Interacting with Photons

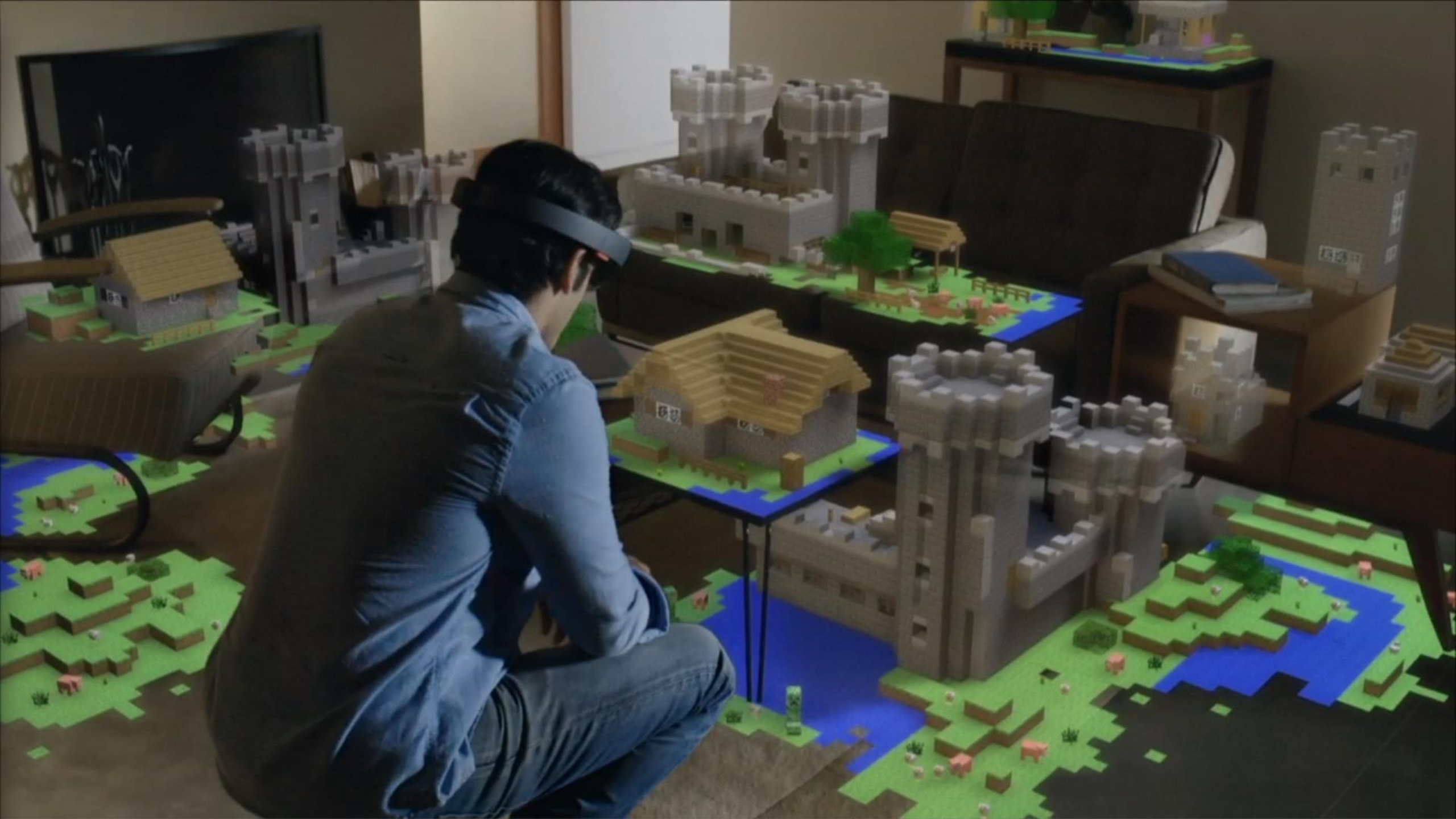
Creating Interactive Projected Augmented Reality Experiences

Hrvoje Benko
Microsoft Research
October 2015


Recipes
Vacation
To-Do List
Ticket
Sun screen
Beach towel
Sunglasses
Charger
Maui
Mon
Tue
Wed
71°F
74°F
76°F

Microsoft HoloLens

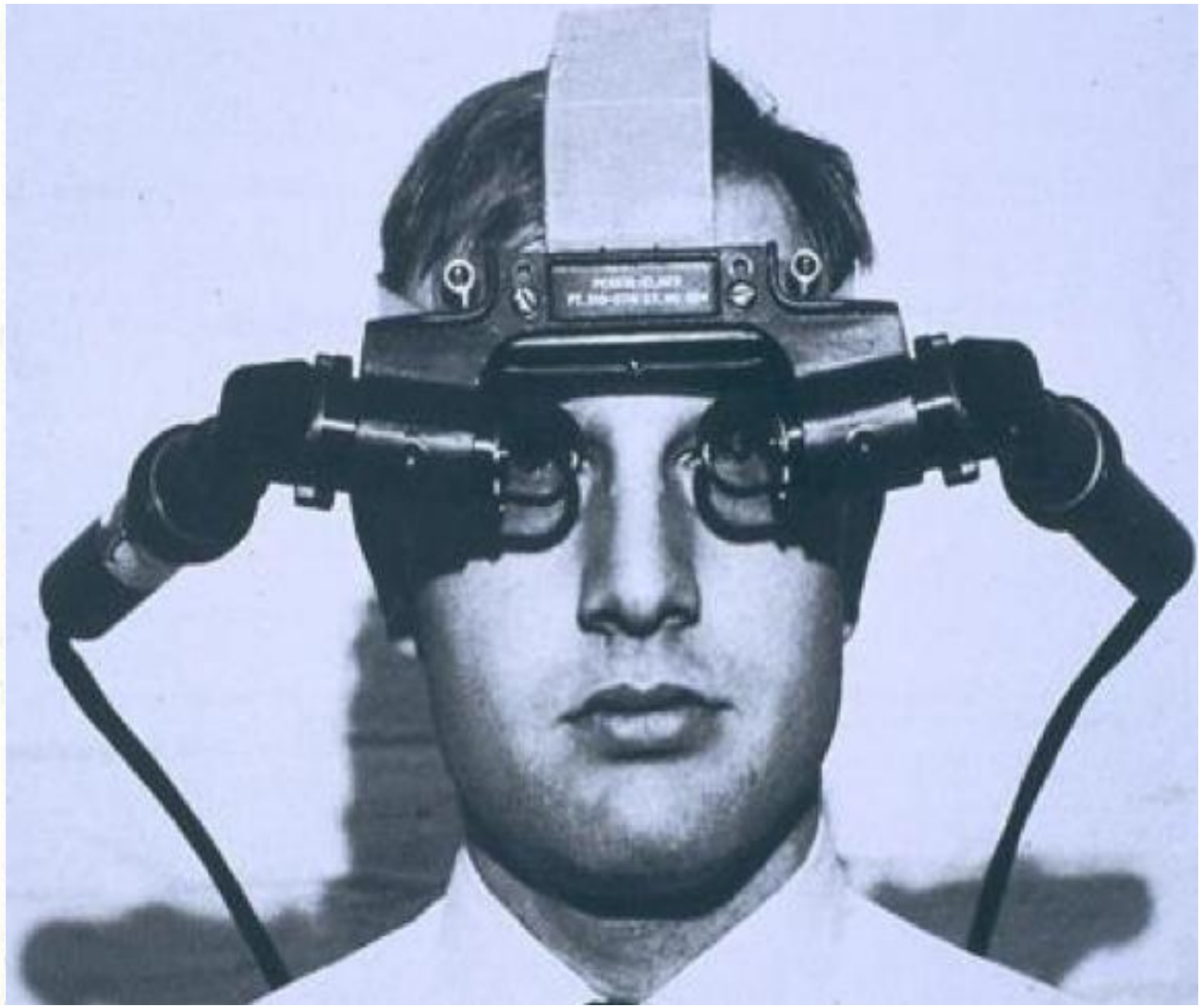
Windows 10




LUMUS


VUZIX

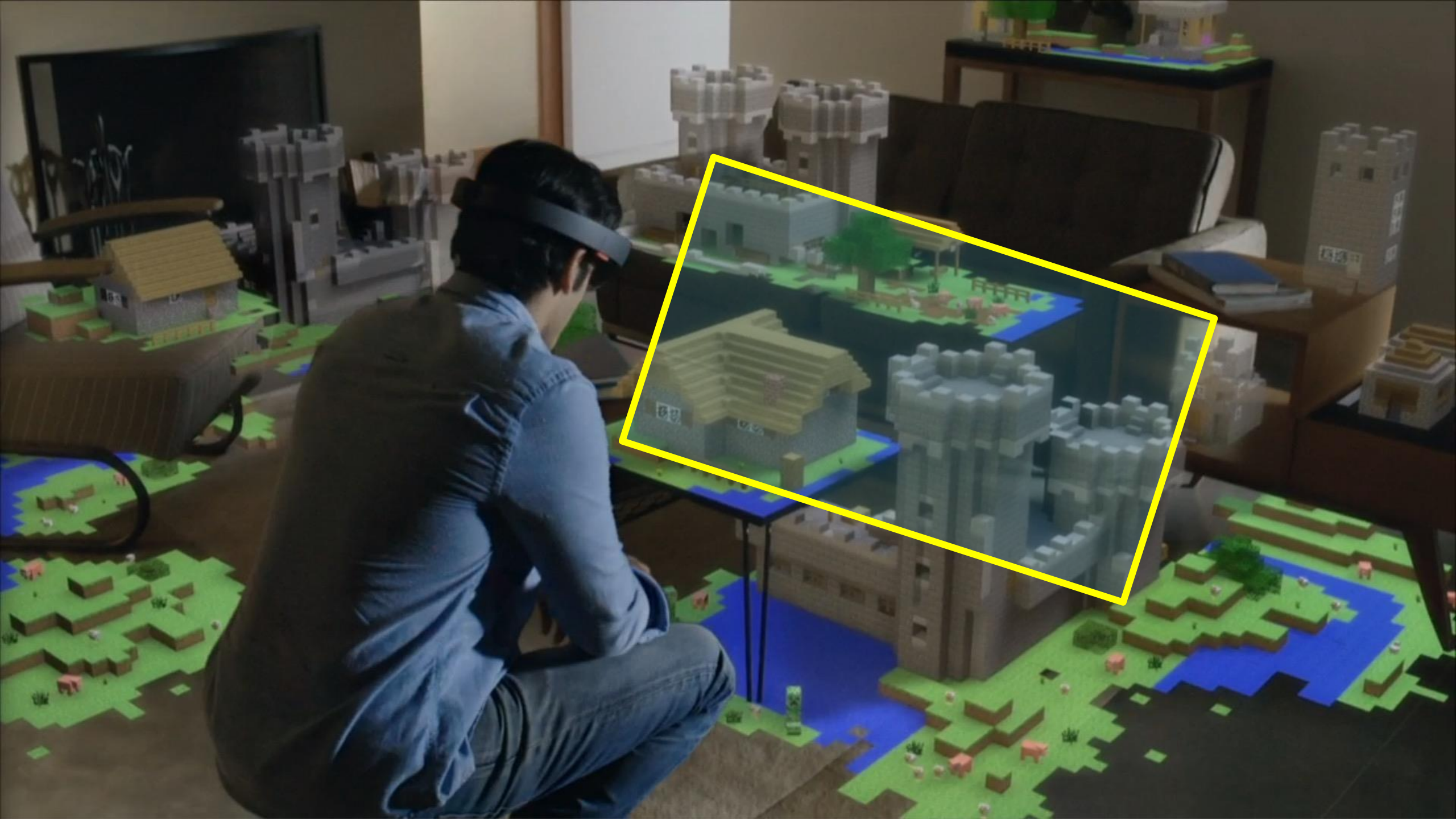

MetaPro
PROTOTYPE v3.8



Ivan Sutherland, 1968.

Challenges with glasses

Columbia Touring Machine. ISAR 2001.



Alternate AR vision

To create authentic augmented reality experiences that are situated in the real world, don’t require additional gear to be worn, yet enable a high degree of interactivity with computer-generated content.

Pro-Cam Unit

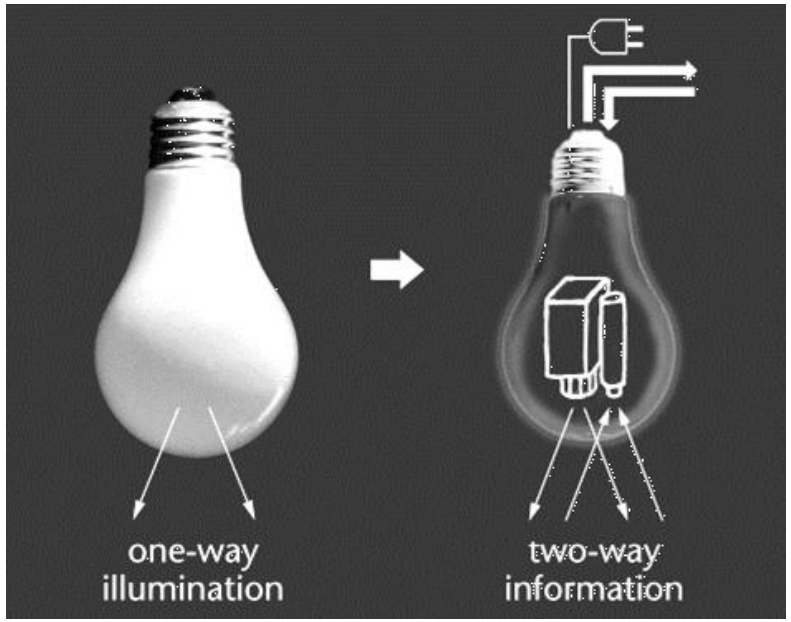
+

Projector

Depth Camera
(Kinect)

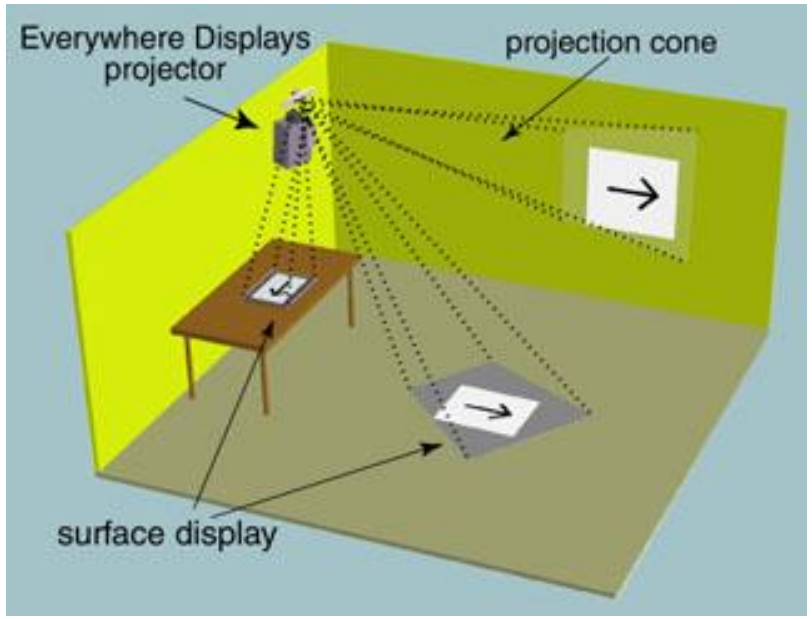
+ GPU-based computation

We are not the first



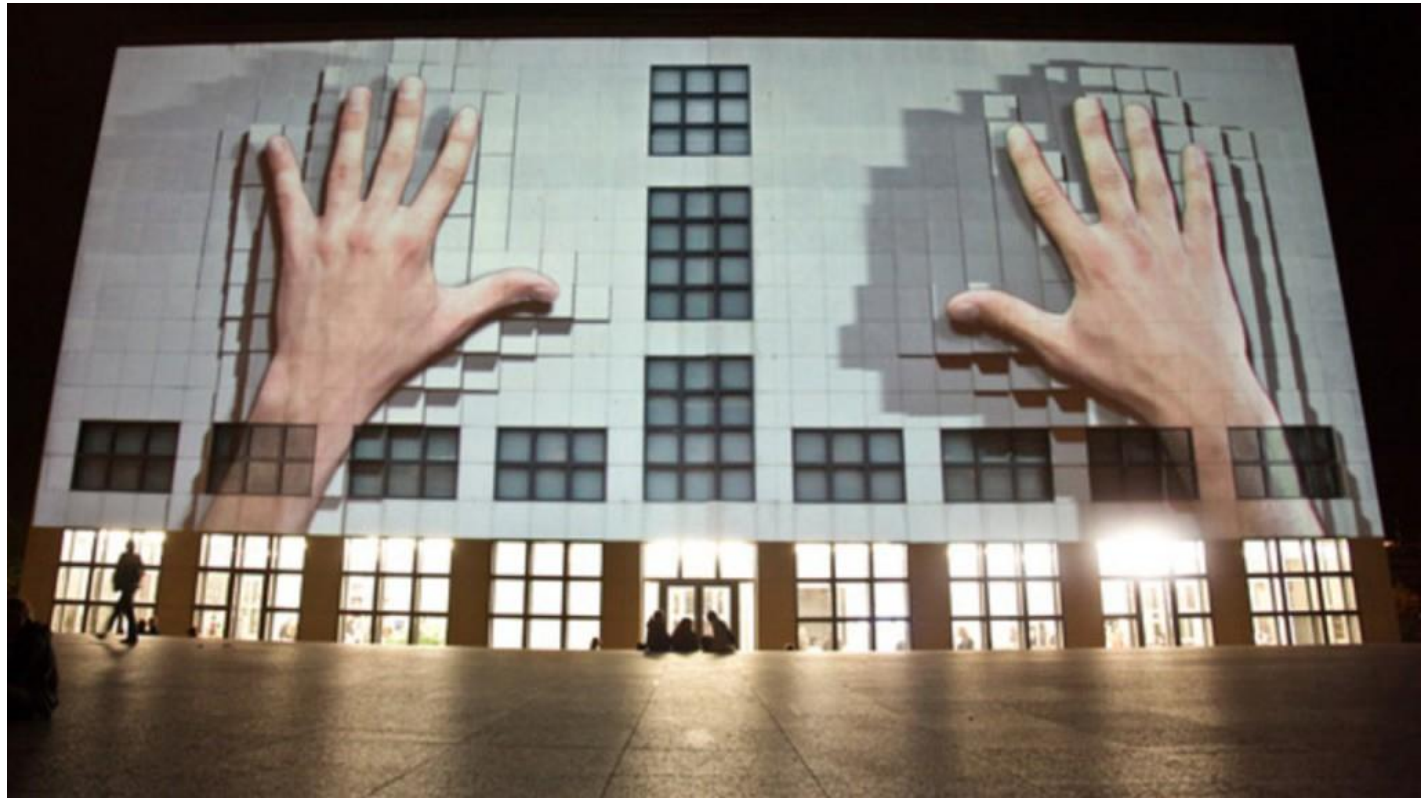
Underkoffler & Ishii, CHI ‘98

Raskar et al., SIGGRAPH ‘98



Pinhanez, UBICOMP ‘01

Projection mapping



555 Kubik - UrbanScreen

Disney

How our work differs?

Real-time! We don’t assume static geometry.

Any surface is a display.

Procedural behaviors and rendering based on the current conditions in the environment.

Our experiences scale from 1 to many nodes.

We want the experiences to be highly interactive, beyond the simple controller input.

We want to enable “**analog**” interactions (i.e., mimic the experience of the real world), while still offering the user “**supernatural**” powers when interacting with computer-generated content.

Analog interactions

MirageTable

Benko, Jota & Wilson, ACM CHI 2012

Benko, Jota & Wilson, ACM CHI 2012

Any surface is a display

Beamatron

Wilson, Benko, Izadi and Hilliges, ACM UIST 2012

Beamatron

Wilson, Benko, Izadi and Hilliges, ACM UIST 2012

Status

Searching from
Searching from
Searching from
Searching from
Searching from
Searching from
Searching from
Searching from
Searching from
Searching from
Searching from
Searching from
Searching from
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Pro-cams enable shared experiences

IllumiRoom

Jones, Benko, Ofek and Wilson, CES Las Vegas and ACM SIGCHI 2013

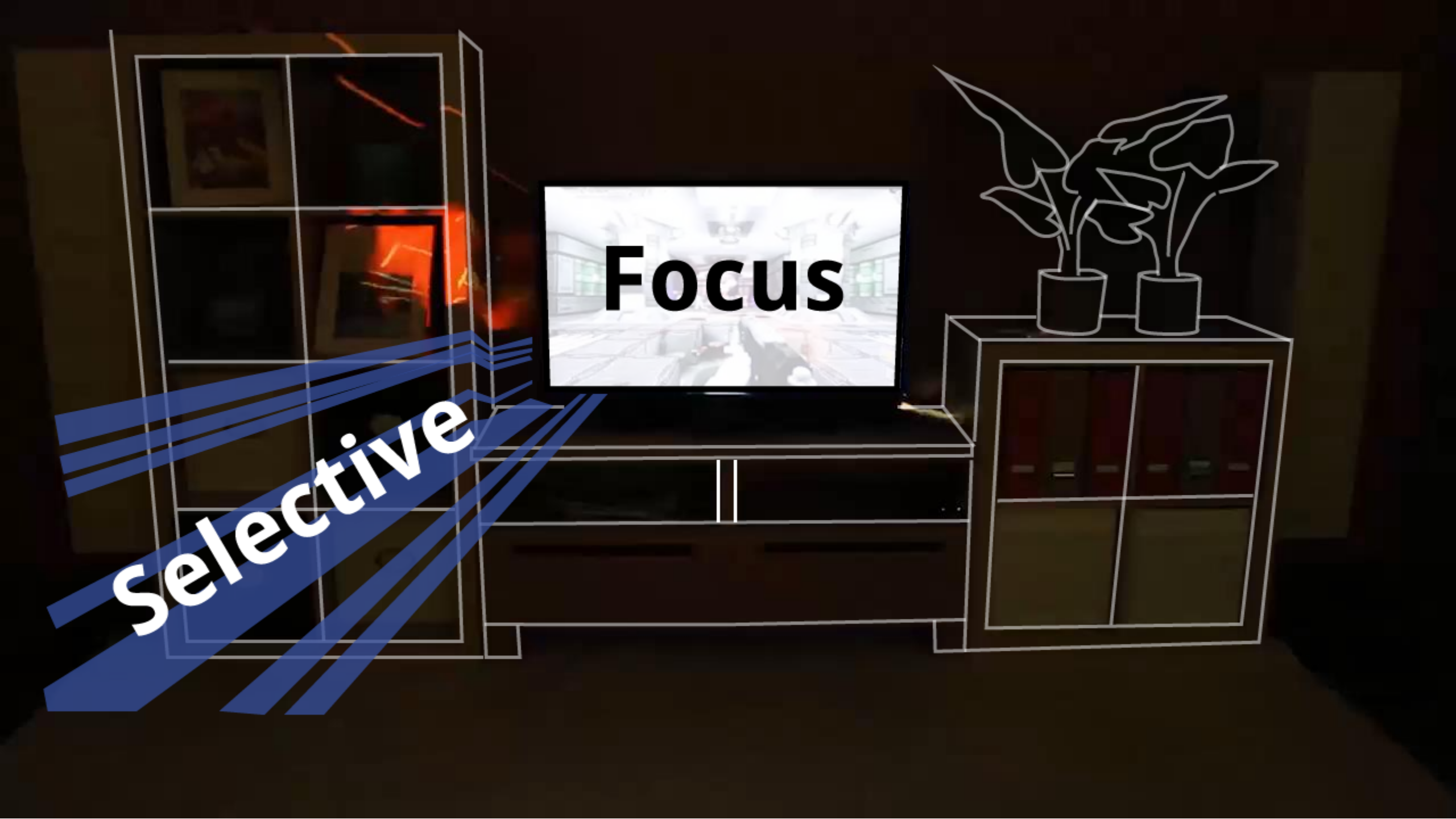

Oculus

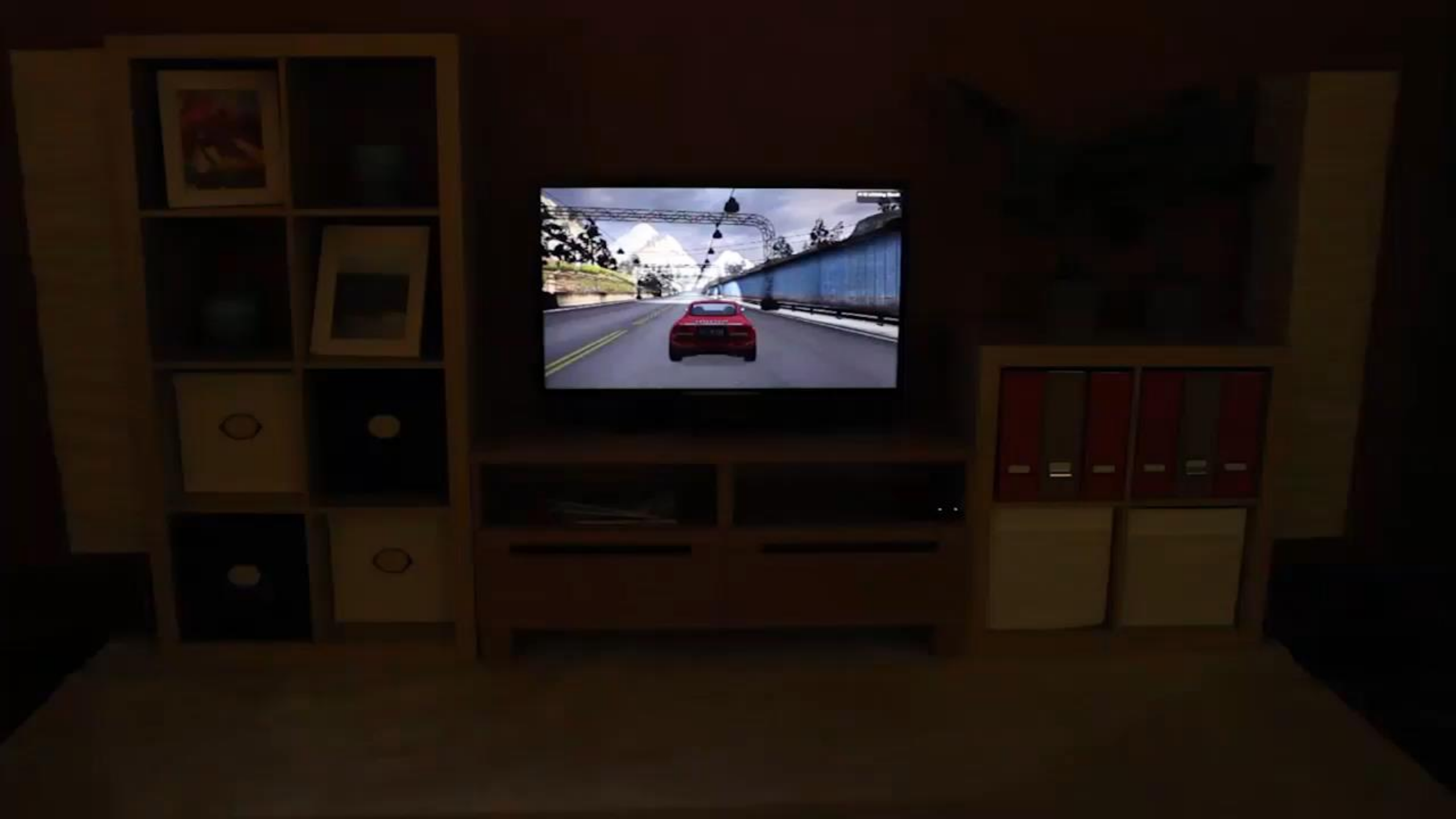
Radiometric Compensation

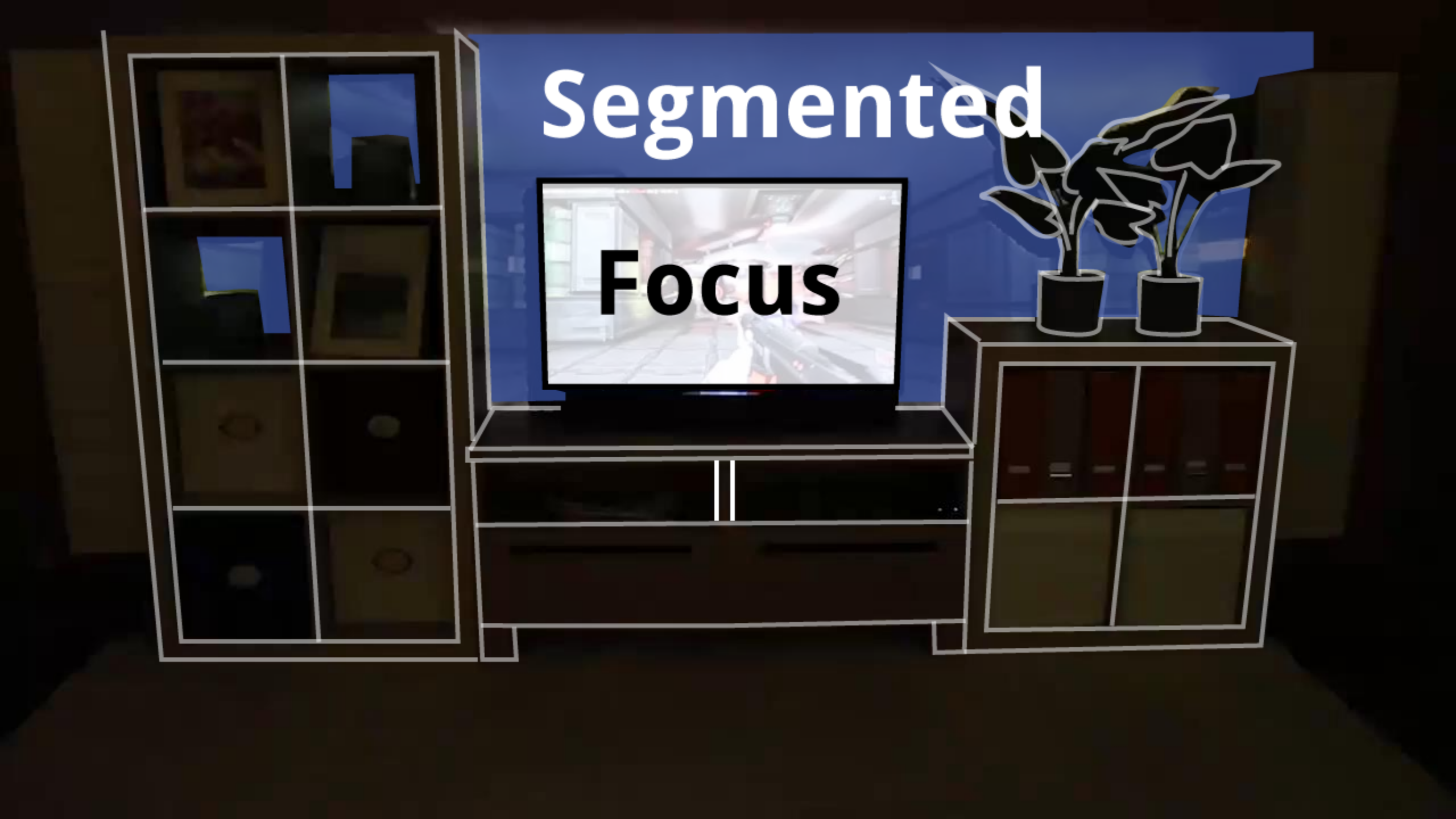
Projected Image

Live Footage


Focus
Context Edges


Focus
Selective




Segmented
Focus


Appearance

YouTube illumiroom

IllumiRoom Projects Images Beyond Your TV for an Immersive Gaming Experience

Microsoft Research

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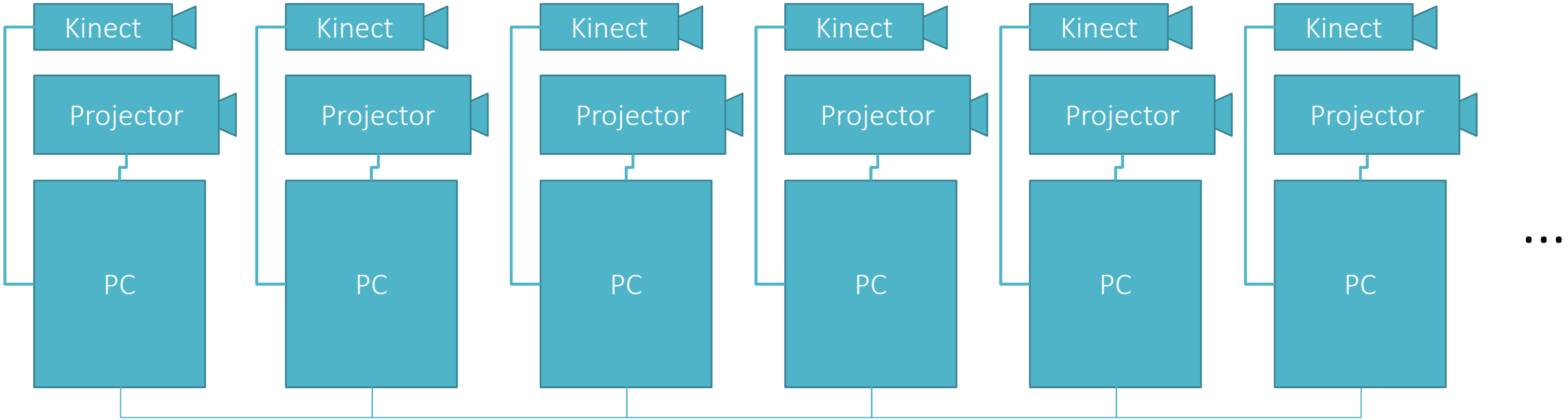
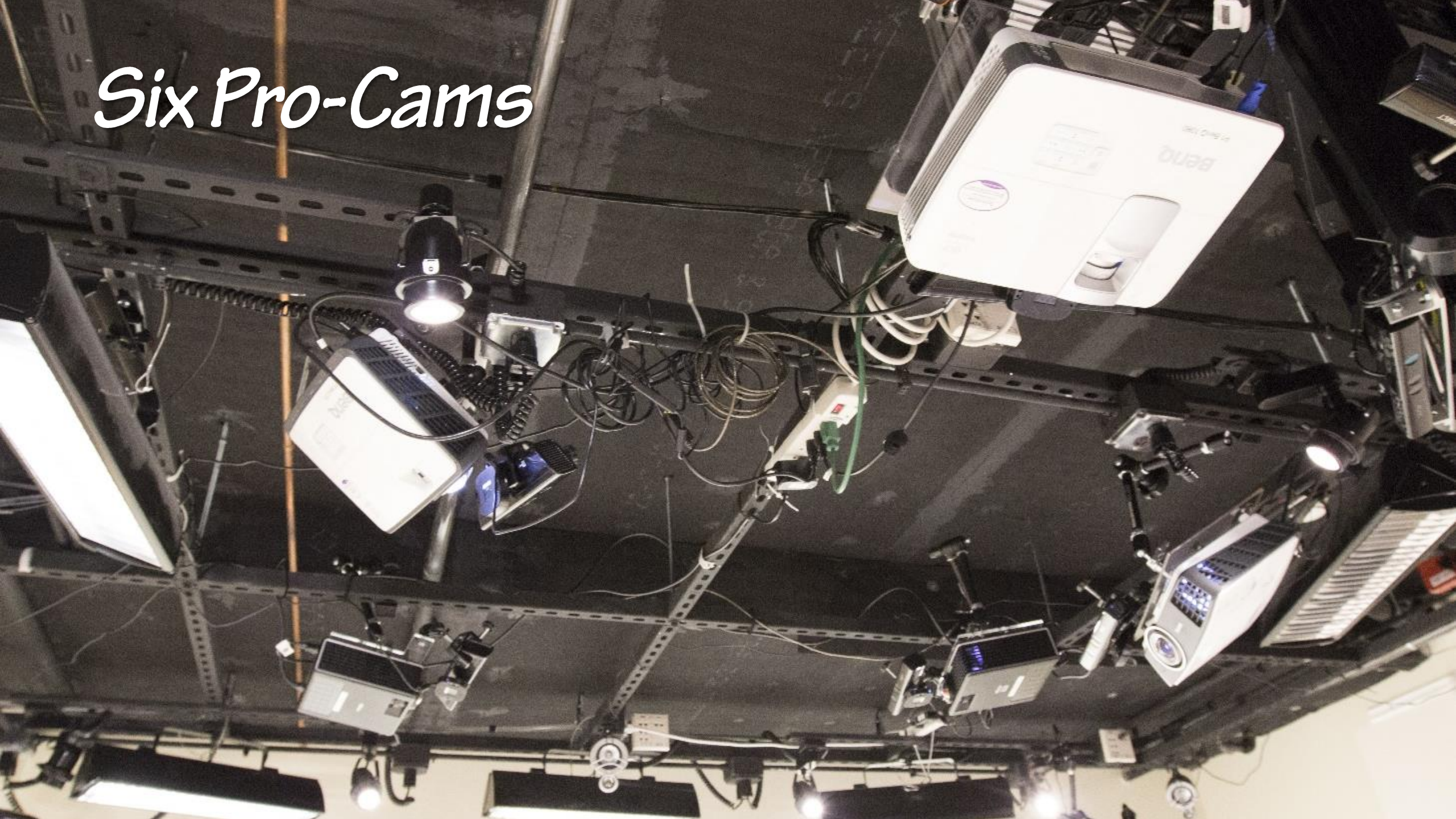
Scaling up to immersive AR rooms

RoomAlive

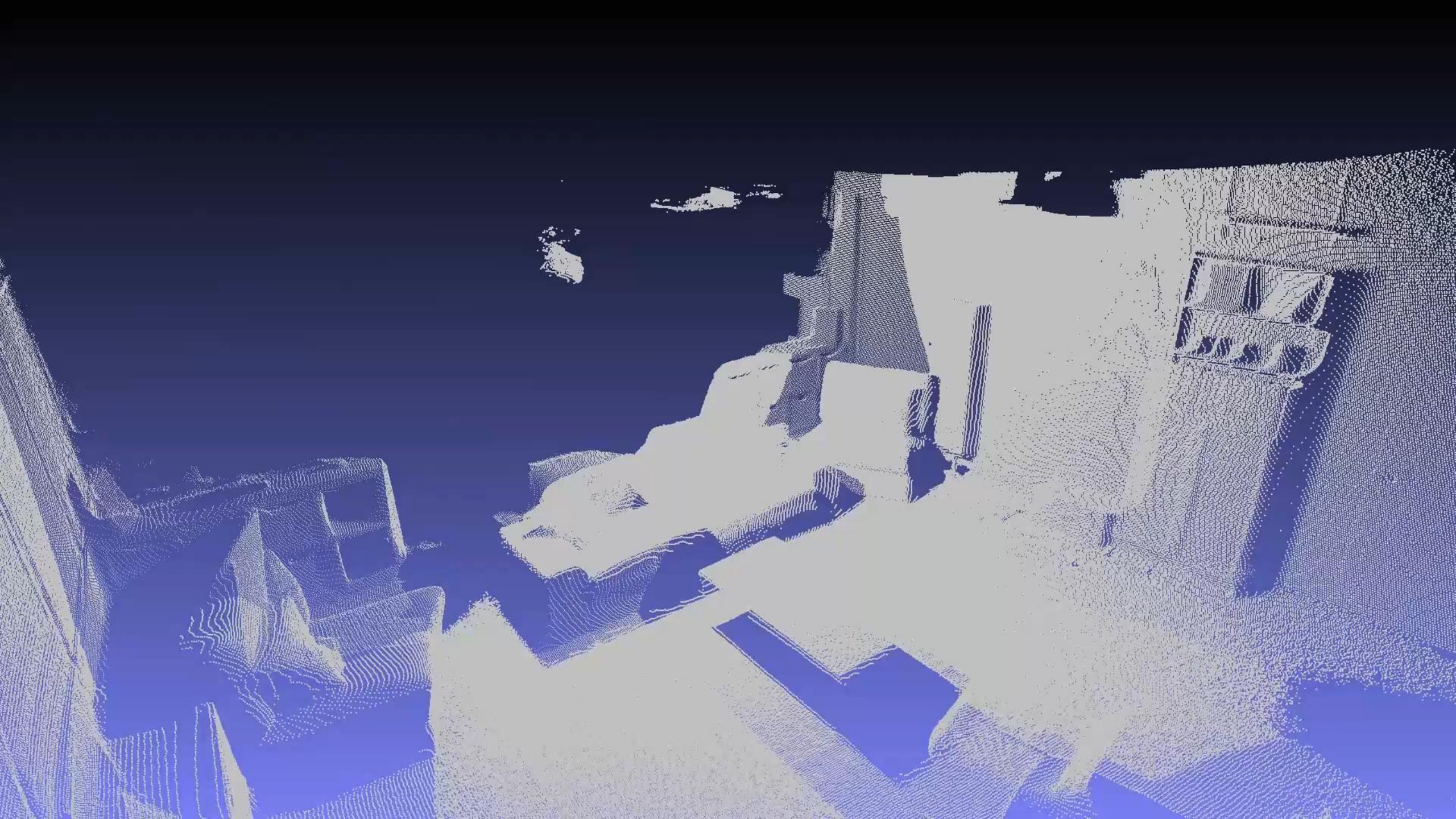
Jones, Sodhi, Murdock, Mehra, Benko, Wilson, Ofek, MacIntyre, Raghuvanshi, and Shapira. In ACM UIST 2014.

RoomAlive Distributed System




Six Pro-Cams


RoomAlive Calibration @ 4x Speed



RoomAlive by the numbers

1 living room (99/3319) 5x6 meters

6 projectors (6.3 megapixels at 60Hz)

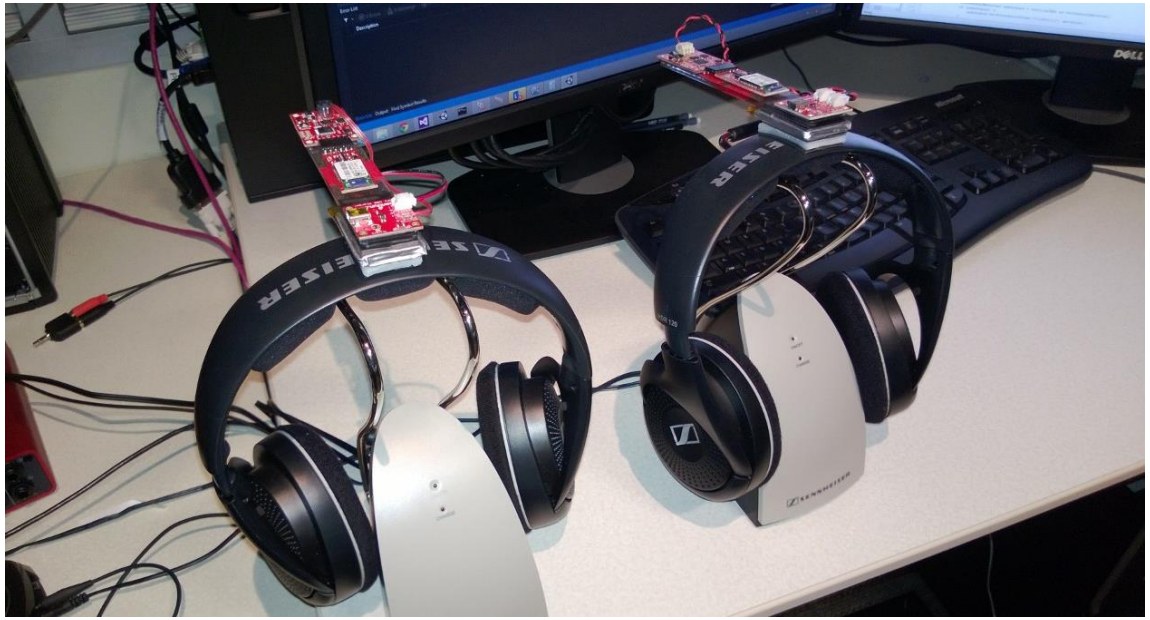
6 Kinect cameras (3.7 megapixels of image data processed at 30 Hz)

6 computers

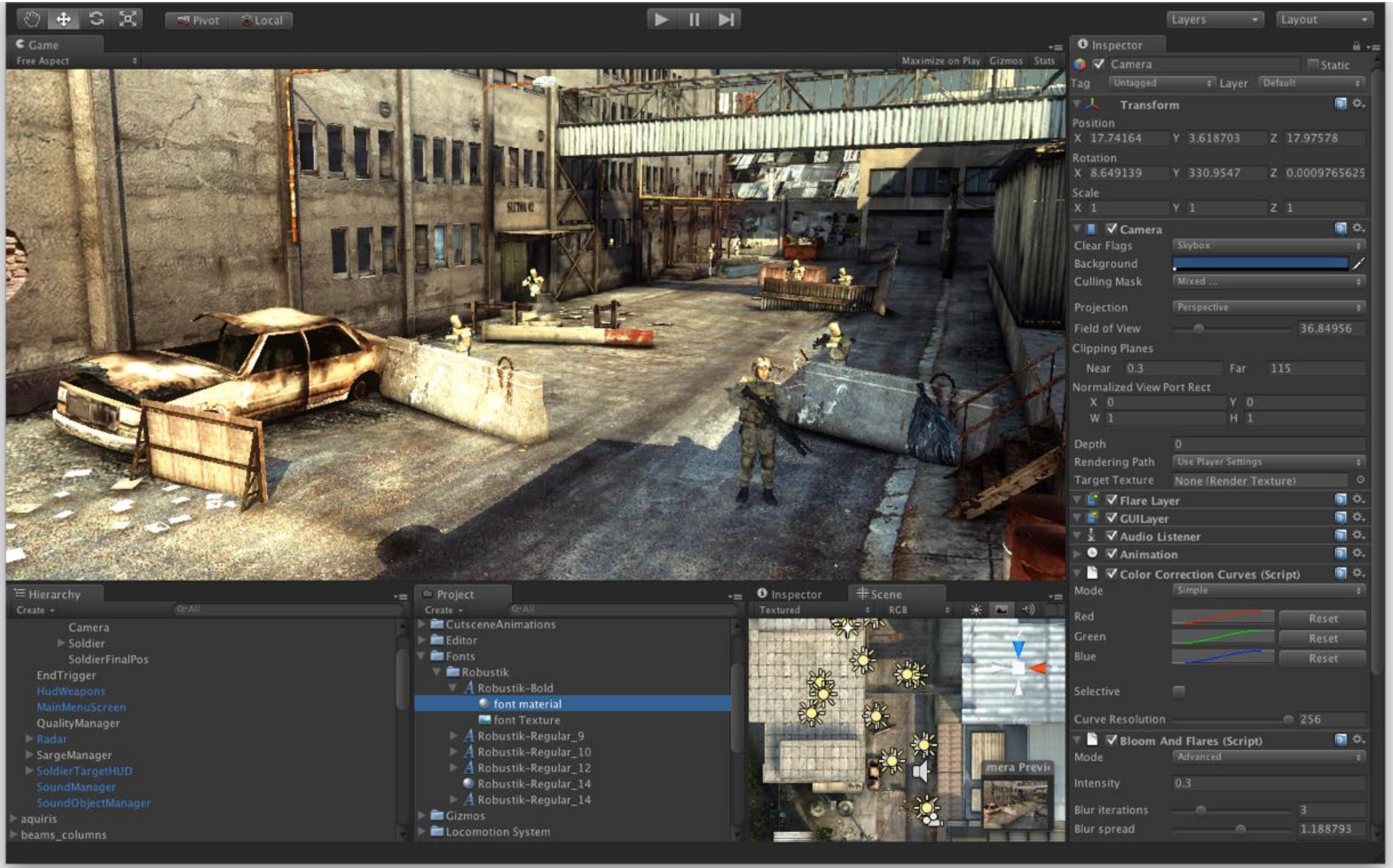
Distributed game engine (Unity)

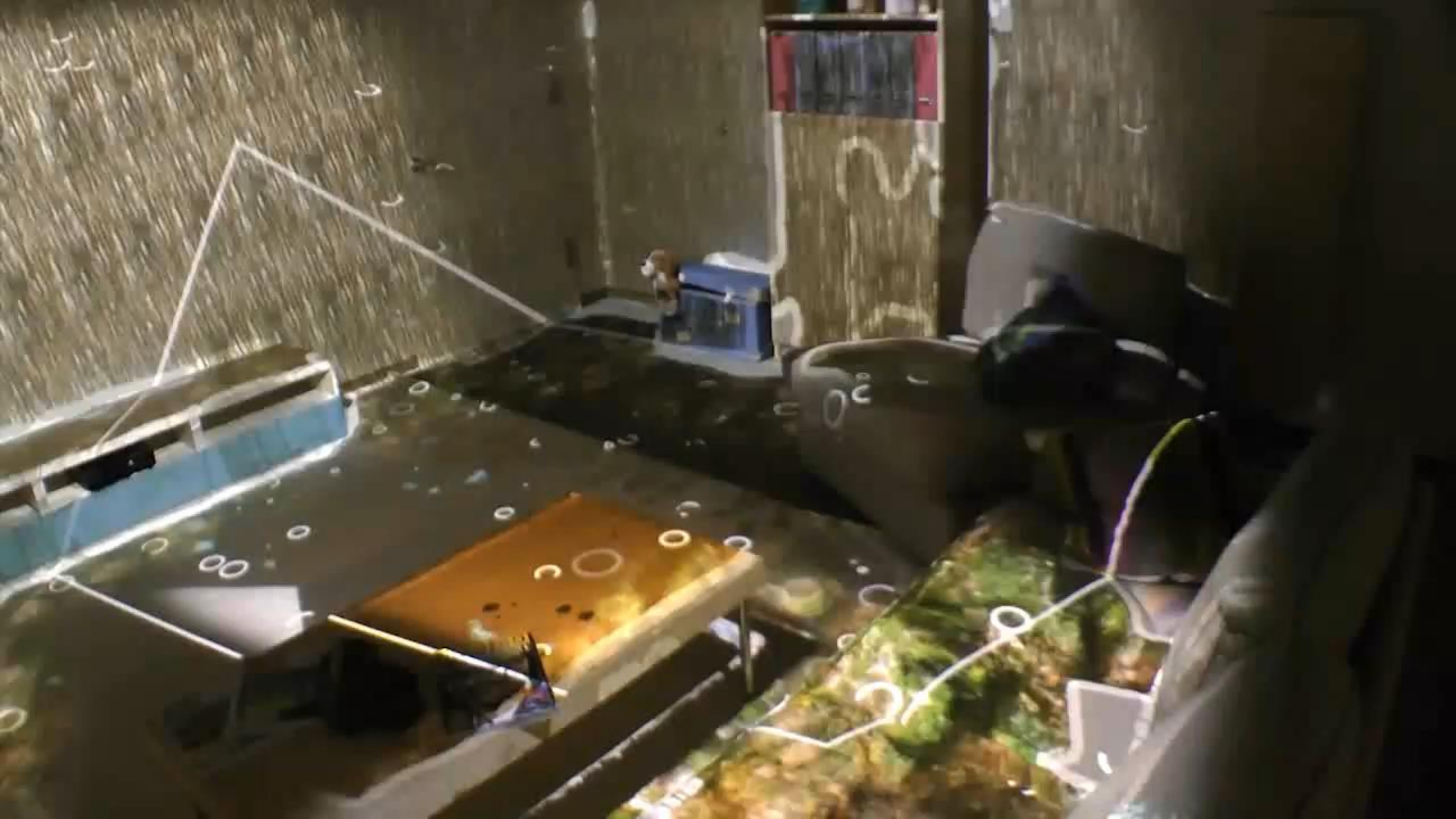
2 head-tracked users

Triton 3D sound spatialization



Authoring experiences

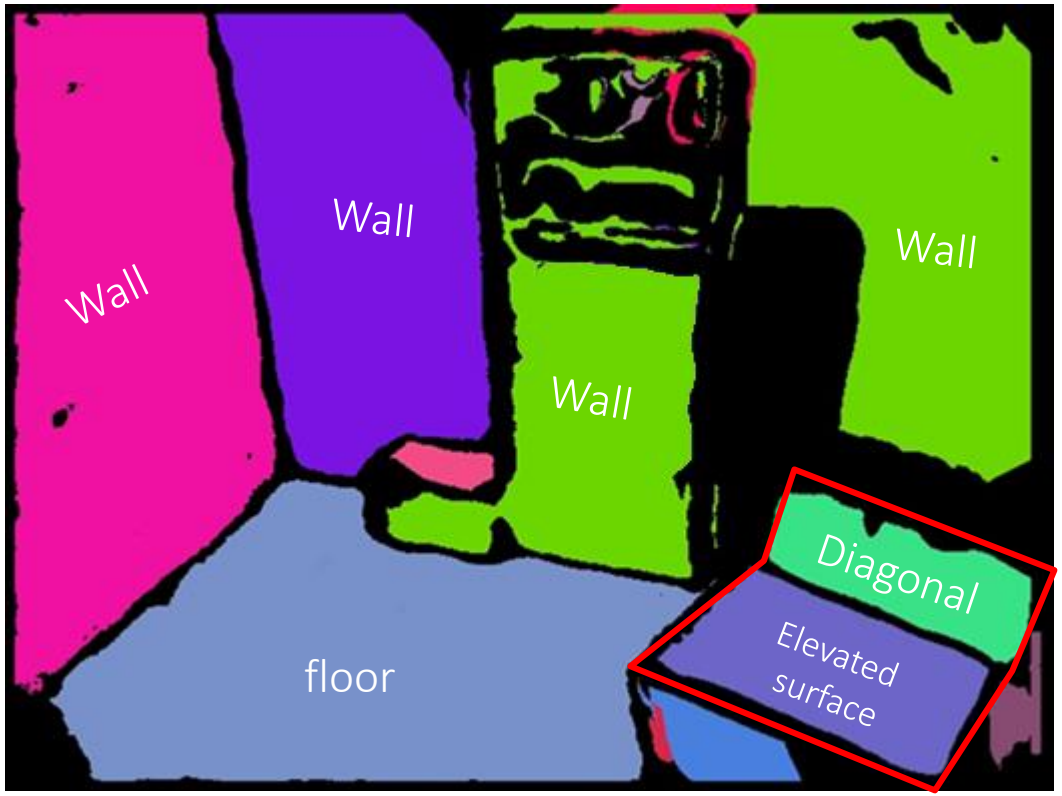

unity
Pivot
Local
Layers
Layout
Game
Free Aspect
Maximize on Play
Gizmos
Stats
Inspector
Camera
Static
Tag
Untagged
Layer
Default
Transform
Position
X 17.74164
Y 3.618703
Z 17.97578
Rotation
X 8.649139
Y 330.9547
Z 0.0009765625
Scale
X 1
Y 1
Z 1
Camera
Clear Flags
Skybox
Background
Culling Mask
Mixed ...
Projection
Perspective
Field of View
36.84956
Clipping Planes
Near 0.3
Far 115
Normalized View Port Rect
X 0
Y 0
W 1
H 1
Depth
0
Rendering Path
Use Player Settings
Target Texture
None (Render Texture)
Flare Layer
GUILayer
Audio Listener
Animation
Color Correction Curves (Script)
Mode
Simple
Red
Green
Blue
Reset
Selective
Curve Resolution
256
Bloom And Flares (Script)
Mode
Advanced
Intensity
0.3
Blur iterations
3
Blur spread
1.188793
Hierarchy
Create
Camera
Soldier
SoldierFinalPos
EndTrigger
HudWeapons
MainMenuScreen
QualityManager
Radar
SargeManager
SoldierTargetHUD
SoundManager
SoundObjectManager
aquiris
beams_columns
Project
Create
CutsceneAnimations
Editor
Fonts
Robustik
Robustik-Bold
font material
font Texture
Robustik-Regular_9
Robustik-Regular_10
Robustik-Regular_12
Robustik-Regular_14
Robustik-Regular_14
Gizmos
Locomotion System
Inspector
Scene
Textured
RGB



Authoring challenges

The environment is unknown at design time.

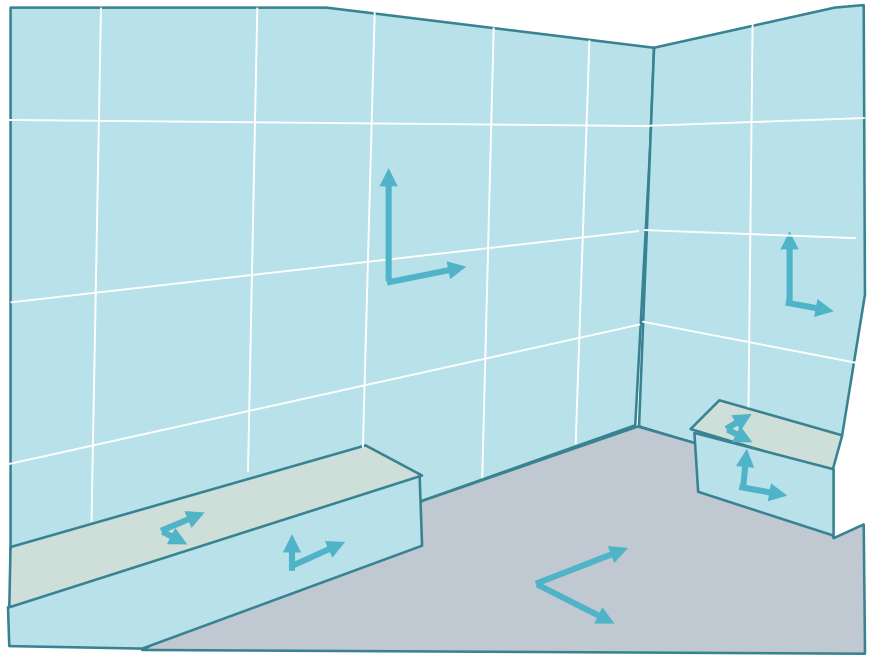
Automatic extraction of scene polygons

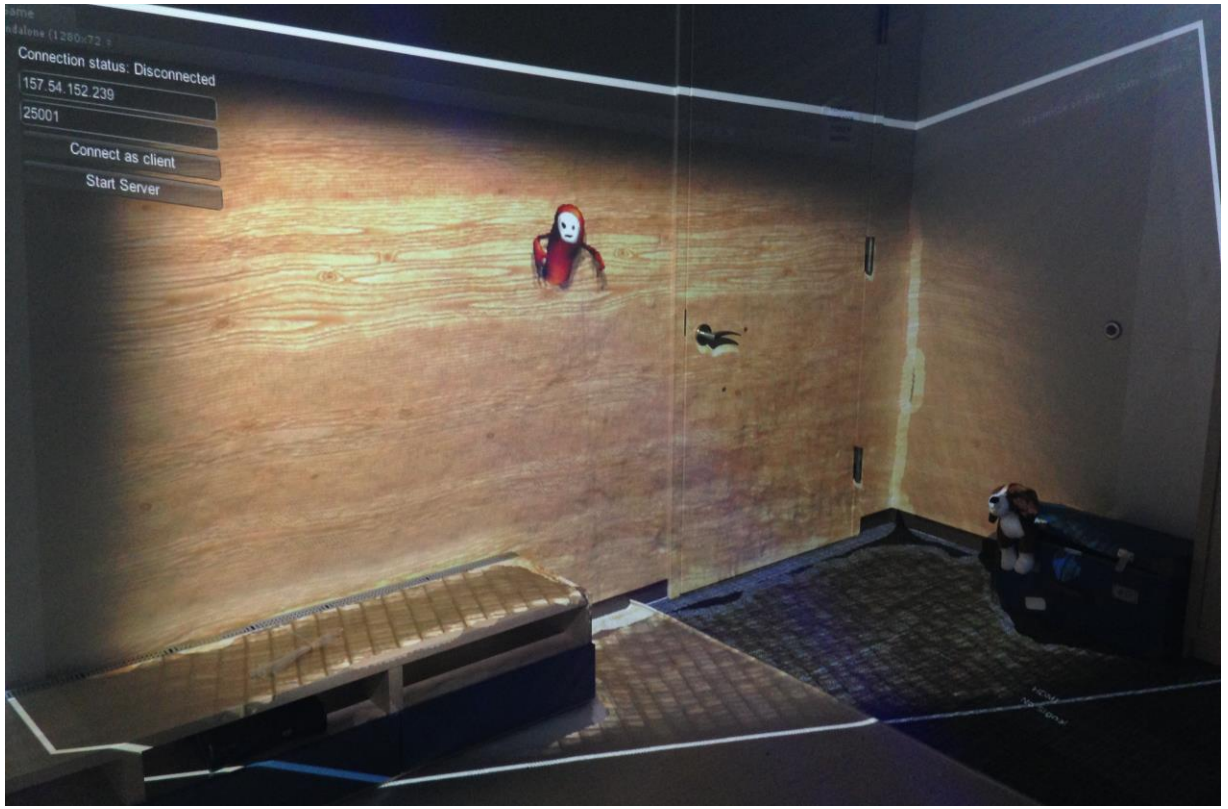


Chair

N. Silberman (NYU), L. Shapira, R. Gal & E. Ofek

Assignment of local uv coordinates





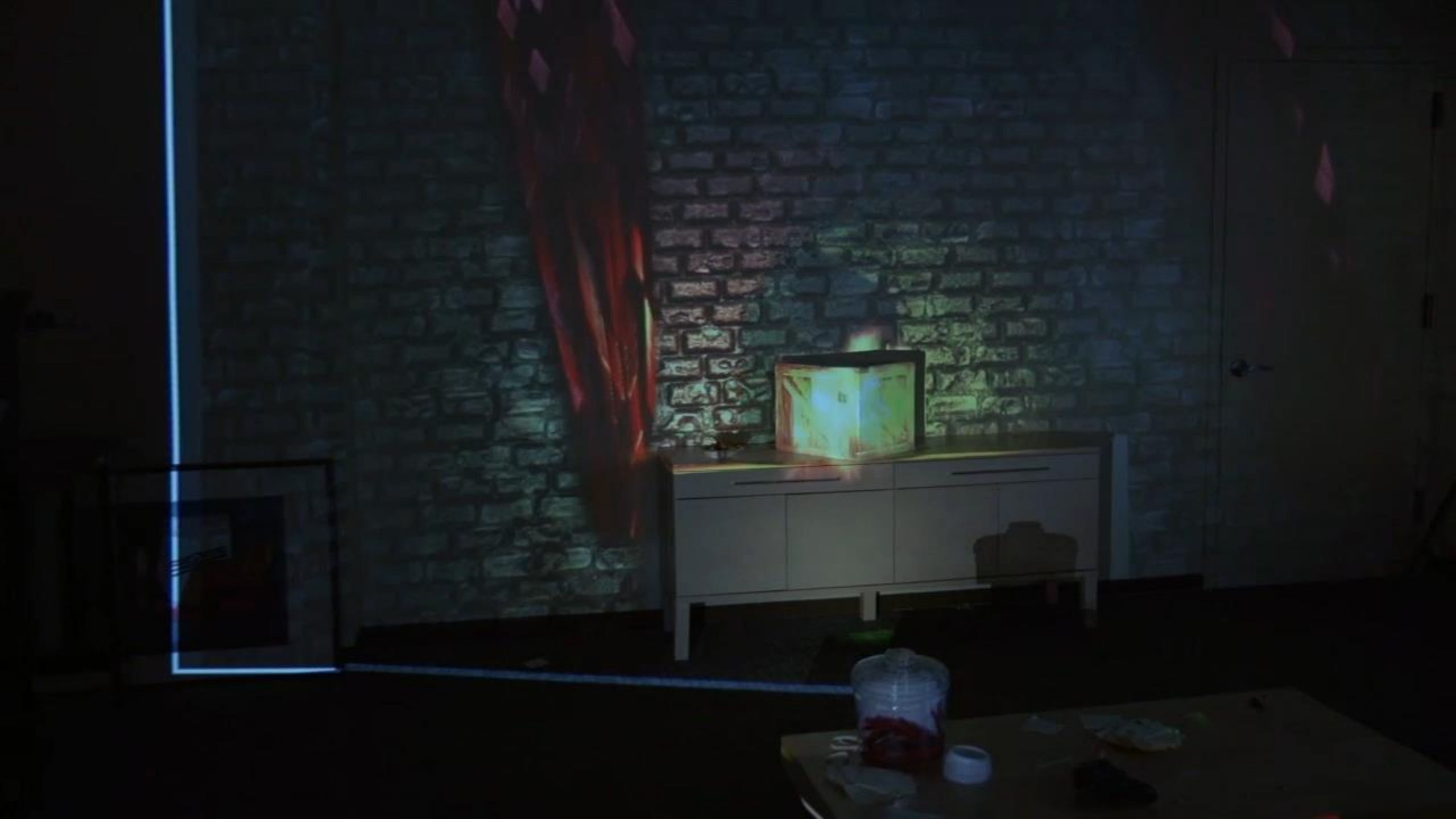
Authoring challenges

The environment is unknown at design time.

Designer is not in complete control of the experience.

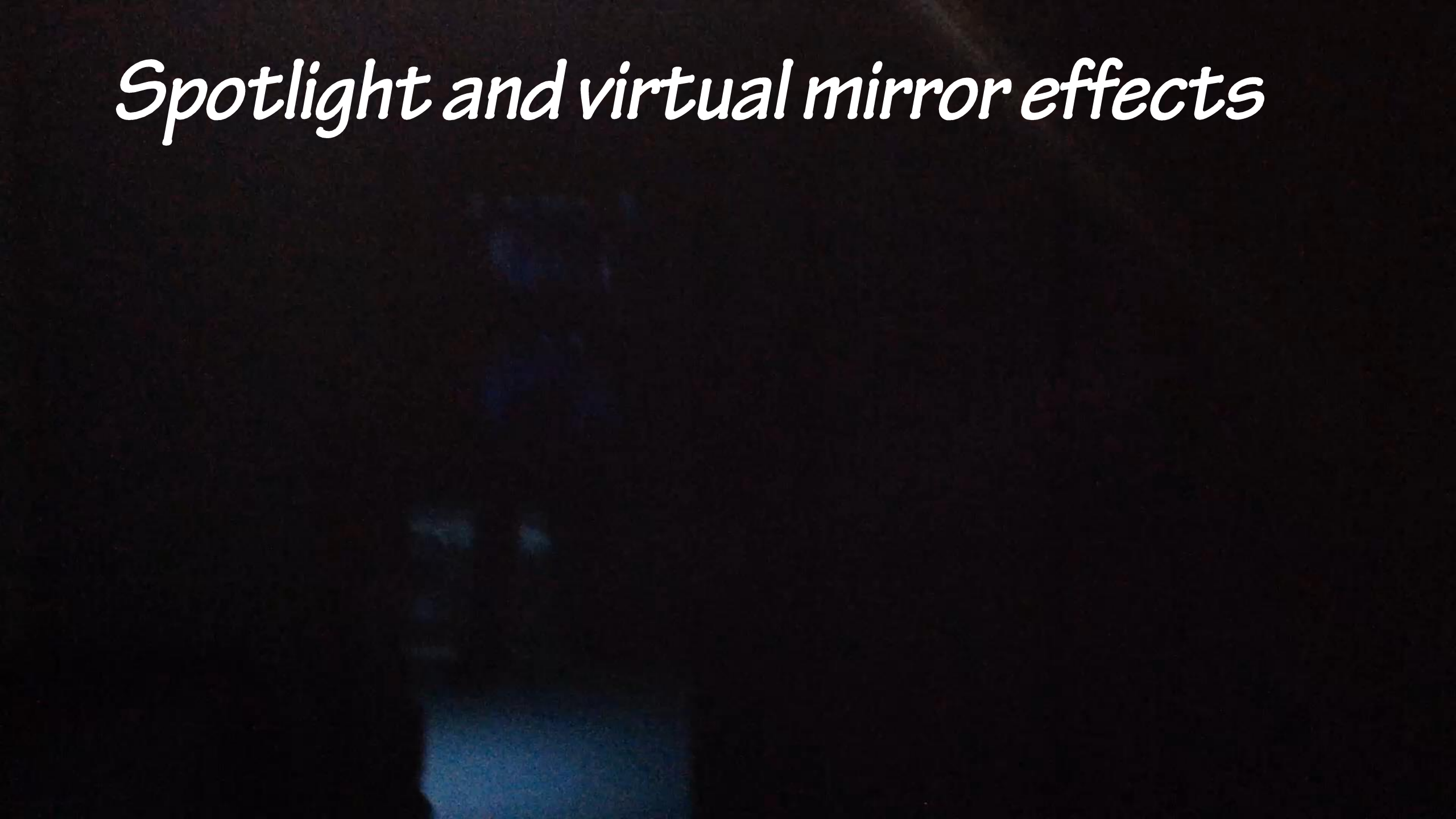
If storytelling, need to direct the person's focus. More like theater/theme park than a movie/game.

Magic happens when virtual stuff interacts with the real world.




The Other Resident

Spotlight and virtual mirror effects



Enabling multi-perspective views

Dyadic Spatial Augmented Reality

Benko, Wilson, and Zannier. In ACM UIST 2014.

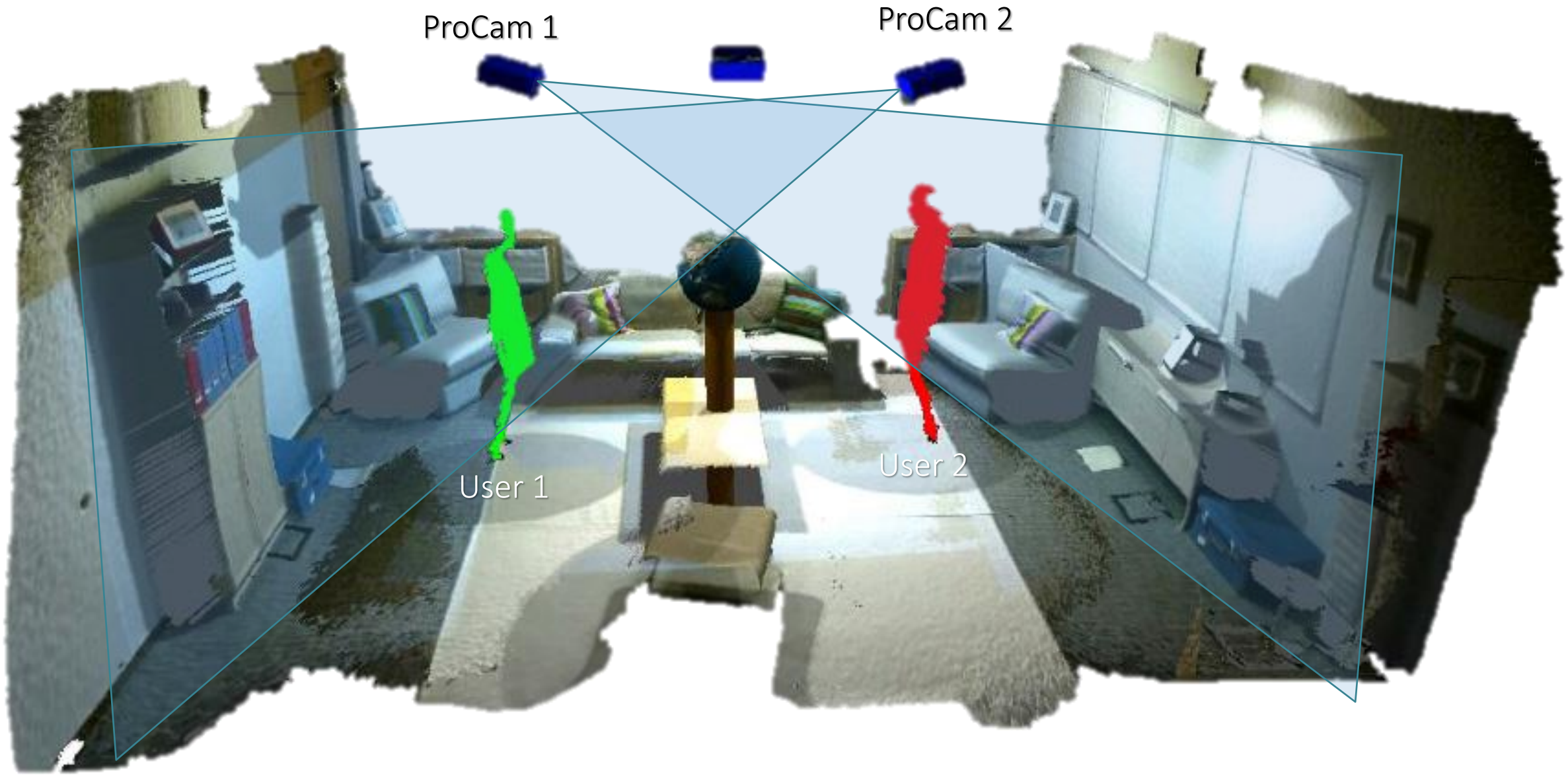
Surface Shading

Edgar Mueller


Felice Varini


OUT

How to support view dependent graphics for multiple users?

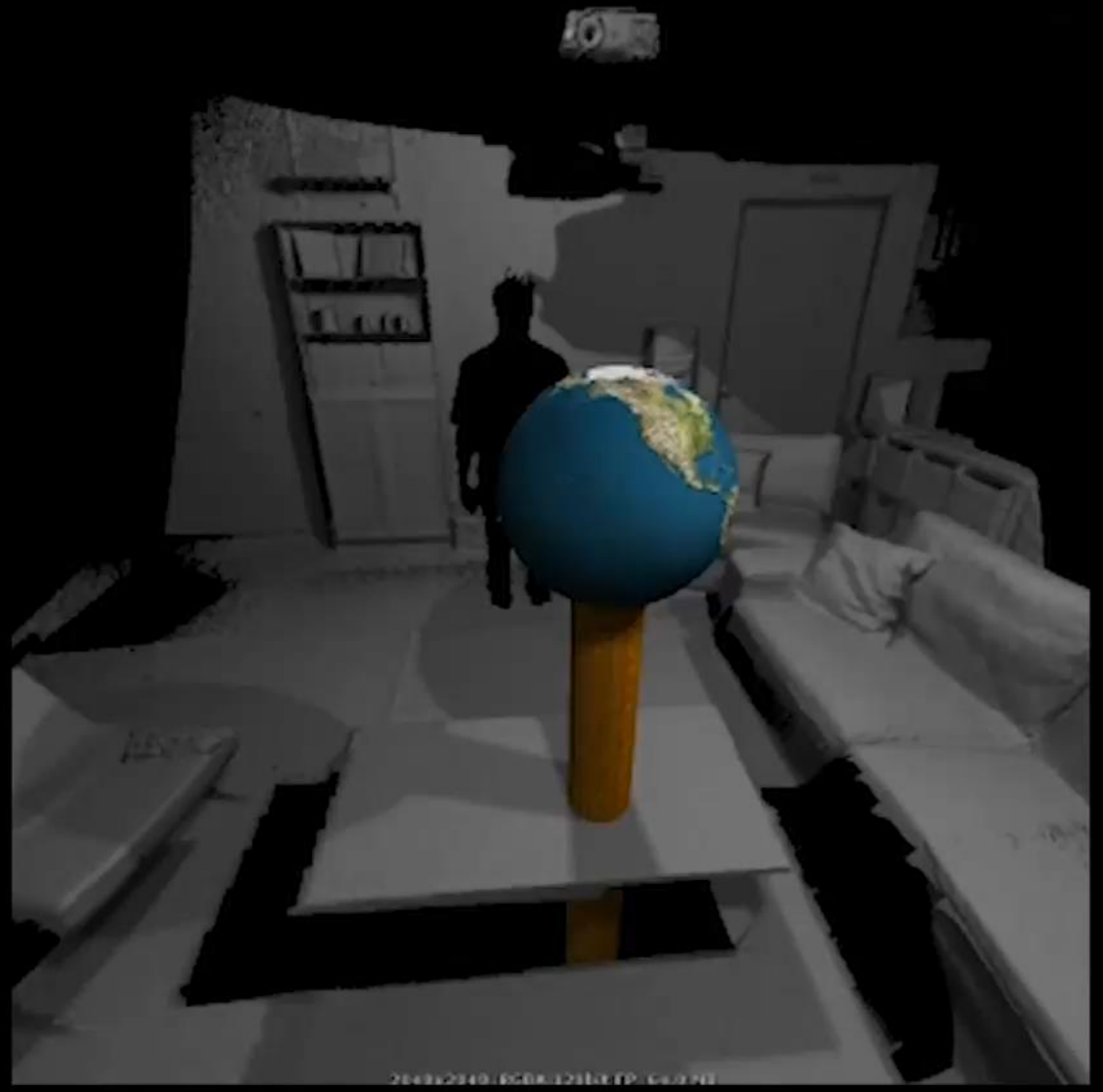

ProCam 1
ProCam 2
User 1
User 2


Target


Projected


User’s POV


OLD NAVY



Two User Experiments

Projected objects are perceived as spatial even without stereo rendering.

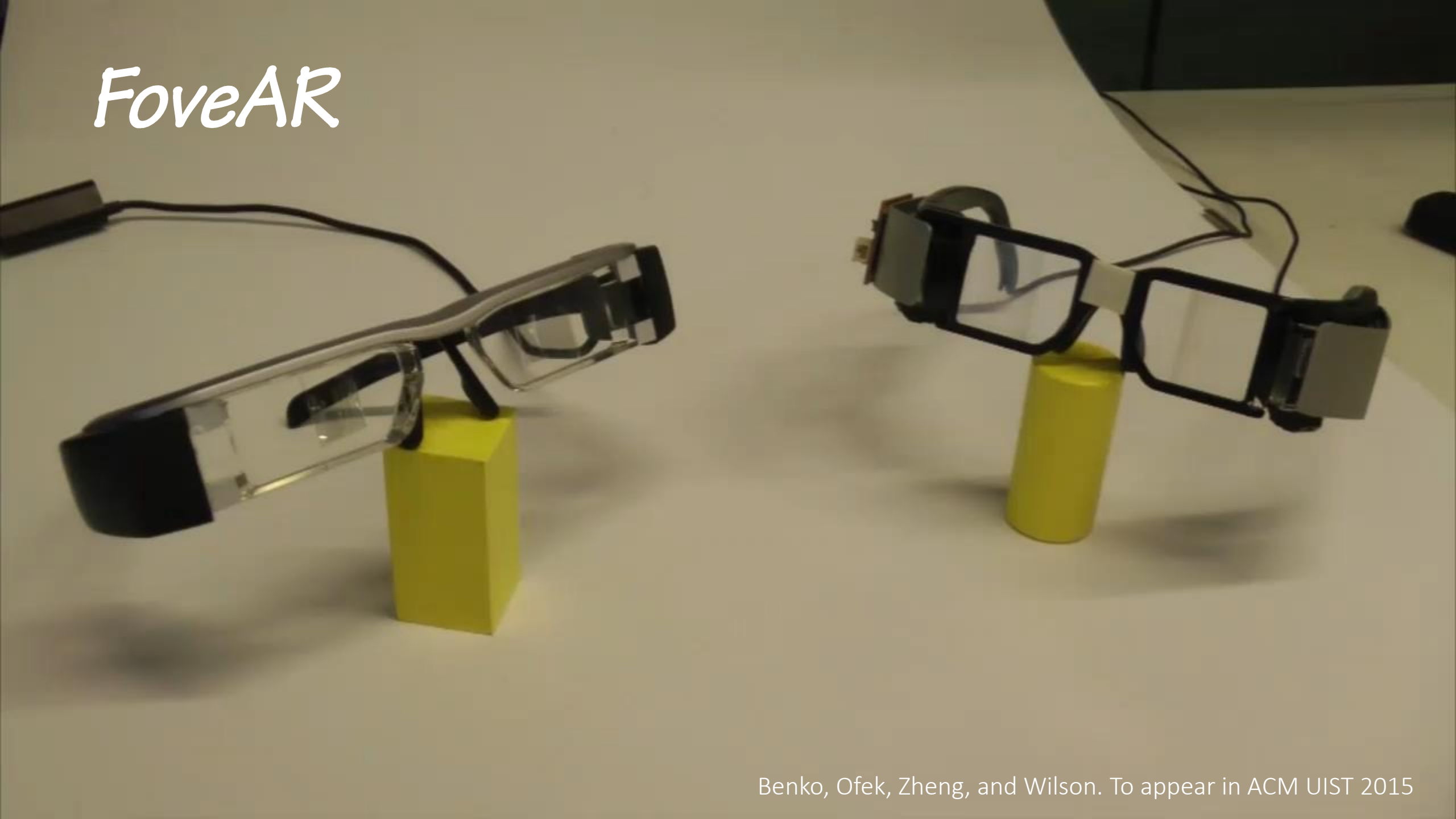
Users can understand their collaborator's spatial references.

Glasses + Pro-Cams

FoveAR

Benko, Ofek, Zheng, and Wilson. To appear in ACM UIST 2015

FoveAR



Benko, Ofek, Zheng, and Wilson. To appear in ACM UIST 2015

Connecting people

Room2Room

Pejsa, Kantor, Benko, Ofek, and Wilson. To appear in ACM CSCW 2016.

Room2Room

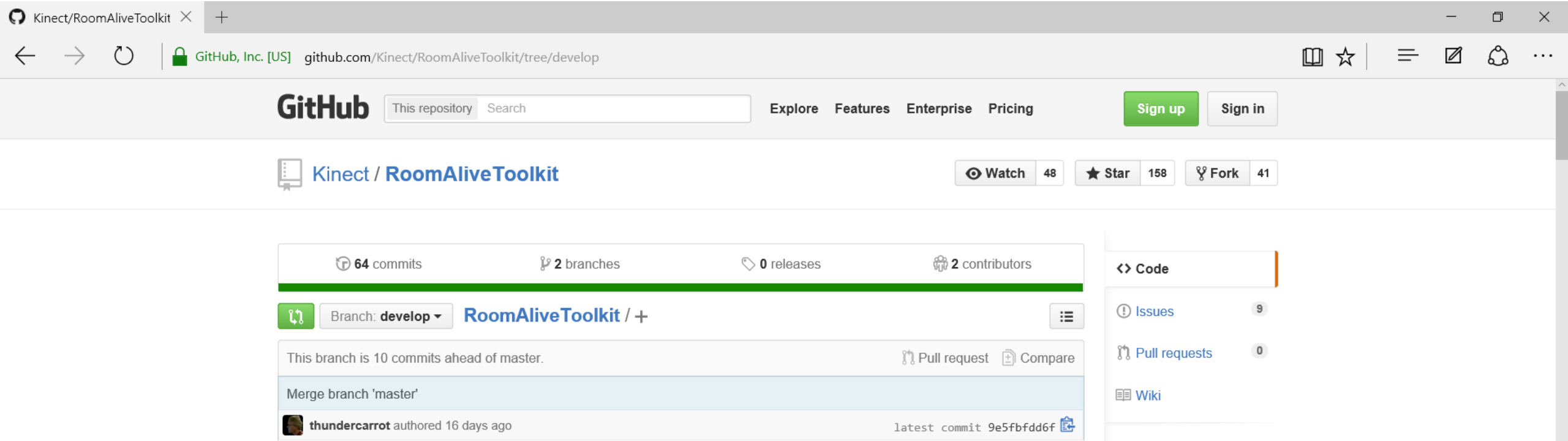
Pejsa, Kantor, Benko, Ofek, and Wilson. To appear in ACM CSCW 2016.


Feel inspired? Want to try it out?

RoomAlive Toolkit

Open source multi-Kinect multi-projector calibration tool and view-dependent rendering samples.

Get the code: https://github.com/Kinect/RoomAliveToolkit/



RoomAlive Toolkit

Thanks to my collaborators

Andy Wilson

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Feng Zheng
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Chris Harrison
Federico Zanier
Blair MacIntyre
Shahram Izadi
Nikunj Raghuvanshi
Lior Shapira
Ran Gal

Hrvoje Benko

benko@microsoft.com

http://research.microsoft.com/~benko