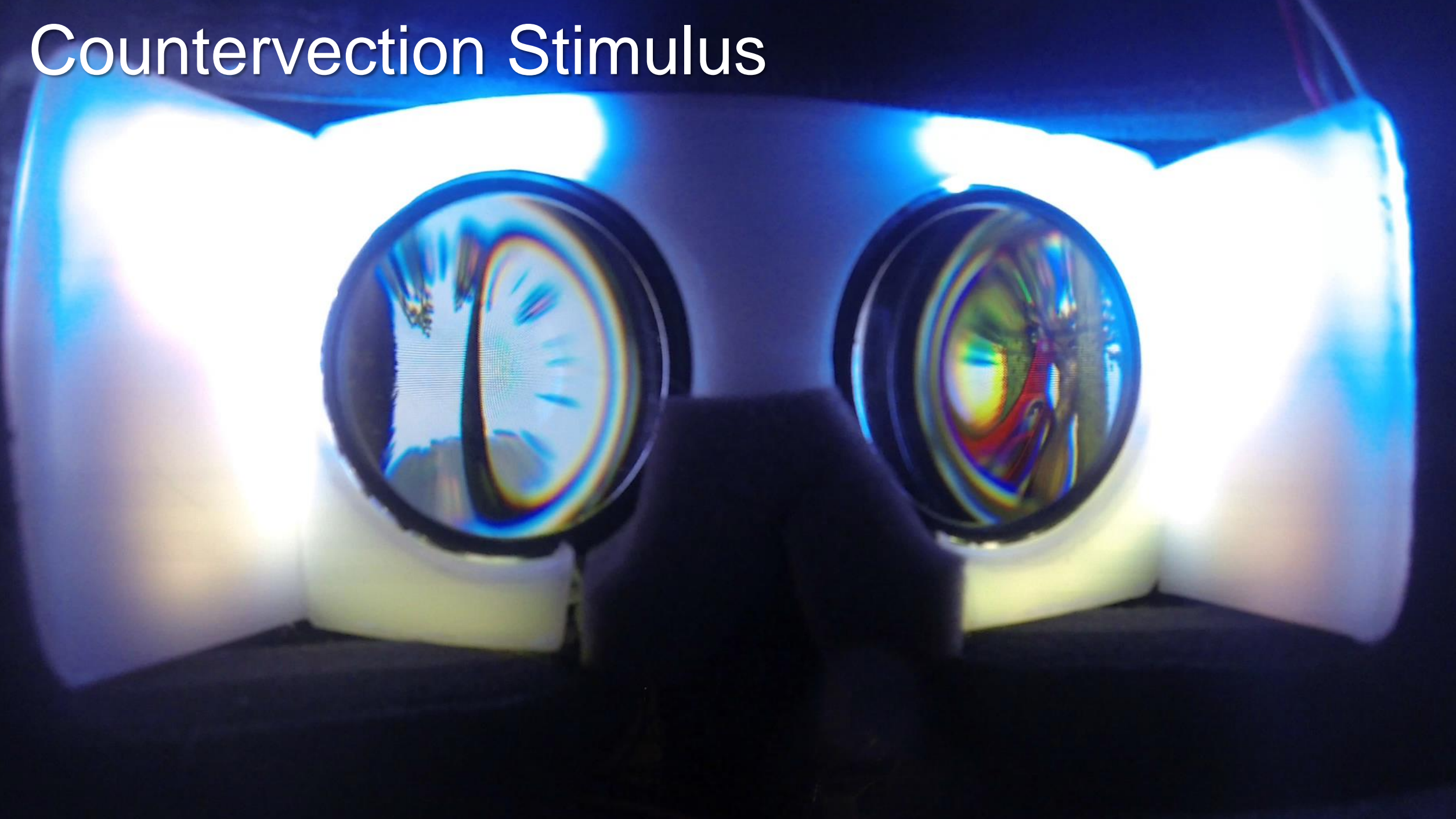


# Inside Oculus Rift DK2



Stereo Rendering

# Countervection Stimulus



# Example #2

Peripheral Illusions

# VR Today



# AR Today







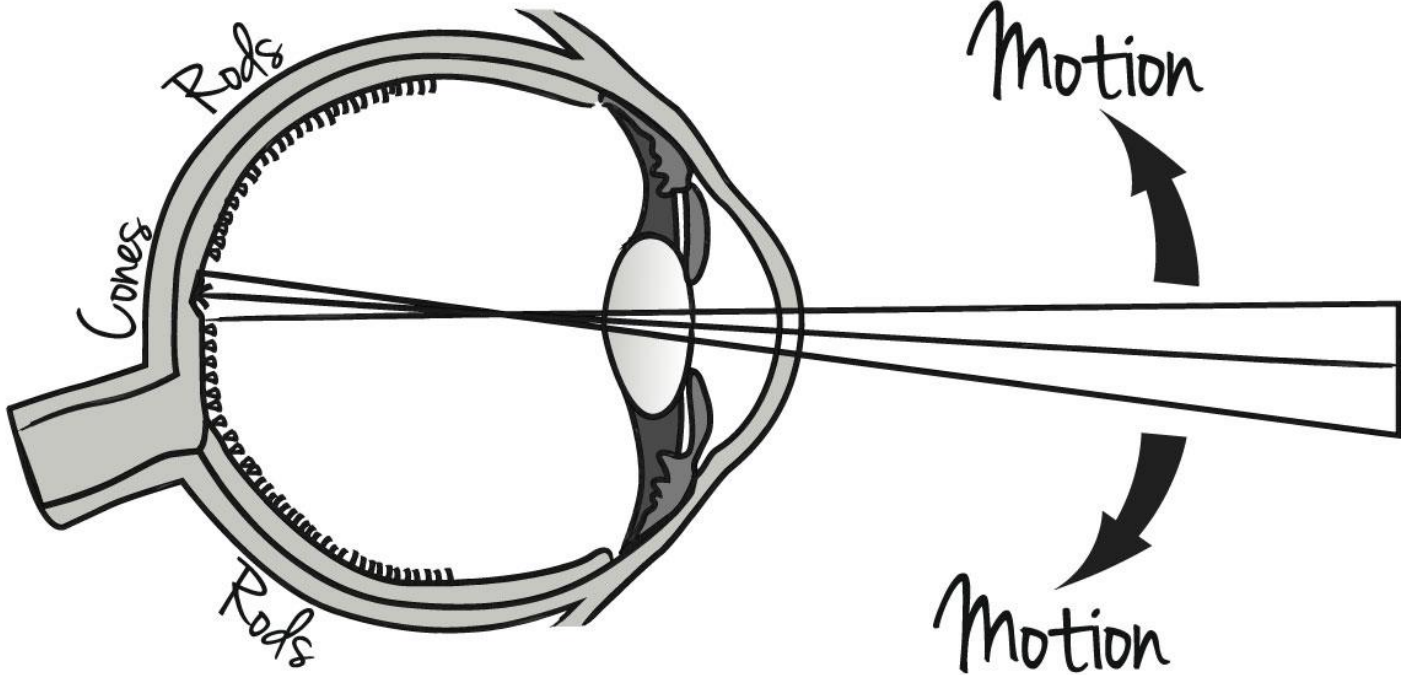
# IllumiRoom





**Context Full**

The periphery does not need to be the same as the focus!





**Focus**

**Context Edges**

A living room scene with a television in the center. The TV screen displays the word "Focus" in large, bold, black letters over a blurred background of a modern interior. To the left is a tall, dark wood shelving unit with a white grid pattern. To the right is a dark wood side table with a white grid pattern, holding two potted plants. The entire scene is overlaid with a white wireframe grid. In the bottom left corner, there is a blue graphic element consisting of several parallel diagonal lines, with the word "Selective" written in white, bold, sans-serif font across it.

**Focus**

**Selective**

# Segmented



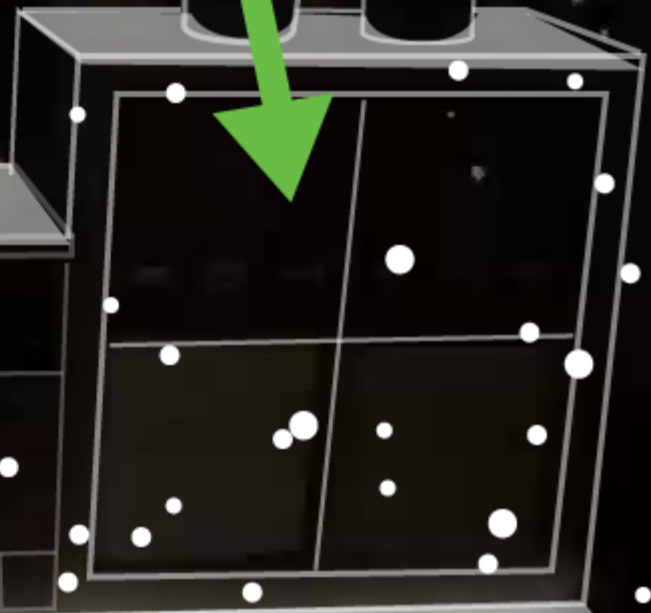
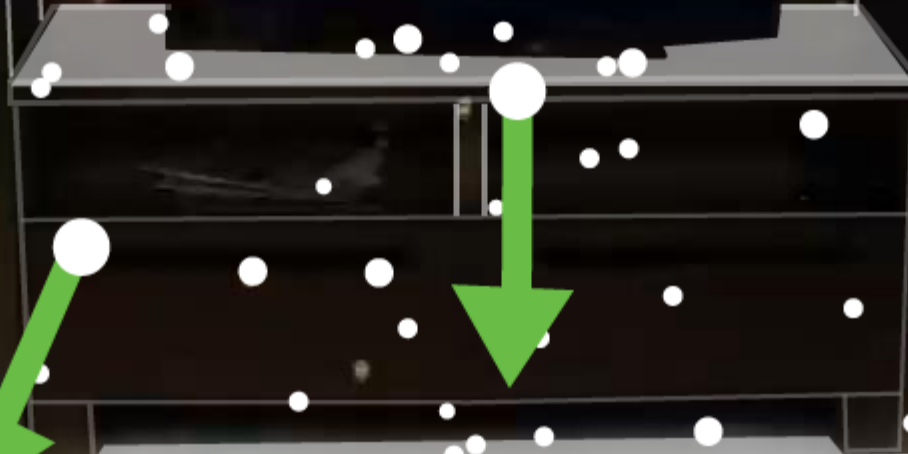
**FOCUS**

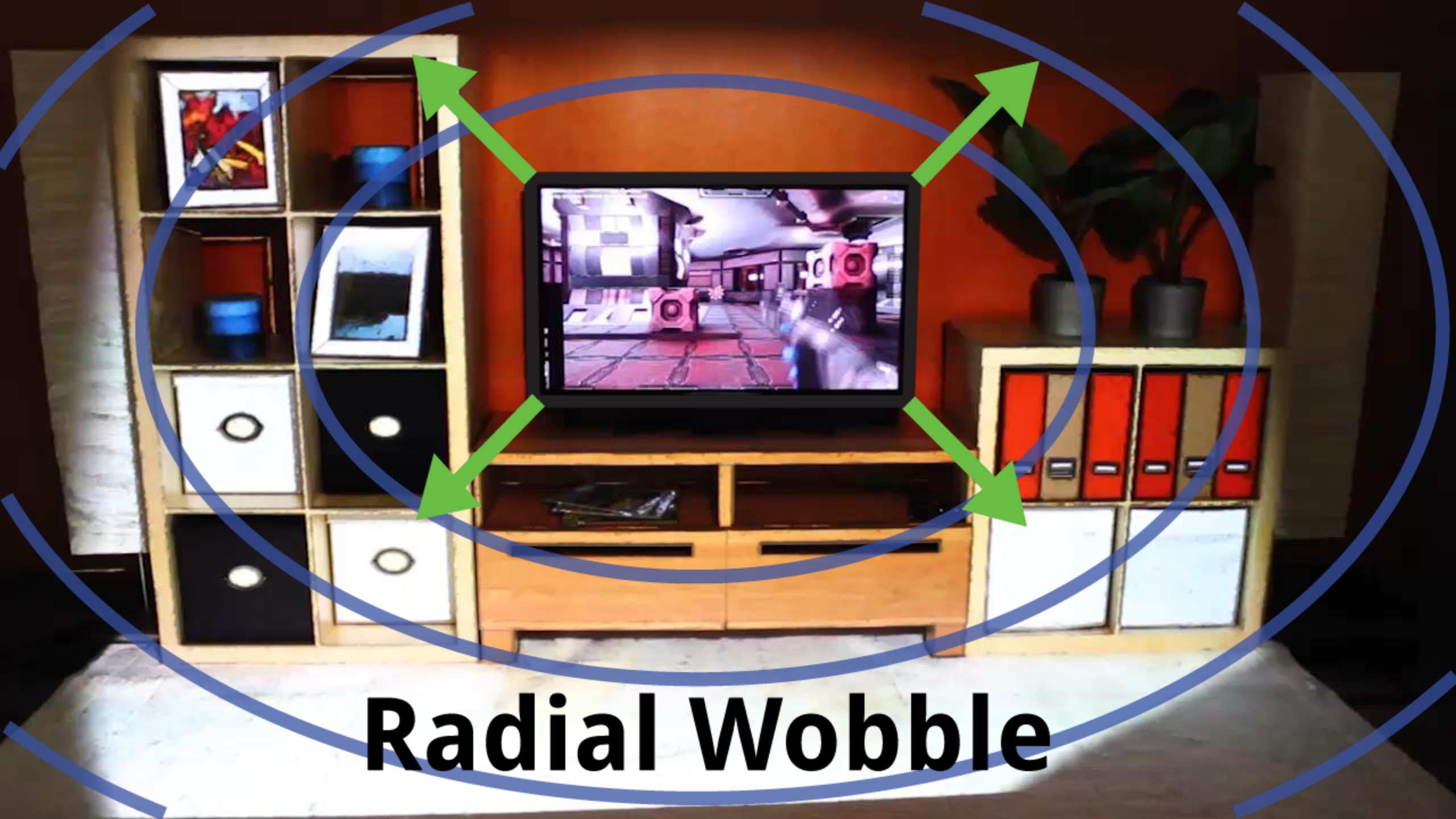




**Appearance**

# Snow





**Radial Wobble**

# Lighting



# Example #3

Perspective Projection Mapping

# Surface Shading





# Perspective 3D views?



Felice Varini





# Pro-Cam Unit

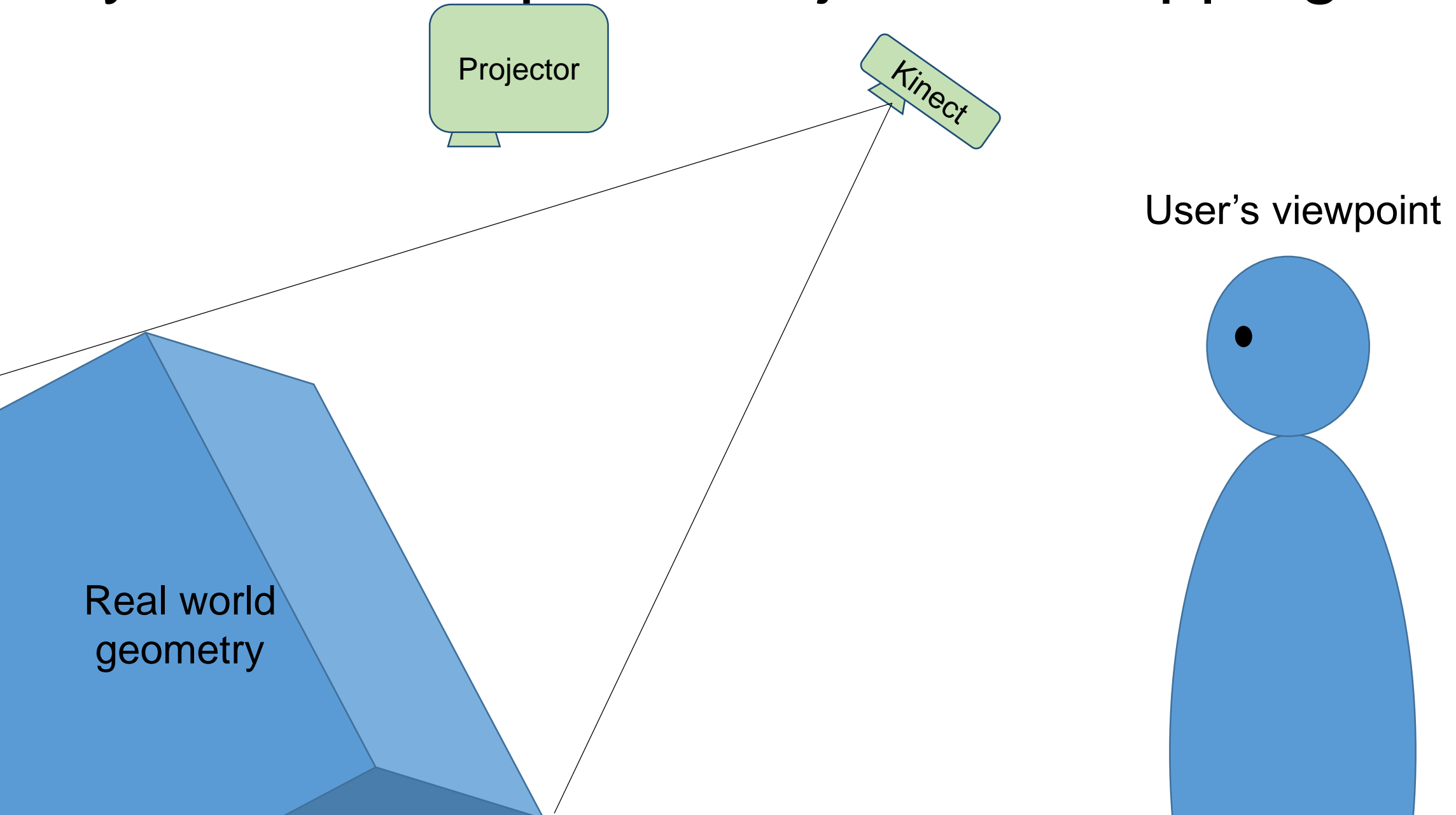


Projector

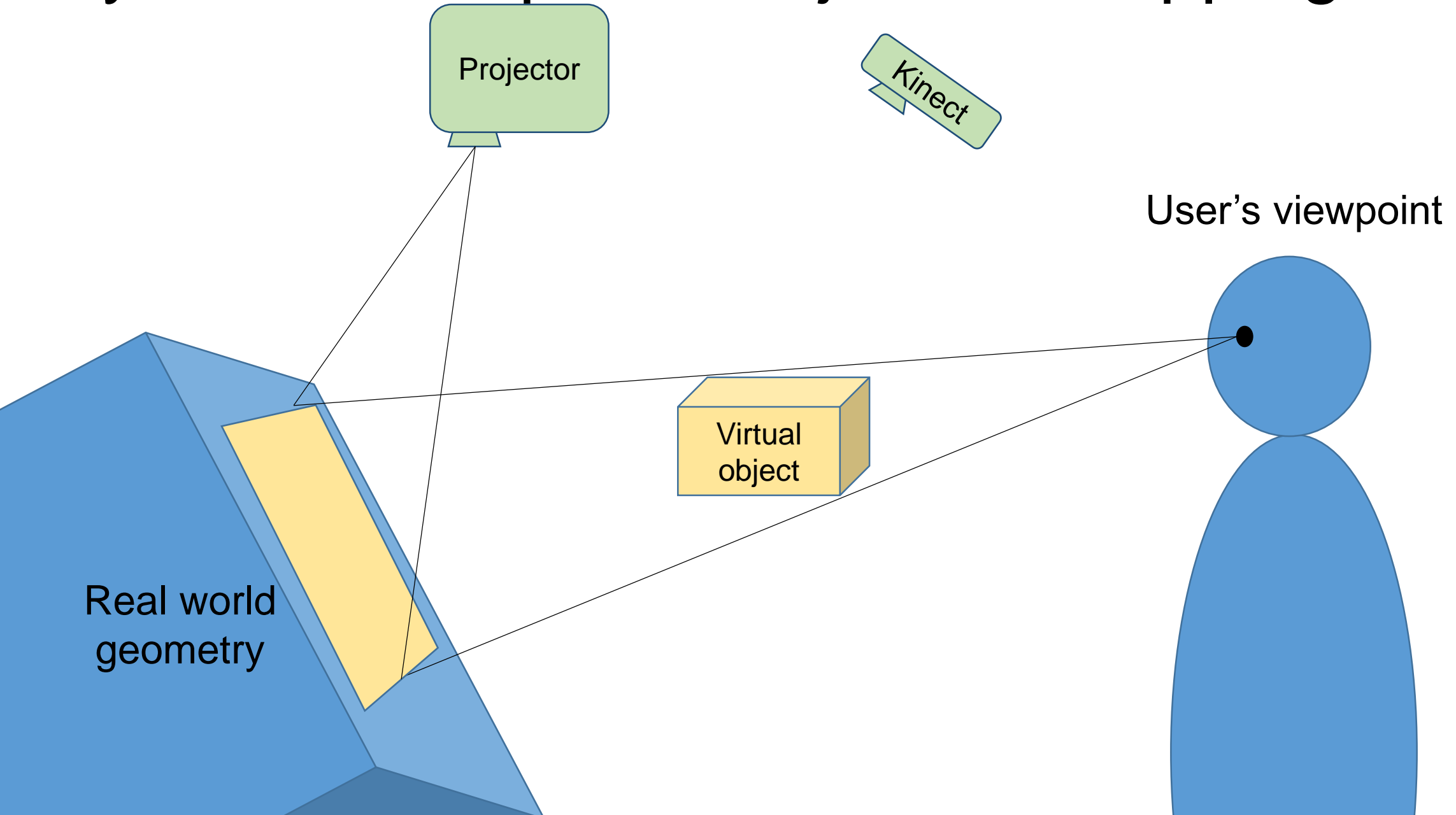


Depth Camera  
(Kinect)

# Dynamic Viewpoint Projection Mapping



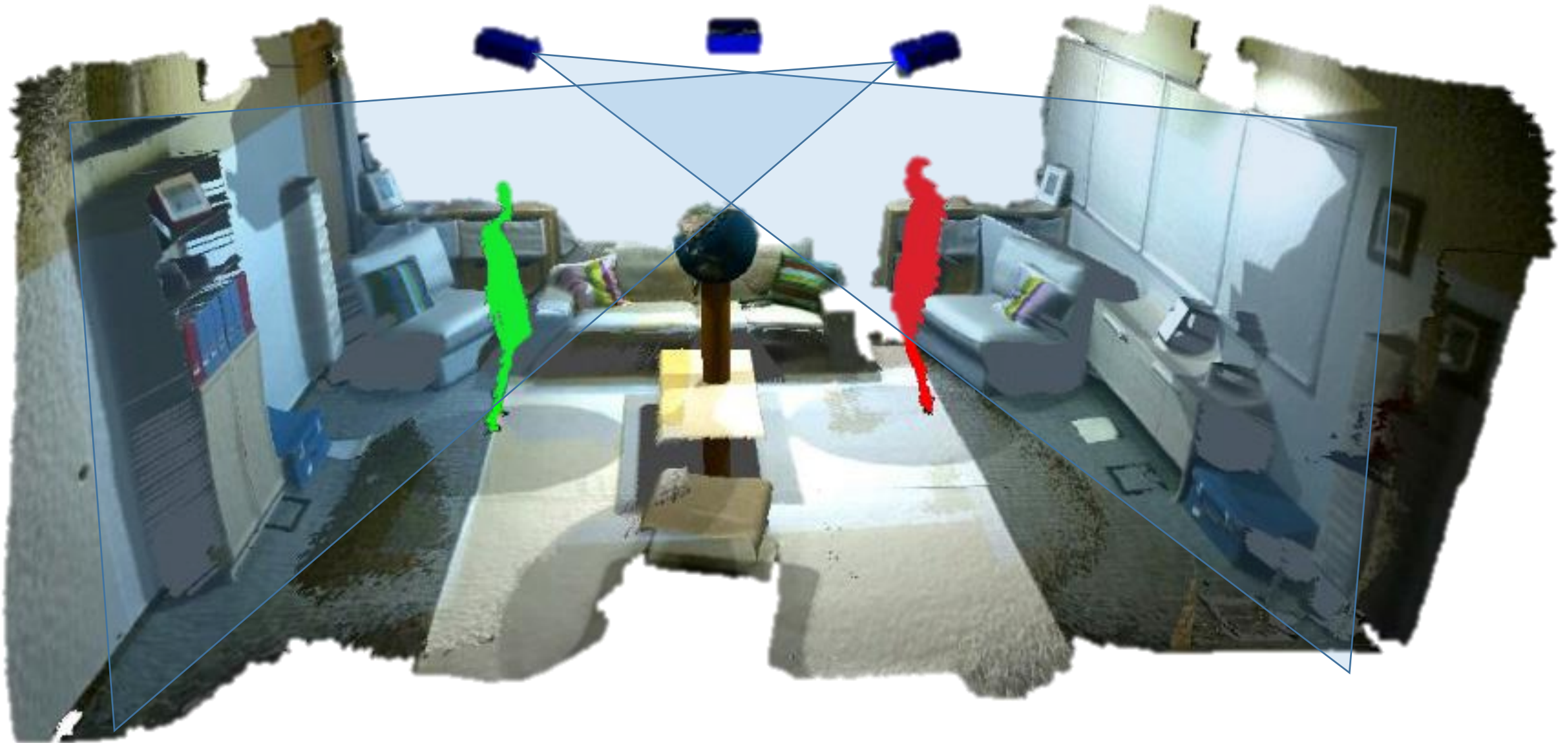
# Dynamic Viewpoint Projection Mapping







We can even do this for **two**  
people!



Benko, Wilson, and Zannier. ACM UIST 2014.



Target



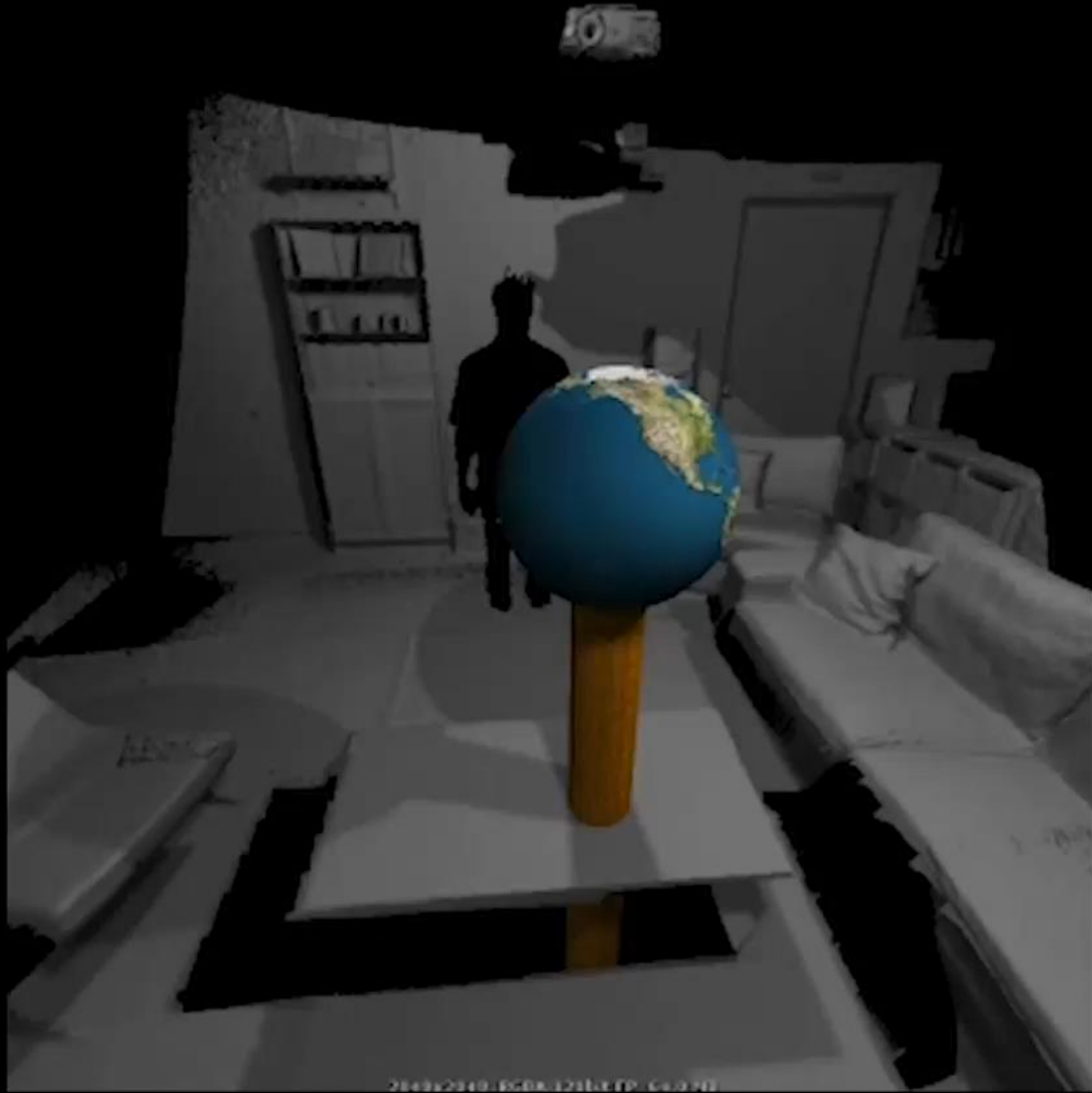
Projected



User's POV











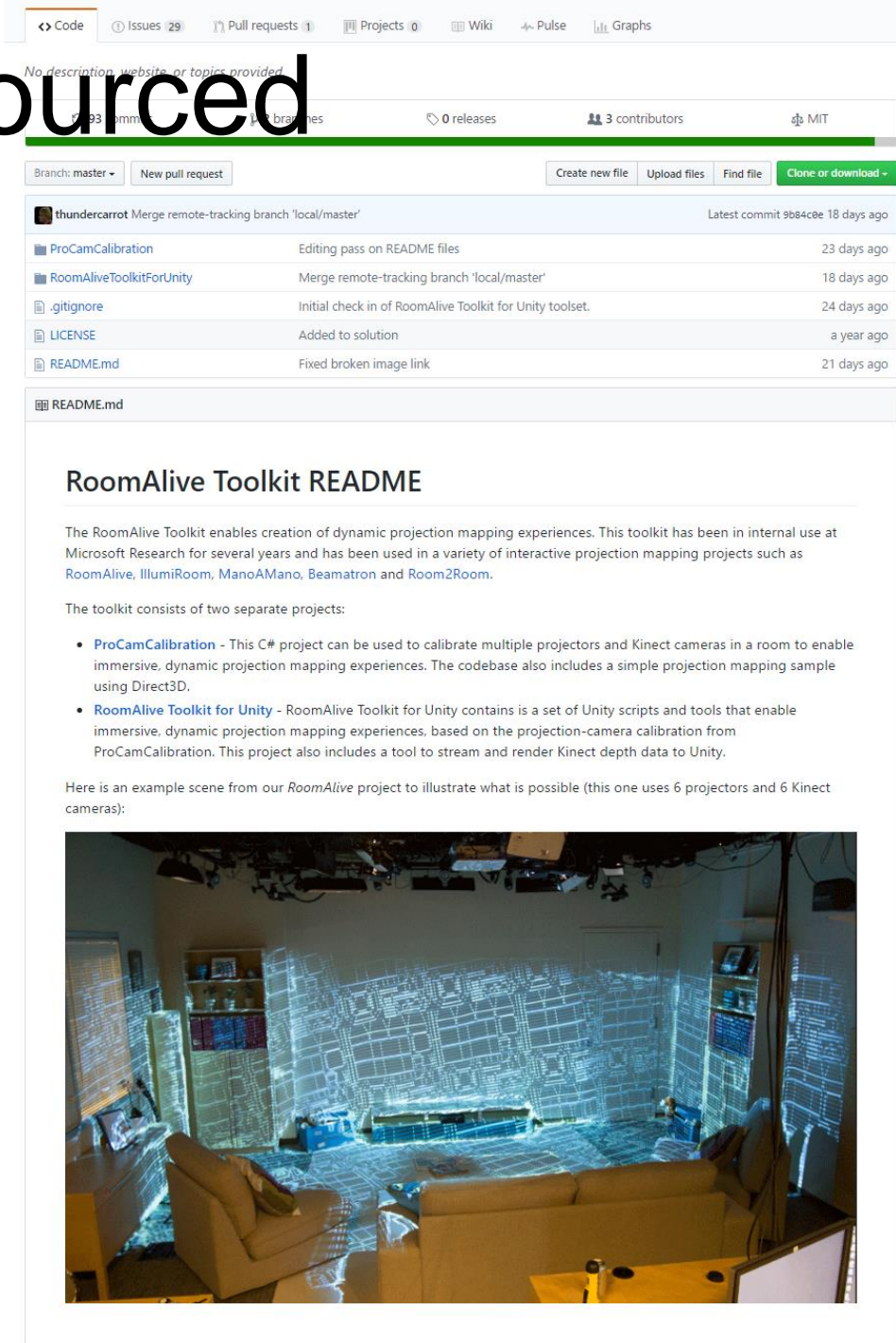
# RoomAlive Toolkit is Open Sourced

Multi-Kinect multi-projector projection mapping toolkit

Includes: calibration utilities, real-time depth mesh streaming and rendering shaders, and Unity bindings

Get the code:

<https://github.com/Kinect/RoomAliveToolkit/>



The screenshot shows the GitHub repository for the RoomAlive Toolkit. At the top, there are navigation links for Code, Issues (29), Pull requests (1), Projects (0), Wiki, Pulse, and Graphs. Below this, the repository name 'RoomAliveToolkit' is displayed with 0 releases, 3 contributors, and the MIT license. A commit history table follows, listing recent changes by user 'thundercarrot'. The main content area shows the README for 'RoomAlive Toolkit', which describes the toolkit's purpose and lists two sub-projects: 'ProCamCalibration' and 'RoomAlive Toolkit for Unity'. At the bottom of the README, there is a photograph of a room with a complex projection mapping setup, showing a wireframe mesh overlaid on the room's surfaces.

Commit	Message	Time
9b84c0e	Merge remote-tracking branch 'local/master'	18 days ago
9b84c0e	Editing pass on README files	23 days ago
9b84c0e	Merge remote-tracking branch 'local/master'	18 days ago
9b84c0e	Initial check in of RoomAlive Toolkit for Unity toolkit.	24 days ago
9b84c0e	Added to solution	a year ago
9b84c0e	Fixed broken image link	21 days ago

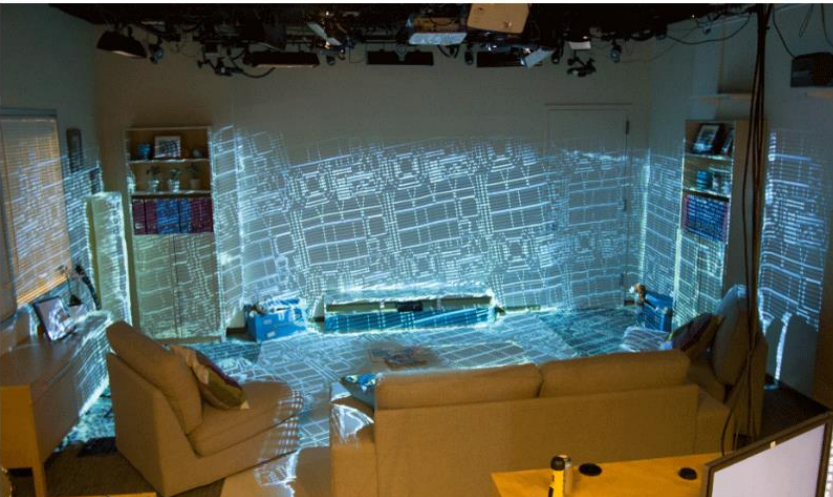
### RoomAlive Toolkit README

The RoomAlive Toolkit enables creation of dynamic projection mapping experiences. This toolkit has been in internal use at Microsoft Research for several years and has been used in a variety of interactive projection mapping projects such as [RoomAlive](#), [IllumiRoom](#), [ManoAMano](#), [Beamatron](#) and [Room2Room](#).

The toolkit consists of two separate projects:

- ProCamCalibration** - This C# project can be used to calibrate multiple projectors and Kinect cameras in a room to enable immersive, dynamic projection mapping experiences. The codebase also includes a simple projection mapping sample using Direct3D.
- RoomAlive Toolkit for Unity** - RoomAlive Toolkit for Unity contains is a set of Unity scripts and tools that enable immersive, dynamic projection mapping experiences. based on the projection-camera calibration from ProCamCalibration. This project also includes a tool to stream and render Kinect depth data to Unity.

Here is an example scene from our *RoomAlive* project to illustrate what is possible (this one uses 6 projectors and 6 Kinect cameras):



# Example #4

Haptic Retargeting

# Realistic Haptics in VR?



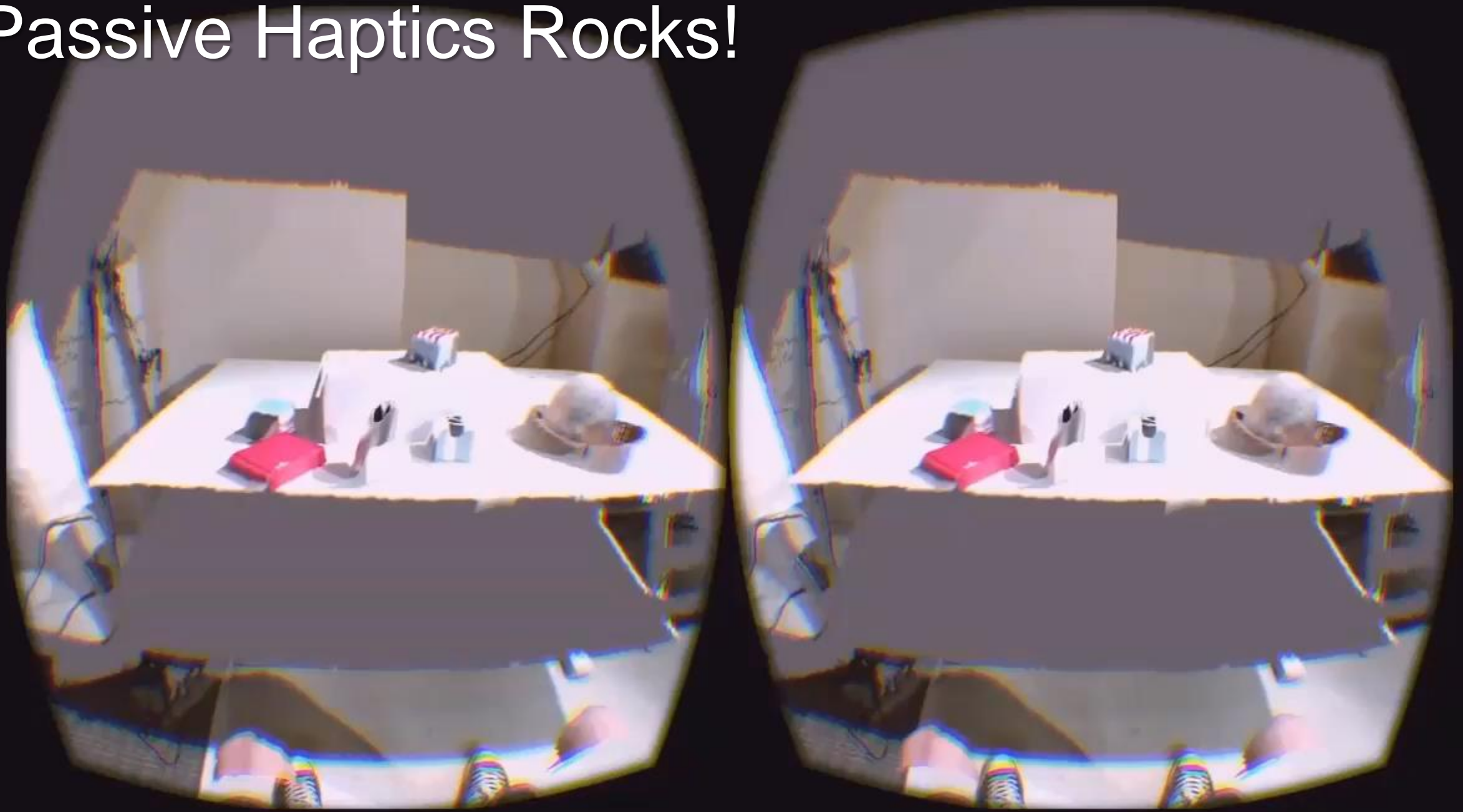
*Phantom*



*CyberGrasp Glove*



# Passive Haptics Rocks!



But, passive haptics approach  
doesn't scale!

# **Haptic Retargeting**

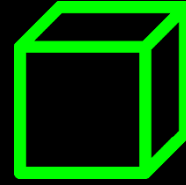
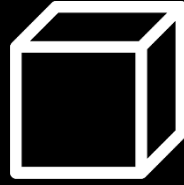
## Dynamic Repurposing of Passive Haptics for Enhanced Virtual Reality Experiences

Mahdi Azmandian, Mark Hancock  
Hrvoje Benko, Eyal Ofek, Andy Wilson  
Microsoft Research

SIGCHI 2016

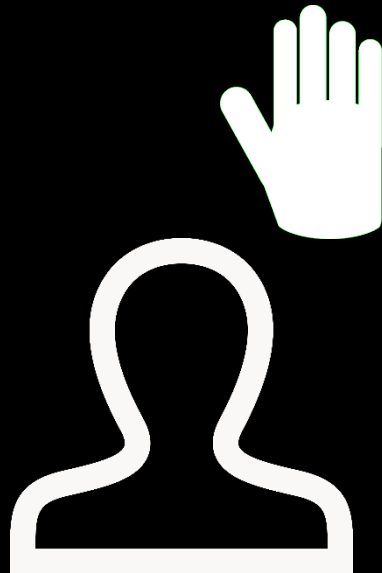
# Body Warping

physical  
cube



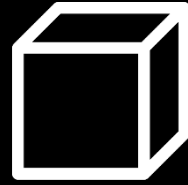
virtual  
cube

*The Rendered Body  
Shifts to The Right*

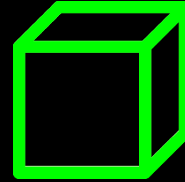


# World Warping

physical  
cube



30°

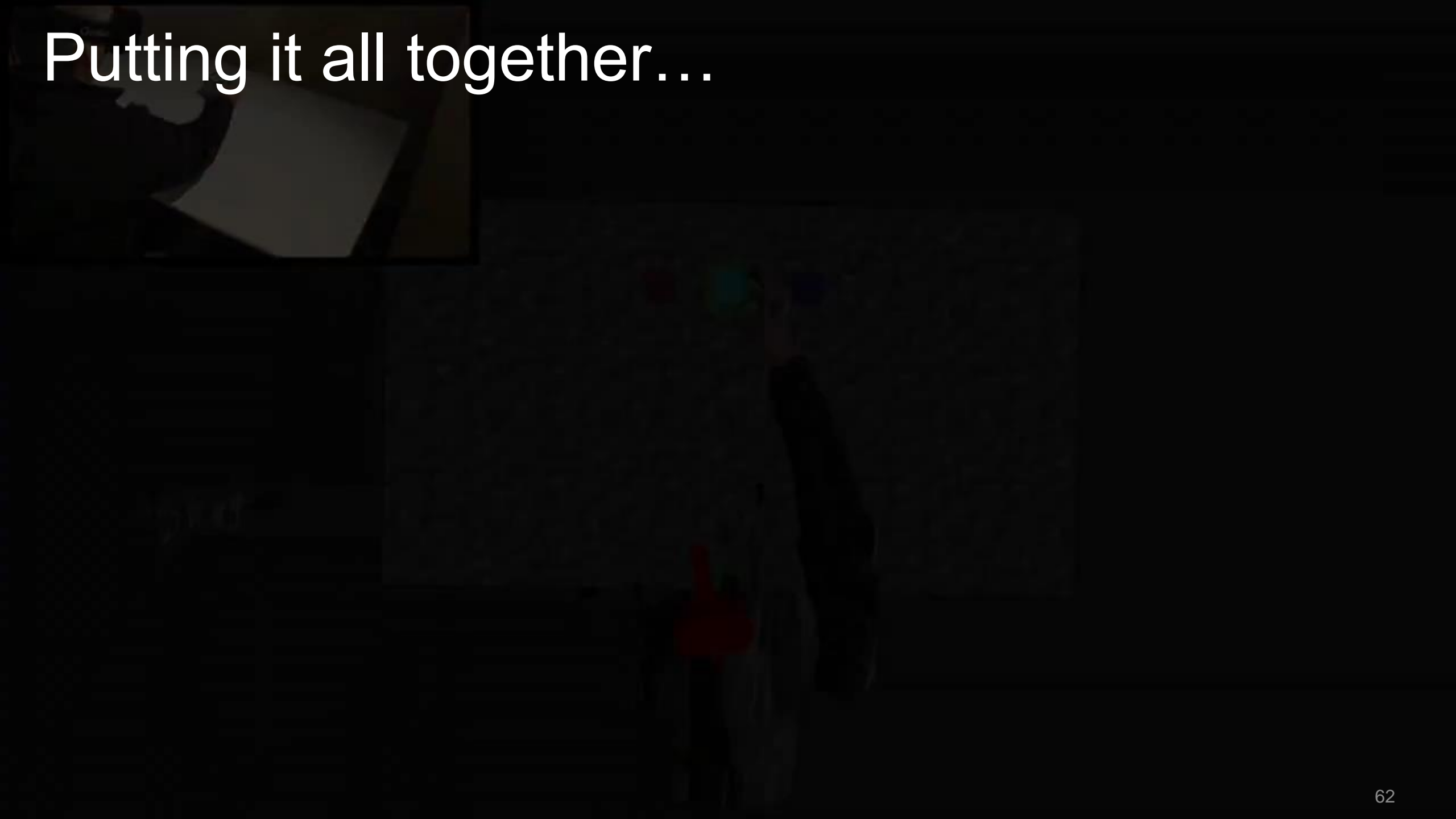


virtual  
cube

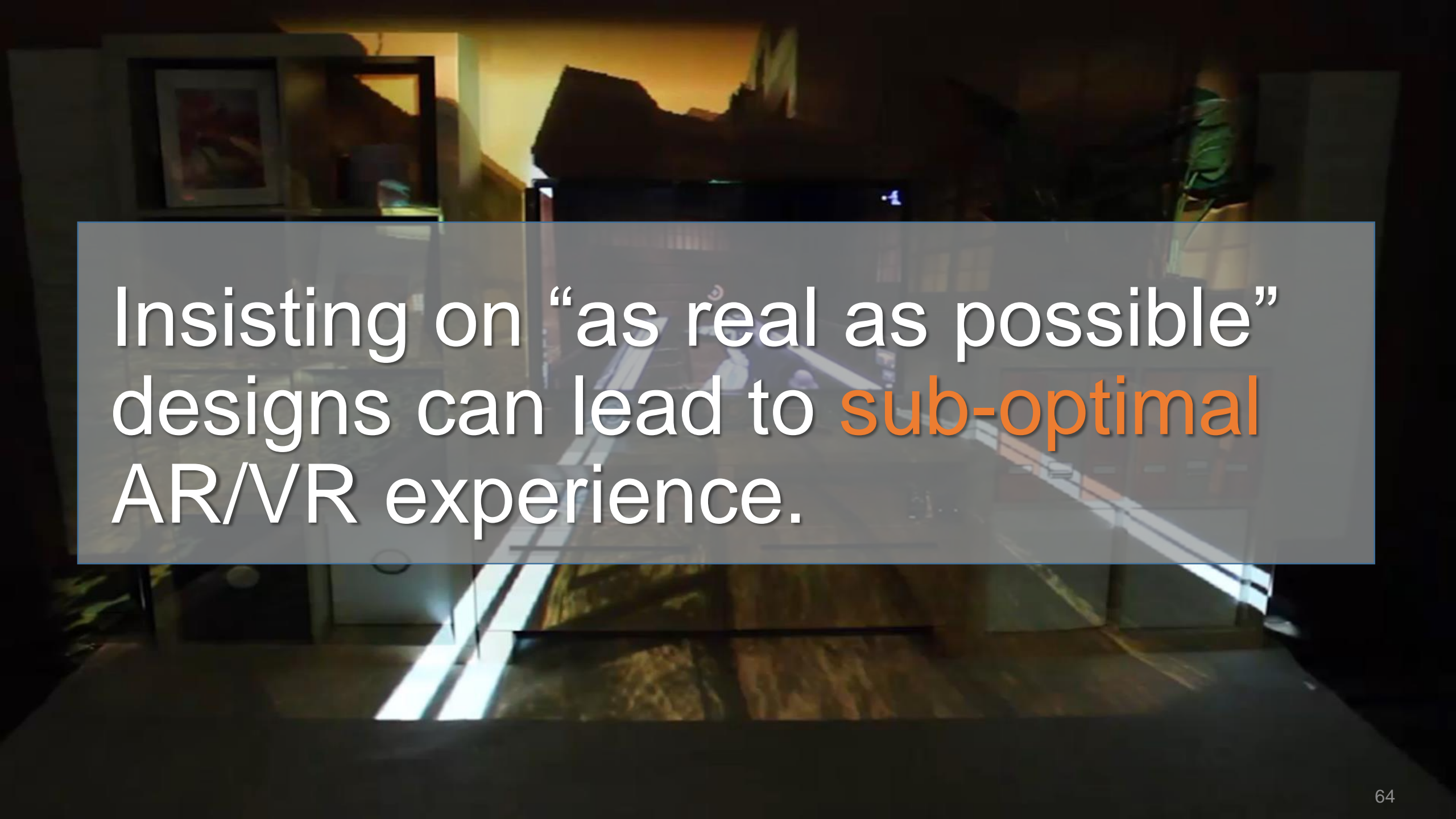
*The World Also Rotates  
(At Different Rate)*



# Putting it all together...



Haptic retargeting allows physical props to be reused for haptics by leveraging the dominance of vision to retarget people's hand motions.

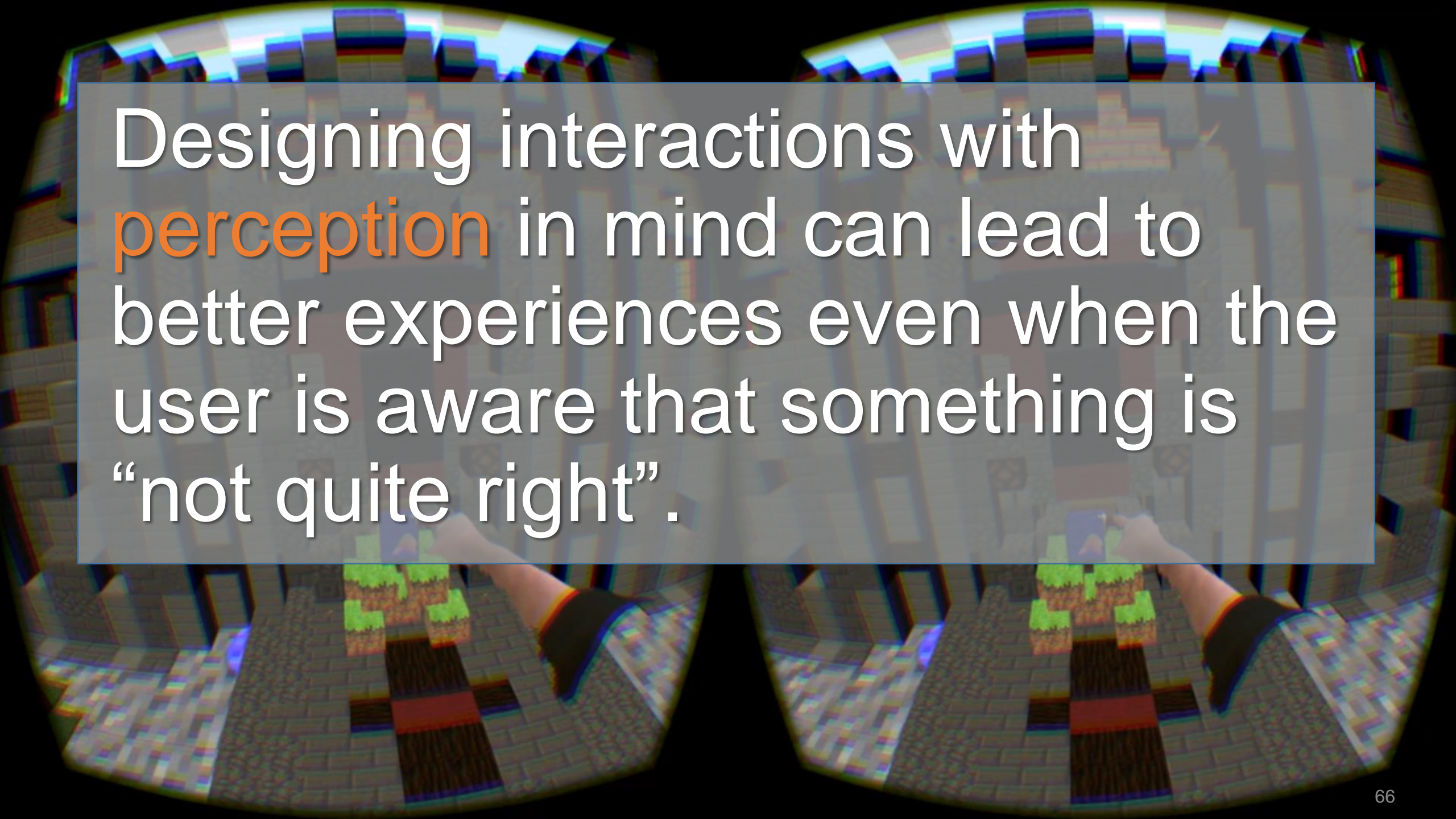
A person wearing a VR headset is shown in a dark room, interacting with a virtual environment projected onto a wall. The virtual environment features a landscape with a path, a small building, and a large mountain range under a sunset sky. The person's hand is visible, reaching towards the virtual scene. The text is overlaid on a semi-transparent grey box in the center of the image.

Insisting on “as real as possible”  
designs can lead to **sub-optimal**  
AR/VR experience.



A man in a dark shirt is holding a large globe in a dimly lit room. The globe is the central focus, showing blue oceans and green landmasses. In the background, there are shelves with various items, including what looks like a bookshelf with blue folders. The lighting is dramatic, with strong highlights on the globe and the man's shirt, and deep shadows elsewhere. A semi-transparent grey box with white and orange text is overlaid on the center of the image.

Human perception offers clues  
on how to effectively **engage**  
and **trick** the user.



Designing interactions with **perception** in mind can lead to better experiences even when the user is aware that something is “not quite right”.

To get the best VR/AR experience, one should **cheat** as much as possible in a **perceptually salient** way.

A man with short grey hair, wearing a pink button-down shirt, is sitting at a desk. He is looking towards the camera with a slight smile. In front of him is a computer monitor displaying a colorful abstract image. The background is a plain wall with two framed pictures. To the right, a door handle is visible.

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