Mixed Reality Trompe L'oiel for Fun and Profit

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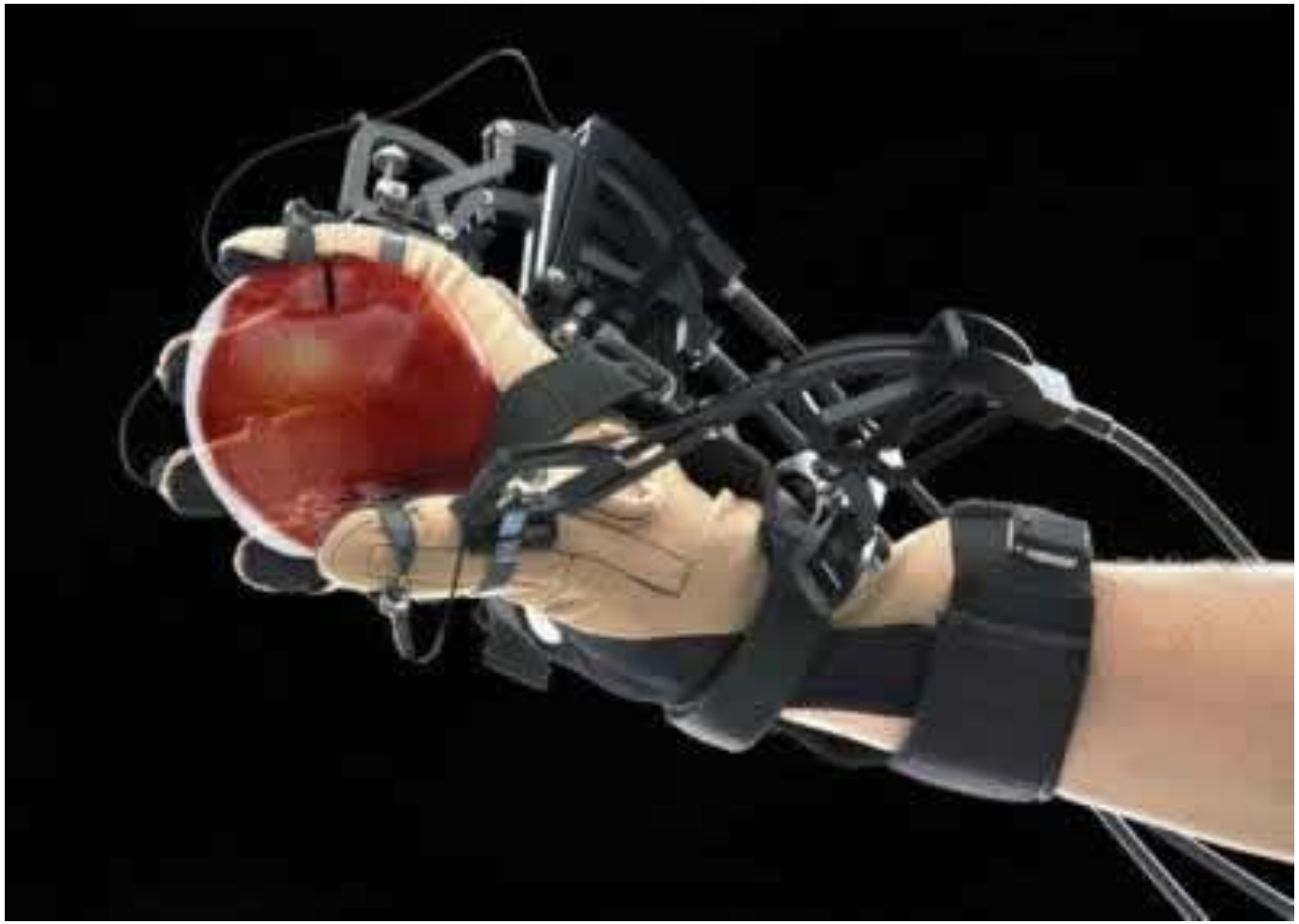
Perception and Interaction

Microsoft Research AI

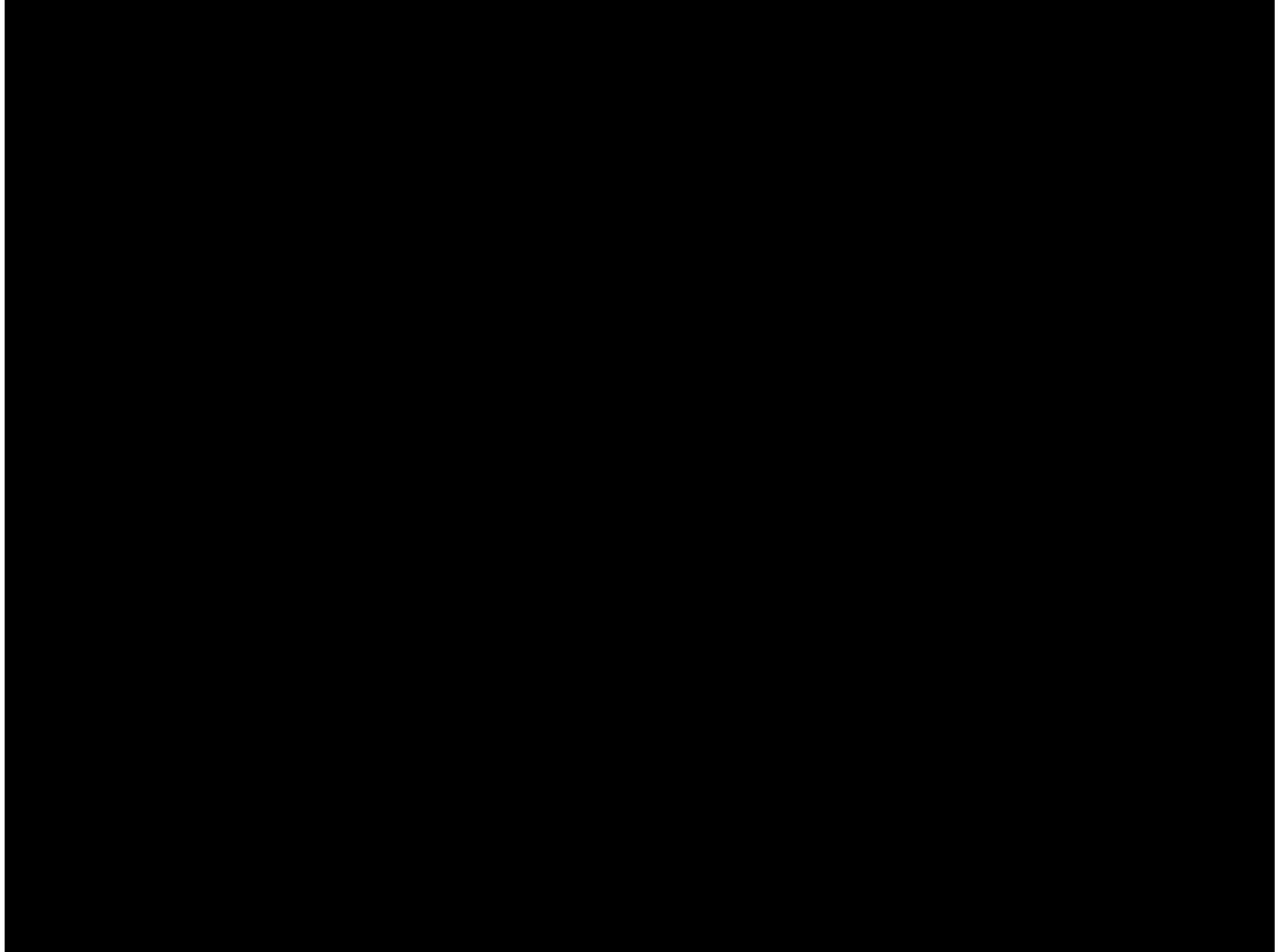
Trompe l’oiel: “Deceive the eye”

an art technique that uses realistic imagery to create the optical illusion that the depicted objects exist in three dimensions

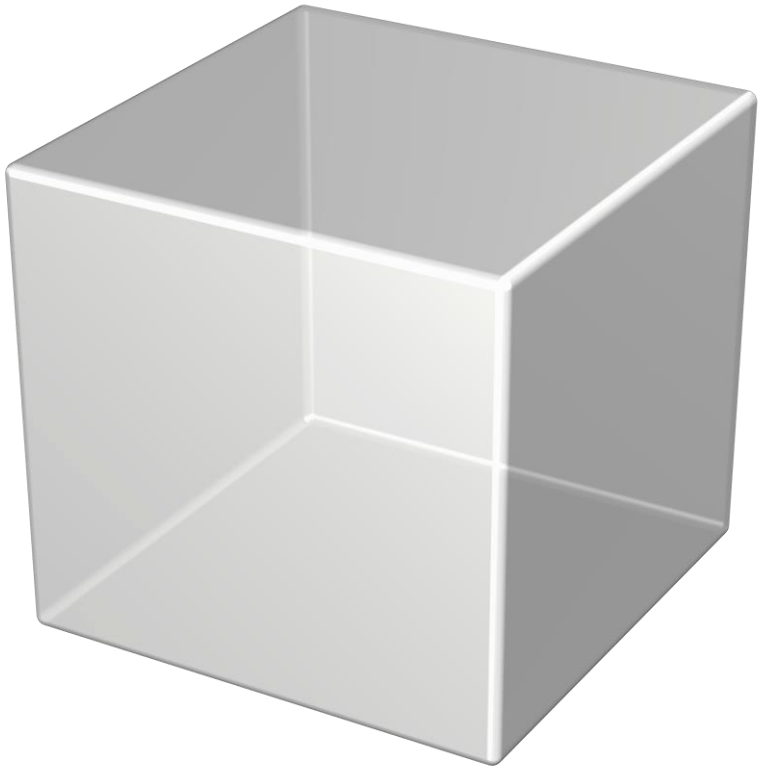
Realistic haptics in VR is not easy



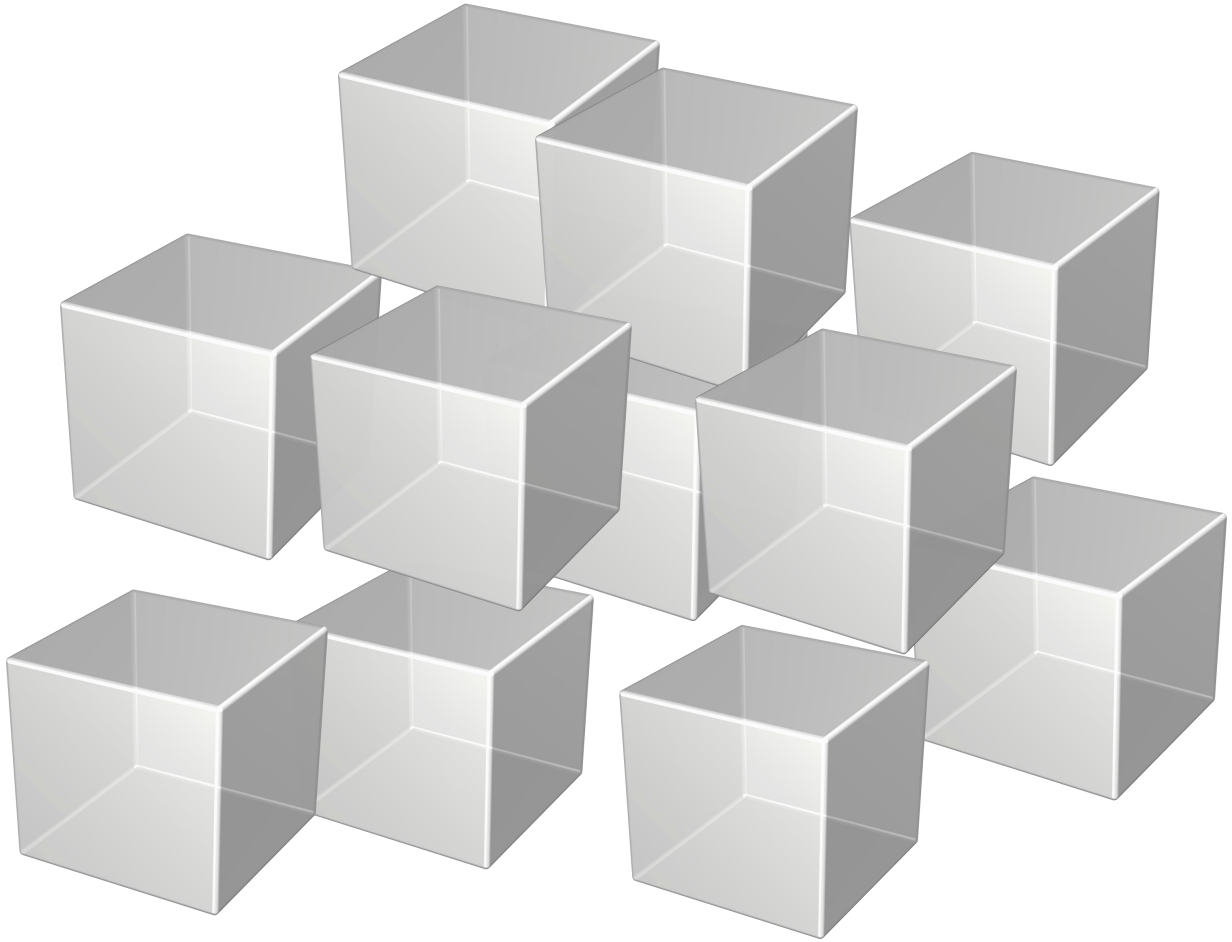
CyberGrasp Glove – Image by Leonardo Crescenti



Passive Haptics in VR

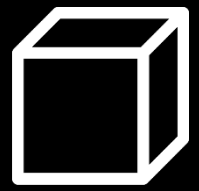


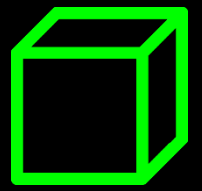
Passive Haptics in VR – Does not Scale



Kinect V2 + Oculus DK2 HMD

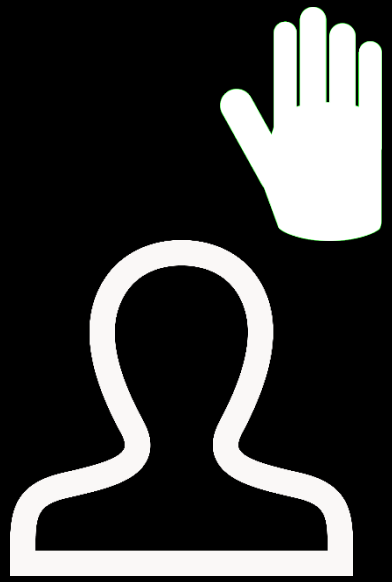
physical cube





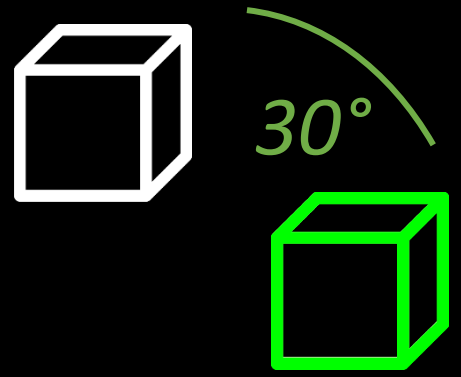
virtual cube

The Rendered Body Shifts to The Right



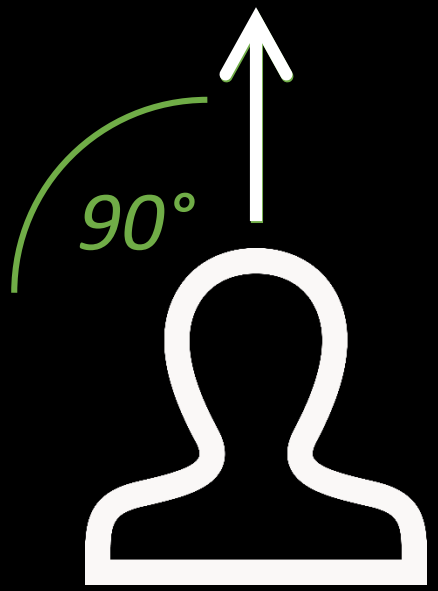
Body Warping

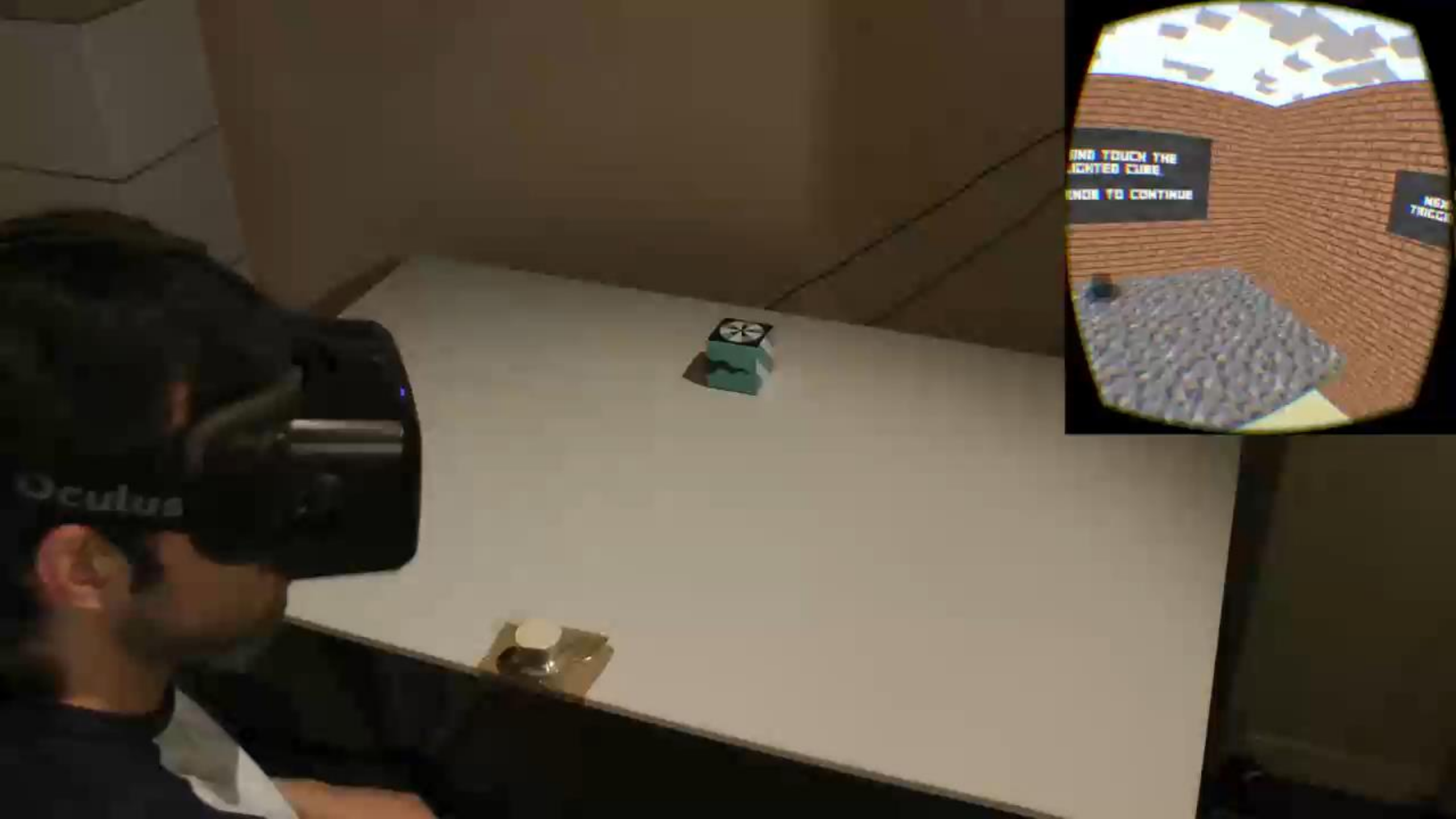
physical
cube



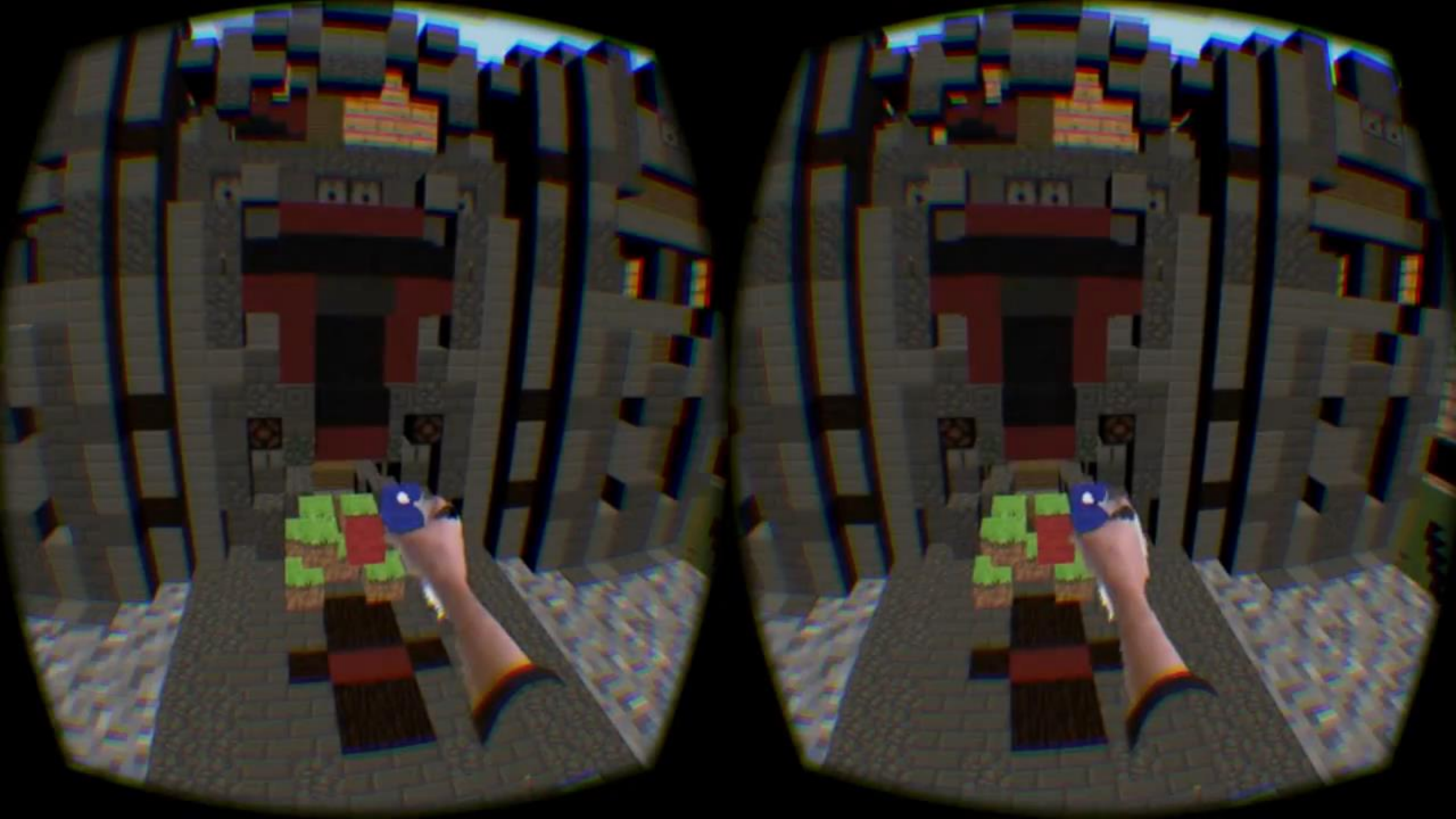
virtual
cube

The World Also Rotates
(At Different Rate)




Oculus

Hybrid Warping

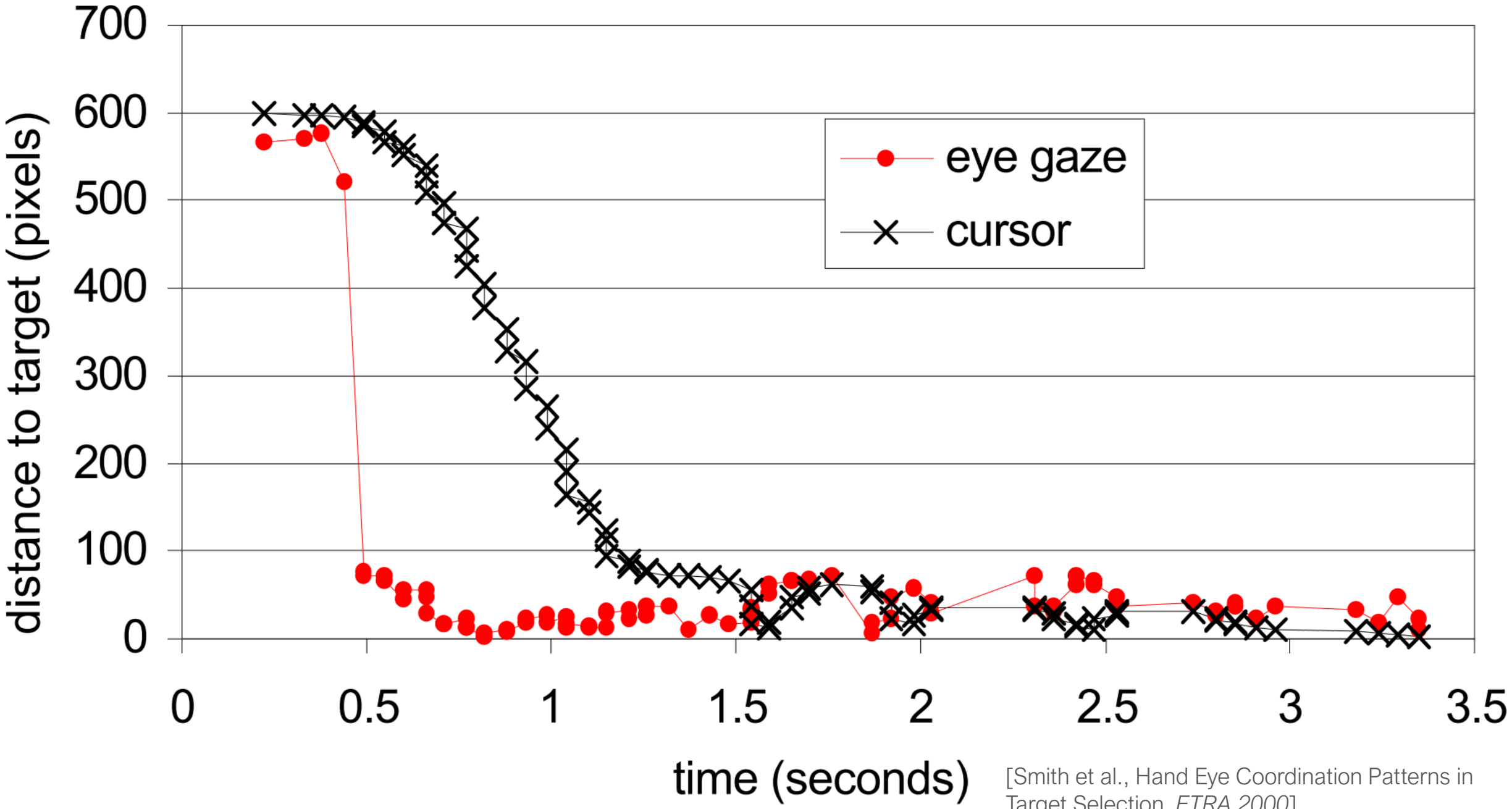


Limitations

- Need to know which object you are reaching for (we tell you)
- Need to press the button before reaching
- No accounting for mismatch in scale and shape

SMI eye-tracking module

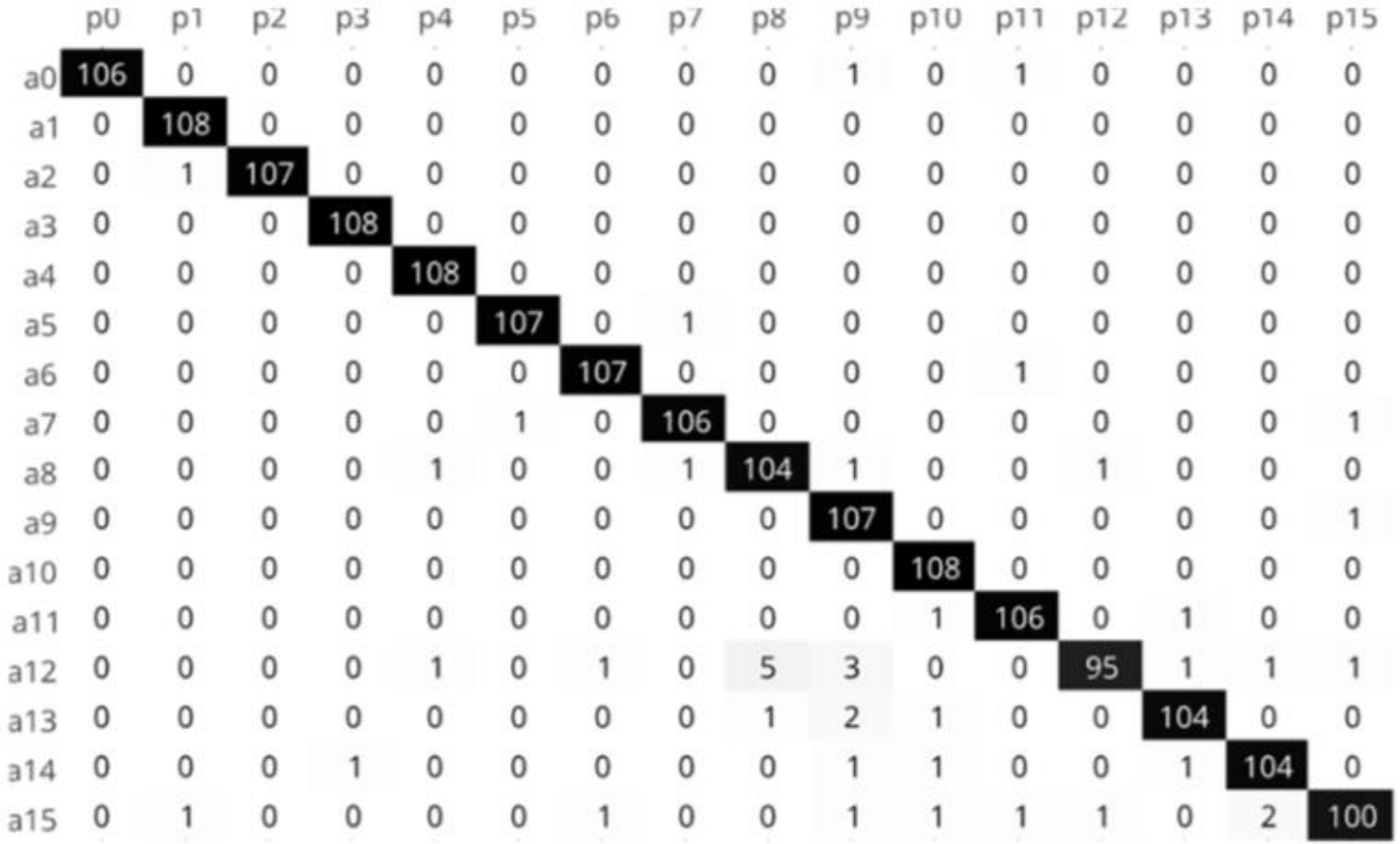
250 hz eye-tracker
on Oculus DK2



[Smith et al., Hand Eye Coordination Patterns in Target Selection, *ETRA 2000*]

predicted target

actual target



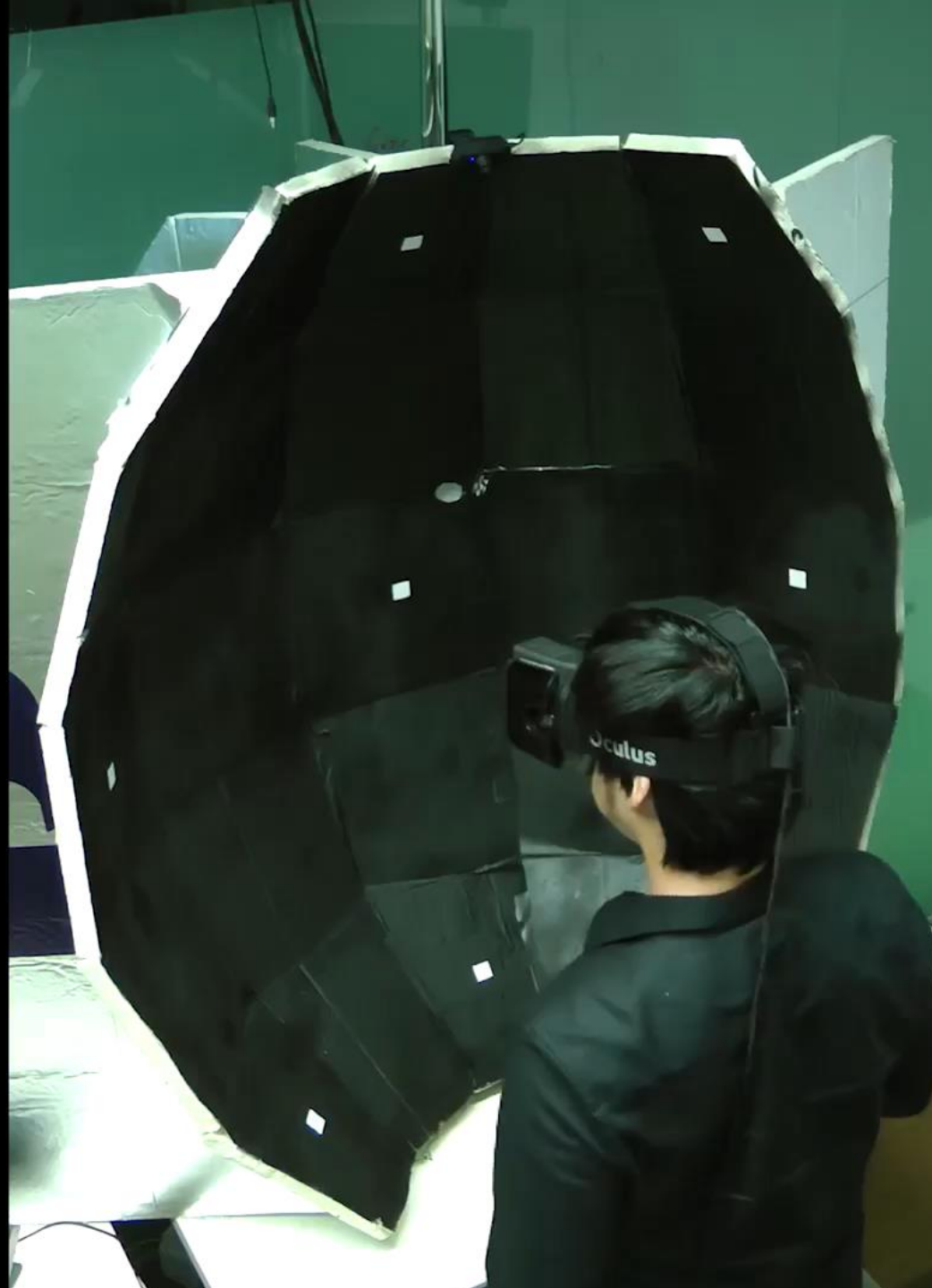
	p0	p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12	p13	p14	p15
a0	106	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
a1	0	108	0	0	0	0	0	0	0	0	0	0	0	0	0	0
a2	0	1	107	0	0	0	0	0	0	0	0	0	0	0	0	0
a3	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0	0
a4	0	0	0	0	108	0	0	0	0	0	0	0	0	0	0	0
a5	0	0	0	0	0	107	0	1	0	0	0	0	0	0	0	0
a6	0	0	0	0	0	0	107	0	0	0	0	1	0	0	0	0
a7	0	0	0	0	0	1	0	106	0	0	0	0	0	0	0	1
a8	0	0	0	0	1	0	0	1	104	1	0	0	1	0	0	0
a9	0	0	0	0	0	0	0	0	0	107	0	0	0	0	0	1
a10	0	0	0	0	0	0	0	0	0	0	108	0	0	0	0	0
a11	0	0	0	0	0	0	0	0	0	0	1	106	0	1	0	0
a12	0	0	0	0	1	0	1	0	5	3	0	0	95	1	1	1
a13	0	0	0	0	0	0	0	0	1	2	1	0	0	104	0	0
a14	0	0	0	1	0	0	0	0	0	1	1	0	0	1	104	0
a15	0	1	0	0	0	0	1	0	0	1	1	1	1	0	2	100

12 participants (7 female), ages 24-30 (M=27.6)

prediction accuracy: 97.5%, 2.04 seconds before touching

Sparse Haptic Proxy

Touch Feedback in Virtual Environments Using a General Passive Prop



Projected Augmented Reality: Holograms without Headsets


13.22 FPS
Perspective Rendering

RoomAlive Toolkit

- Interactive projection mapping
- Support for multiple Kinects + multiple projectors
- Robust calibration tool
- Projection mapping sample
- MIT license
- http://github.com/Kinect/RoomAliveToolkit

Projection Mapping

- What to render on the projector so that viewer has a desired perception?
  - Must account for irregularity of projection surface, pose of projector, viewer’s eye position


Edgar Mueller


Felice Varini

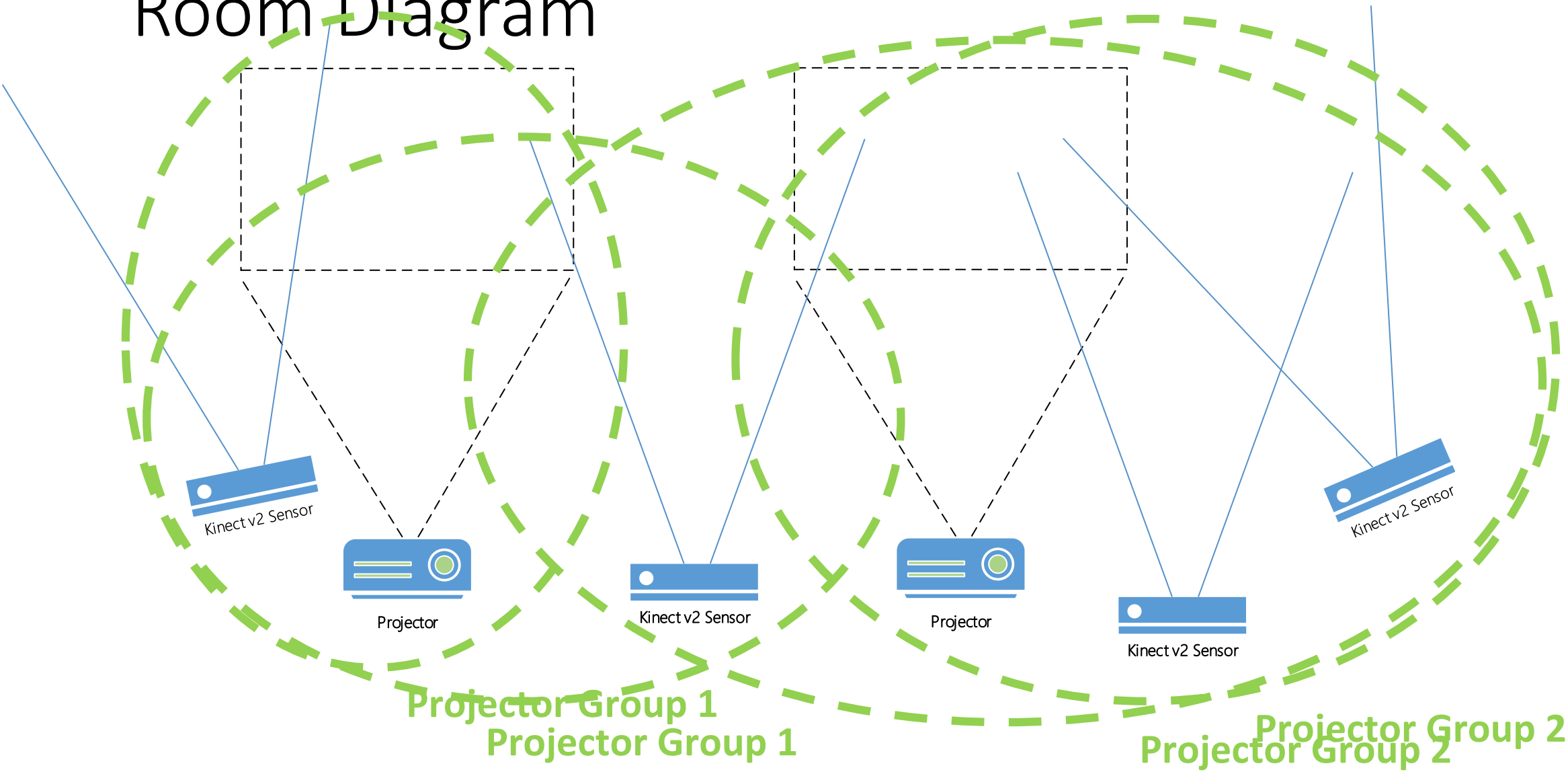

OUT

Calibration

- Finds the position and pose of *every* Kinect and projector along with focal length and lens distortion
- Projectors display Gray codes which are observed by all Kinect color cameras

Calibrating 3 Kinects and 3 projectors

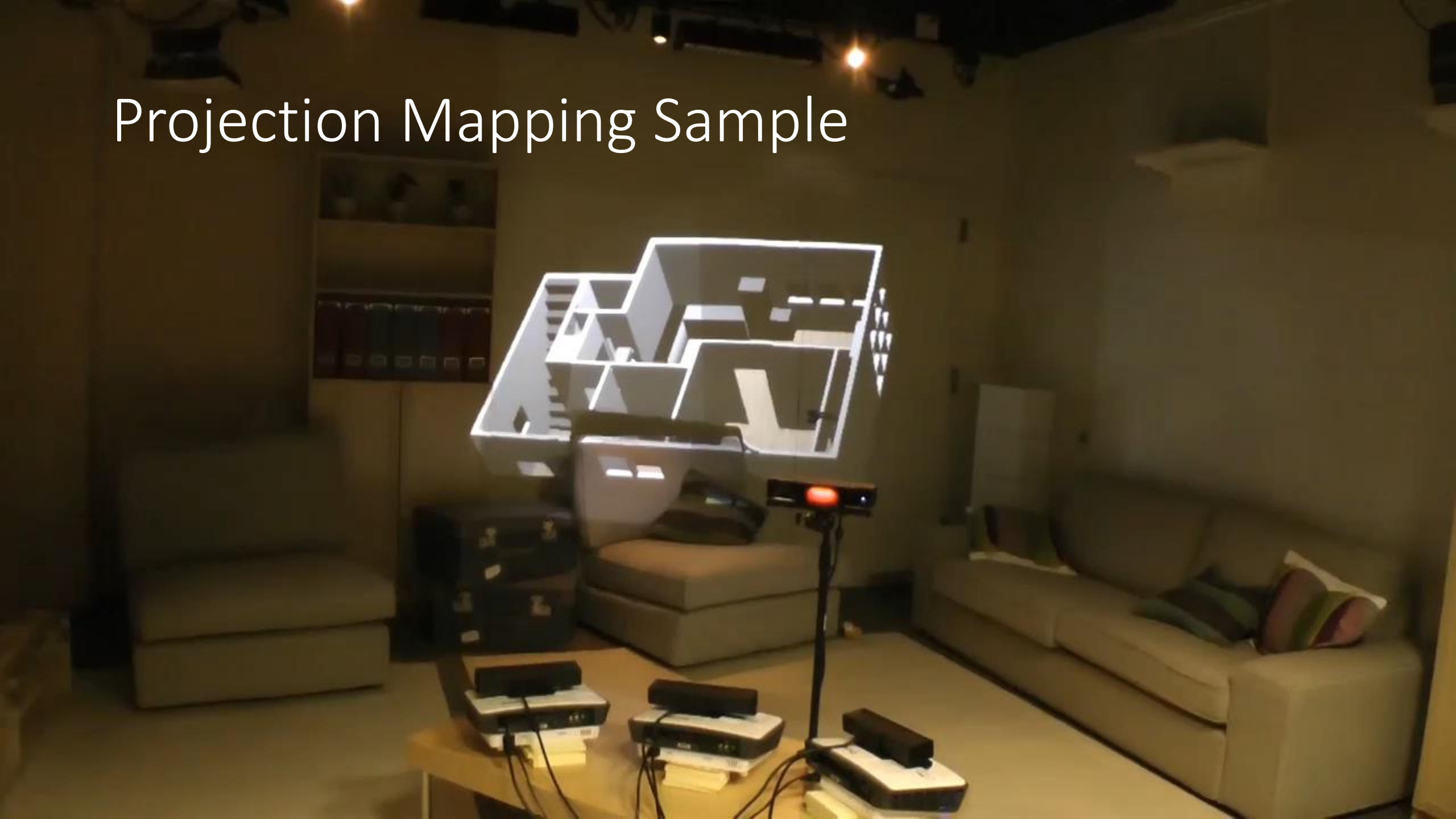
Room Diagram

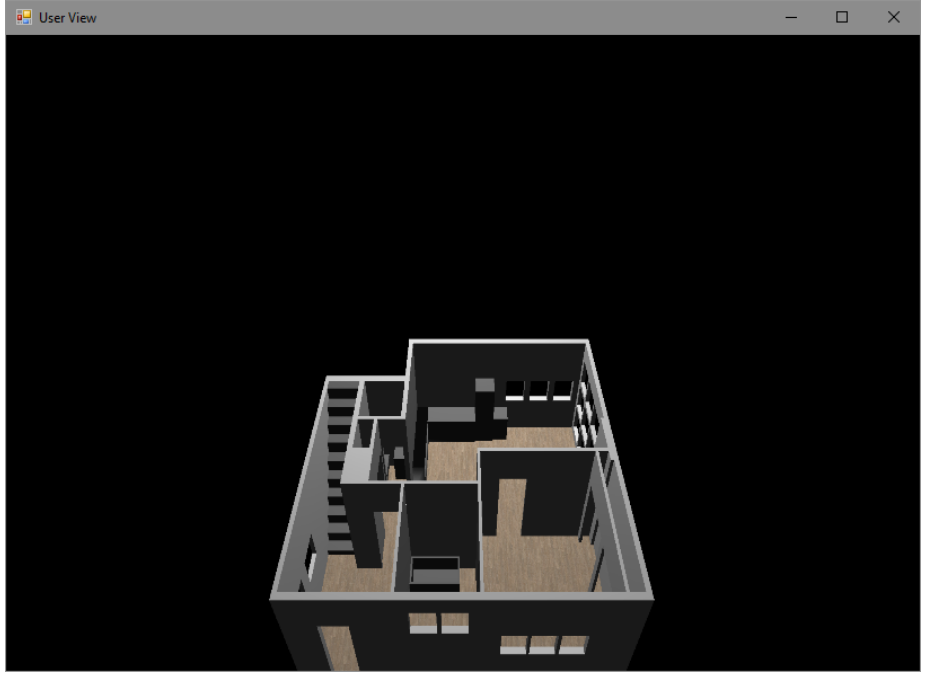


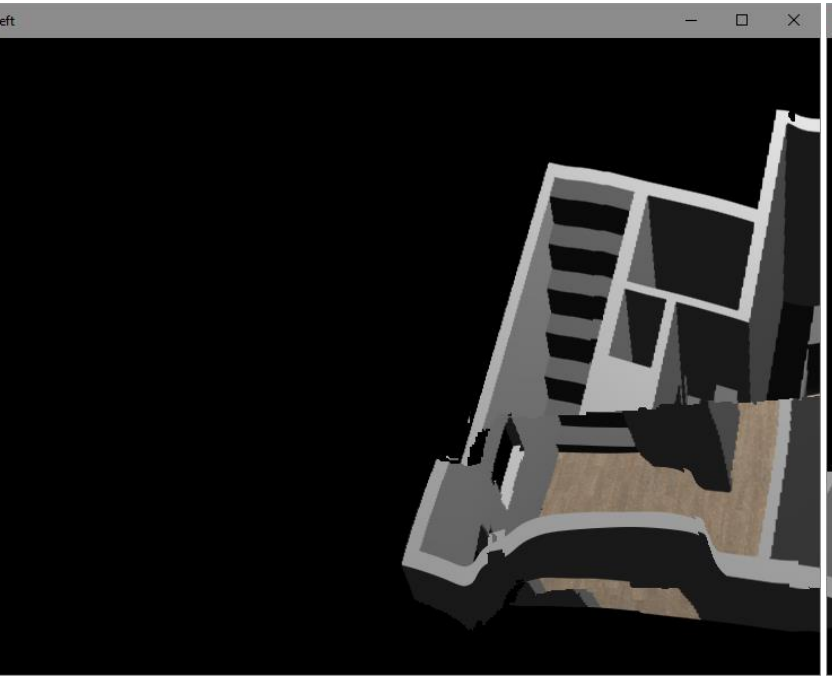
Projection Mapping (briefly)

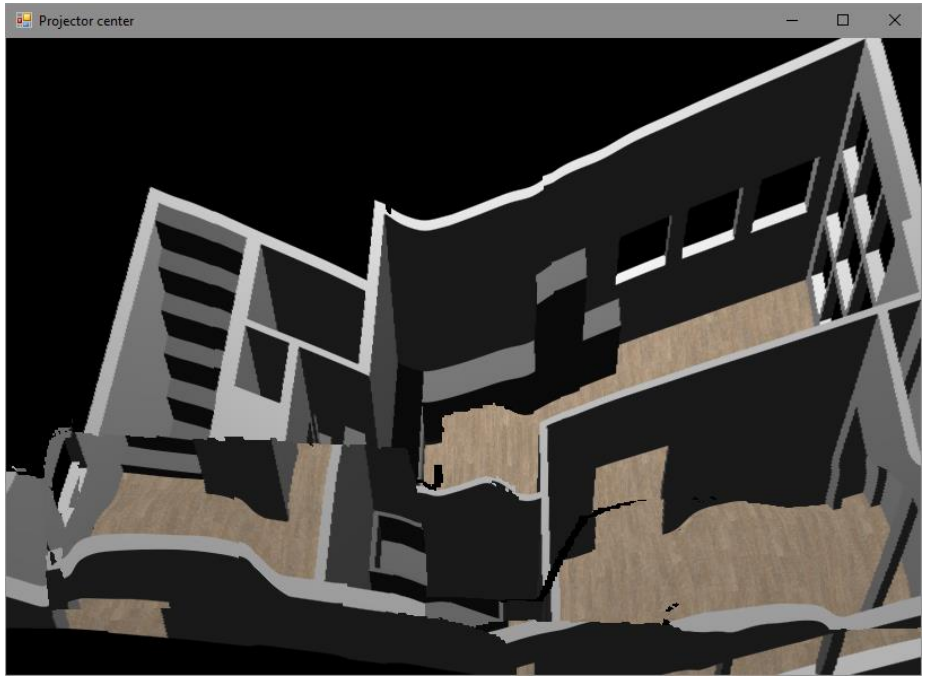
- A 'user view' off-screen render is performed.
- A graphics projection matrix is assembled for each projector in the ensemble.
- The projector's projection matrix is combined with calibrated projector and depth camera pose information
  - Create a transformation matrix mapping a 3D point in the coordinate frame of a given depth camera to a 3D point in the projector's view volume.

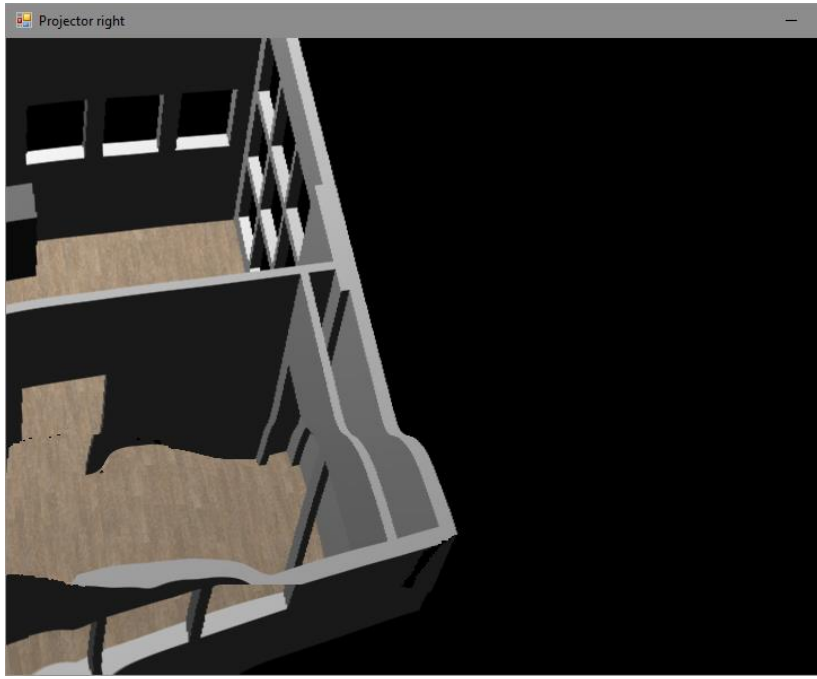
Projection Mapping Sample

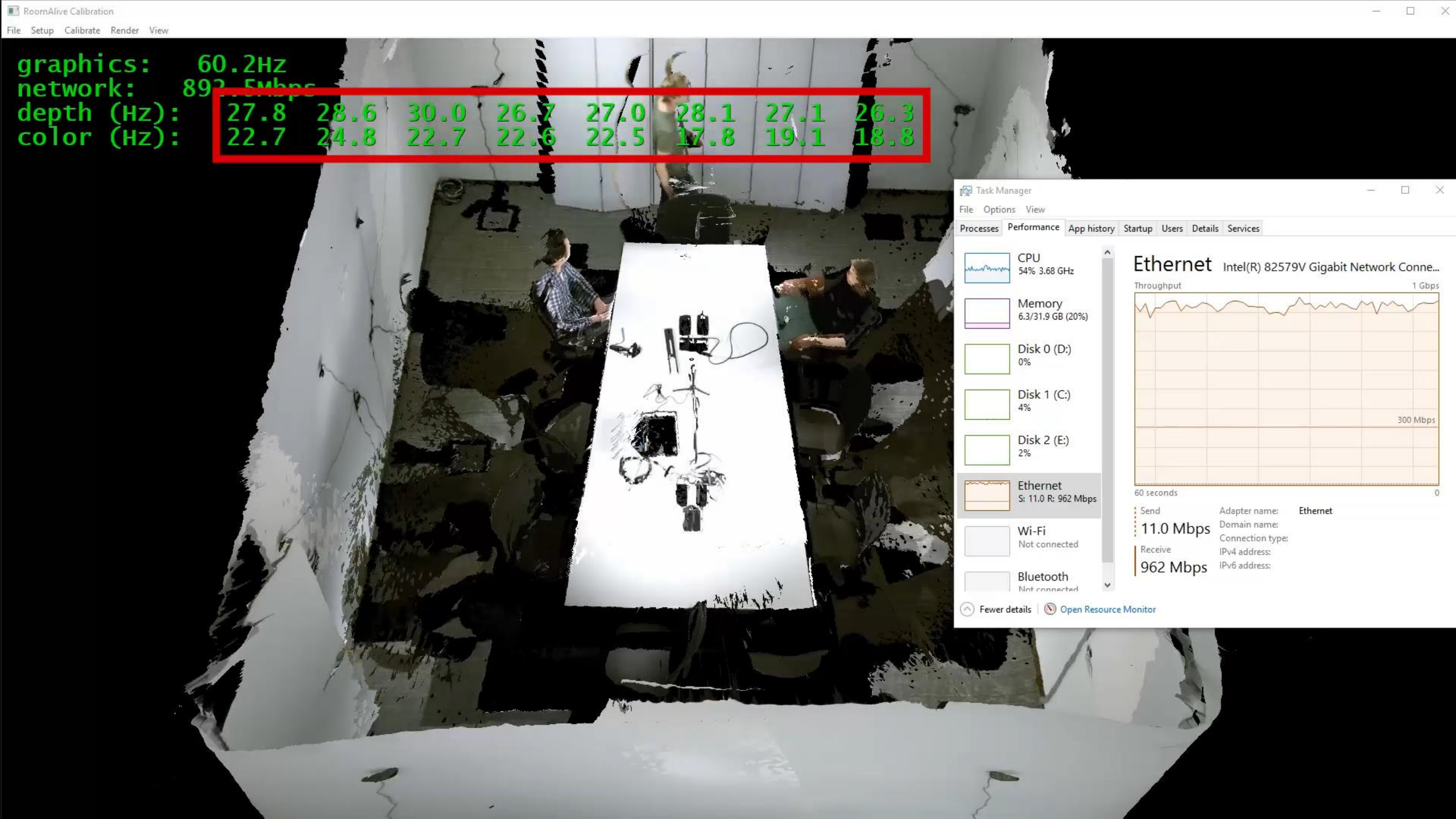



User View


eft

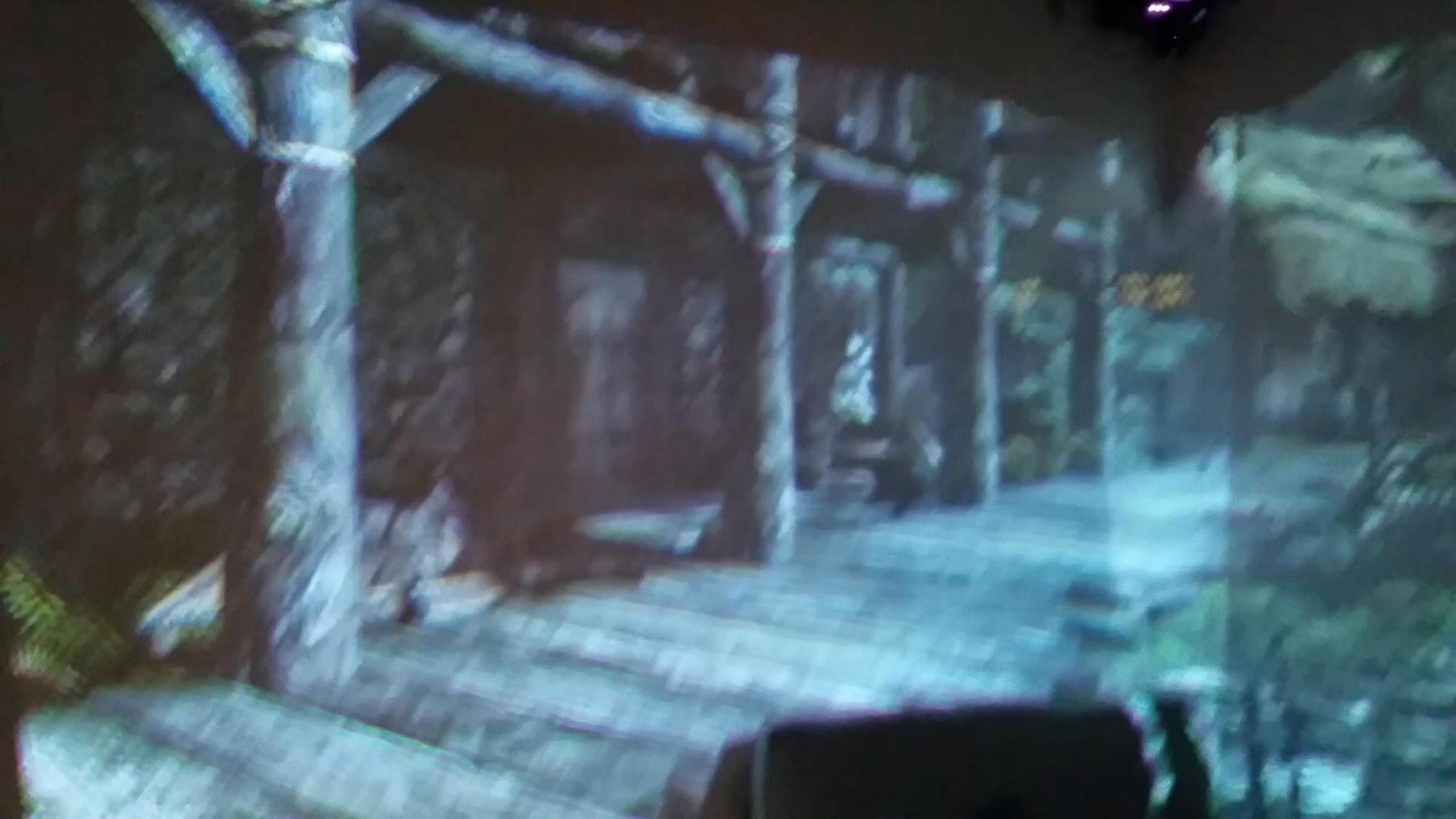

Projector center


Projector right


RoomAlive Calibration
File Setup Calibrate Render View
graphics: 60.2Hz
network: 892.5Mbps
depth (Hz): 27.8 28.6 30.0 26.7 27.0 28.1 27.1 26.3
color (Hz): 22.7 24.8 22.7 22.6 22.5 17.8 19.1 18.8
Task Manager
File Options View
Processes Performance App history Startup Users Details Services
CPU
54% 3.68 GHz
Memory
6.3/31.9 GB (20%)
Disk 0 (D:)
0%
Disk 1 (C:)
4%
Disk 2 (E:)
2%
Ethernet
S: 11.0 R: 962 Mbps
Wi-Fi
Not connected
Bluetooth
Not connected
Ethernet
Intel(R) 82579V Gigabit Network Conne...
Throughput
1 Gbps
300 Mbps
60 seconds
0
Send
11.0 Mbps
Receive
962 Mbps
Adapter name: Ethernet
Domain name:
Connection type:
IPv4 address:
IPv6 address:
Fewer details
Open Resource Monitor

RealityCheck

Combining VR and projected AR



RealityShader (RoomAlive 2.0)

Rewritten from the ground up

Support for Kinect, RealSense, Azure Kinect

Refactored to support a variety of game engines (Unity, Unreal, etc)

OpenVR support