VR Haptic Controllers

Multi-Purpose Handheld Haptics Beyond Vibro-Tactors

Hrvoje Benko

Currently @

Work conducted @

Visuals
Audio

Epic’s Robo Recall

Visuals
Audio

Haptics

Epic’s Robo Recall

VR Controllers – vibrotactile only

Oculus Touch

HTC Vive

Sony PSVR

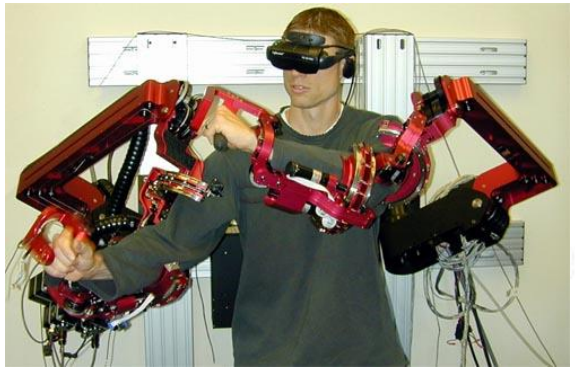
Two Realities of Haptics in VR Today

Mainstream Use

Vibrotactile only, low encumbrance

Research Use

High forces, high encumbrance

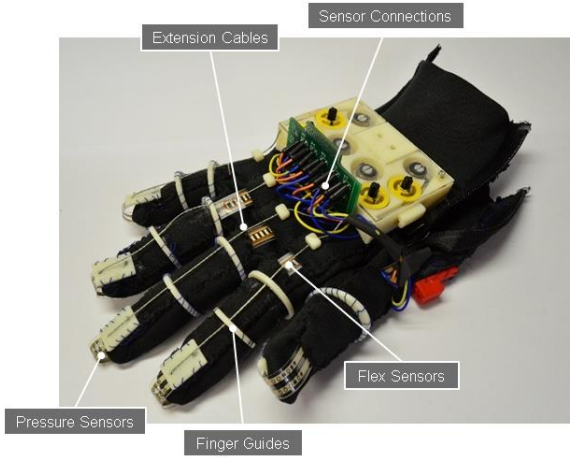


Actuated Gloves –
individual feedback to each finger/low comfort/low resolution

CyberTouch

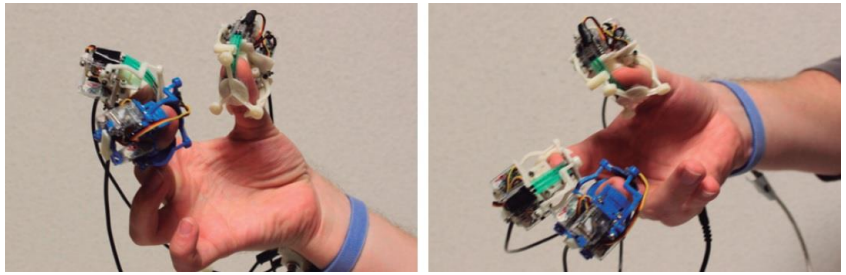
CyberGrasp - 1997

Rutgers Master II-ND - 2002



Delph et al. Soft Exo-Skeletal Arm - 2013

Dexmo Robotics - 2016

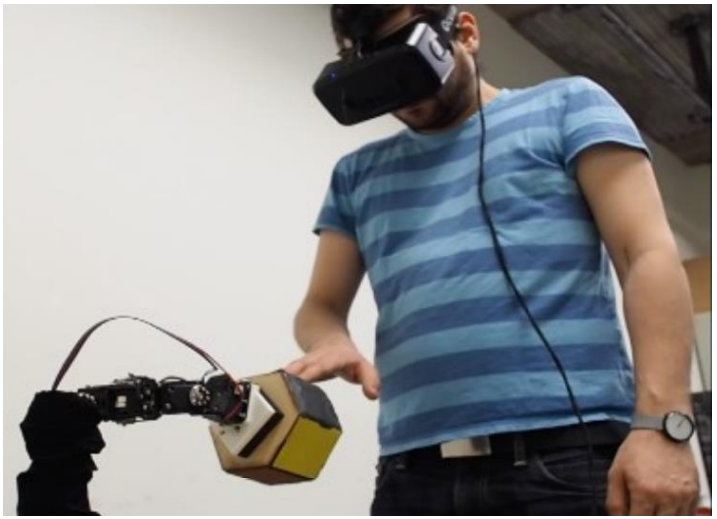


Perez et al. Haptics Symposium 2016

Haptic Robotic Arms – high force/restricted mobility/low resolution

SeansAble Phantom Omni

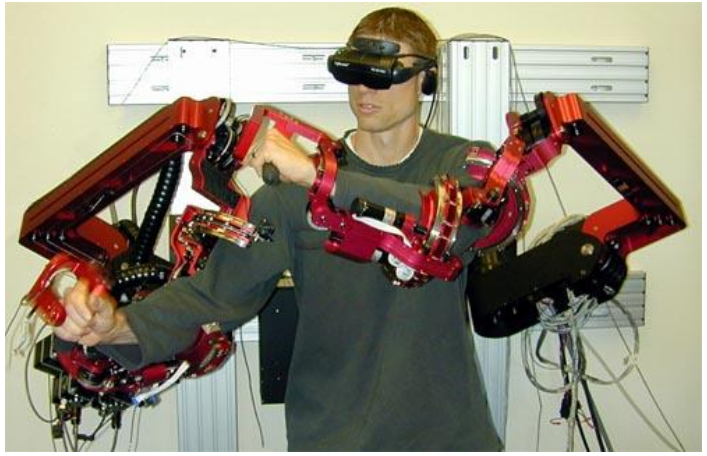
Van der Linde et al. HapticMaster 2002



Araujo et al. SnakeCharmer TEI 2016

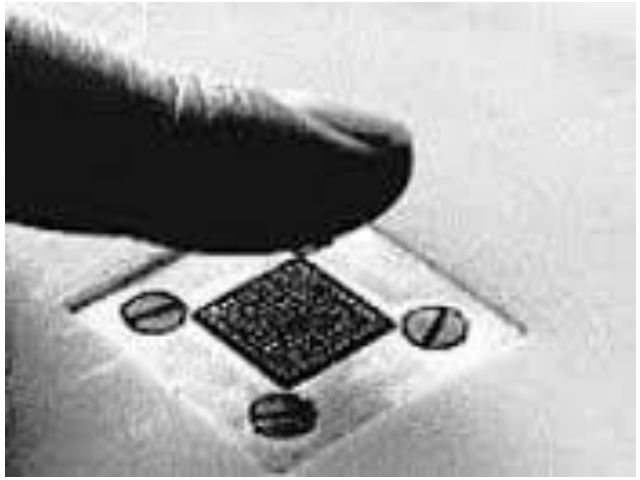
Novint Falcon

Haption Virtuose 6D

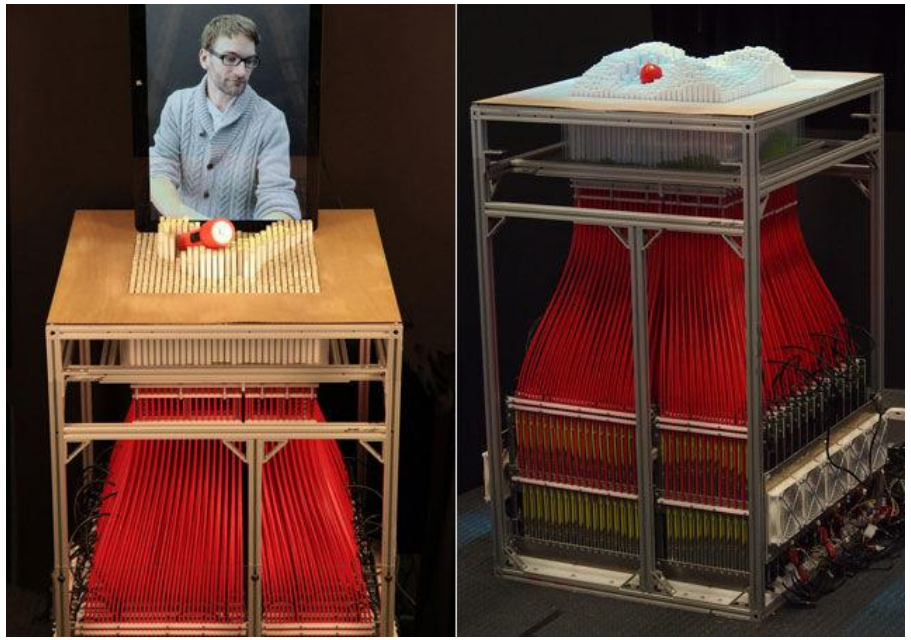


UCLA Bionics Lab

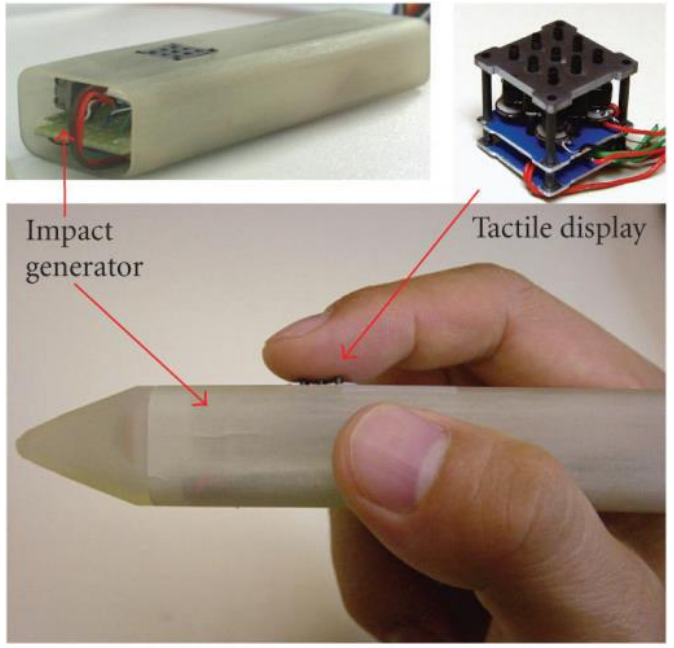
Tactile Arrays – higher resolution/stationary/2.5D at best



Summers et al. Exeter Touch Array. EuroHaptics 2001



Follmer et al. InFORM. UIST 2013



Kyung et al. Ubi-Pen IEEE CG&A 2009

Poupyrev et al. Lumen Siggraph Etech 2004

Why such discrepancy between haptic research and product?

None of the research prototypes have demonstrated significant utility without a significant drawback.

VR Controllers are:

- Easy to hold for a variety of people with different hand sizes.
- Easily acquired, dropped, and tracked.
- A platform for additional buttons and joysticks.
- In a tool form factor.

Tools:

Familiar objects

Amplify our abilities

Become extensions of our body

Tool-use induces morphological updating of the body schema

L Cardinali, F Frassinetti, C Brozzoli, C Urquizar, et. al. - Current Biology, 2009

An opportunity: VR Haptic Controllers

Extend the tool form factor of VR handheld controllers with higher fidelity haptics.

What kinds of VR Haptic Controllers do we need?

5 Ideas for VR Haptic Controllers Toolbox

#1

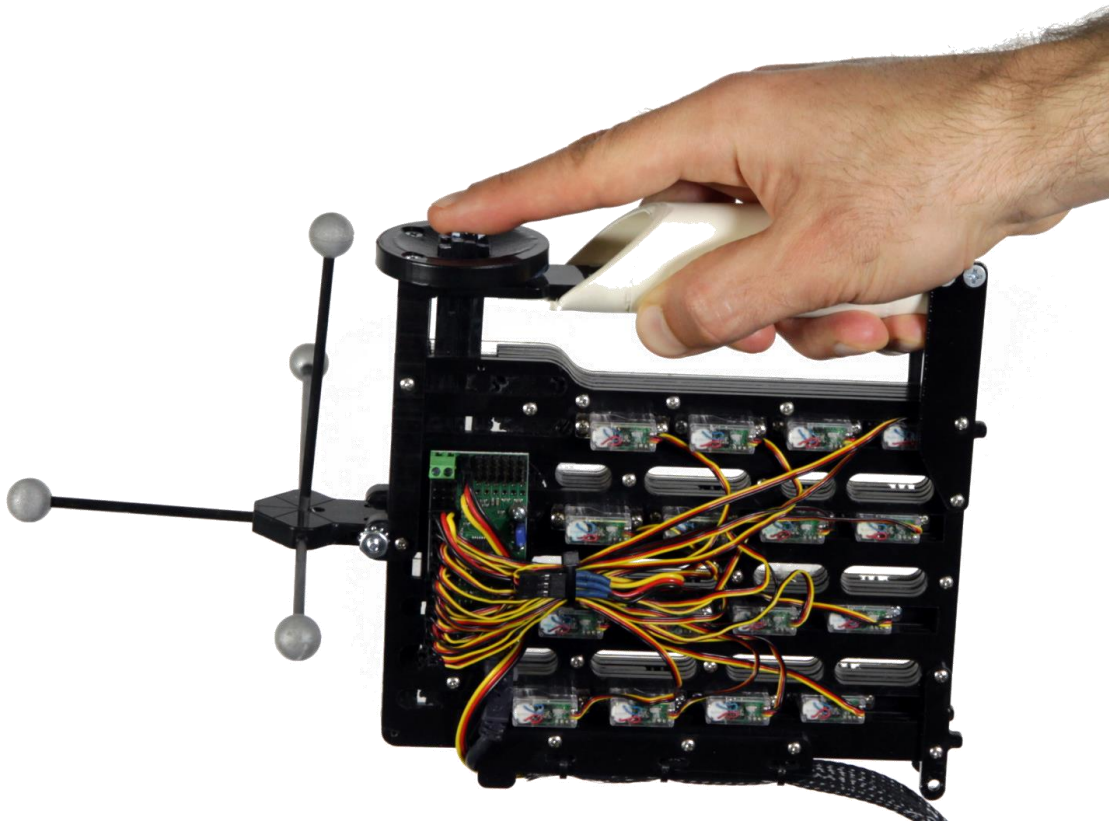
Ungrounded haptic devices
with *force feedback* rendering.

Reactive Grip by Tactical Haptics

W.R. Provancher, “Creating Greater VR Immersion by Emulating Force Feedback with Ungrounded Tactile Feedback,” IQT Quarterly 6(2), 2014, pp. 18-21.

NormalTouch and TextureTouch

3D shape output on the handheld controller form factor



Hrvoje Benko, Christian Holz, Mike Sinclair, and Eyal Ofek. (2016). NormalTouch and TextureTouch: High-fidelity 3D Haptic Shape Rendering on Handheld Virtual Reality Controllers. In *Proc. of ACM UIST 2016.*

NormalTouch and TextureTouch

High-fidelity 3D Haptic Shape Rendering on Handheld Virtual Reality Controllers

Hrvoje Benko, Christian Holz, Mike Sinclair, Eyal Ofek
Microsoft Research
2016

#2

Multi-purpose haptic devices that *adapt* to the user's context of use.

Goal

One VR Haptic Controller device that
integrates multiple haptic rendering capabilities and
adaptively selects which one to use
based on the user’s grip and the environmental context.

CLAW

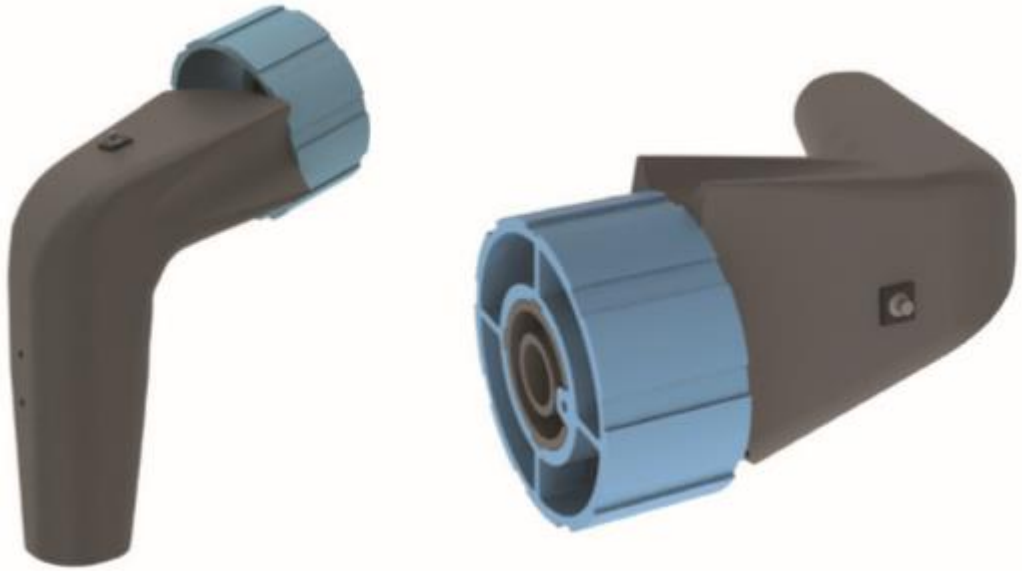
CLAW:
A Multifunctional Handheld Haptic Controller
for Grasping, Touching, and Triggering in Virtual Reality

Choi, I., Ofek, E., Benko, H., Sinclair, M. and Holz, C. CLAW: A Multifunctional Handheld Haptic Controller for Grasping, Touching, and Triggering in Virtual Reality. To appear in *Proc. of ACM CHI '18*.

#3

User-customizable
haptic devices.

Haptic Revolver



Whitmire, E., Benko, H., Holz, C., Ofek, E. and Sinclair, M. Haptic Revolver: Touch, Shear, Texture, and Shape Rendering on a Reconfigurable Virtual Reality Controller. To appear in *Proc. of ACM CHI '18*. Honorable mention.

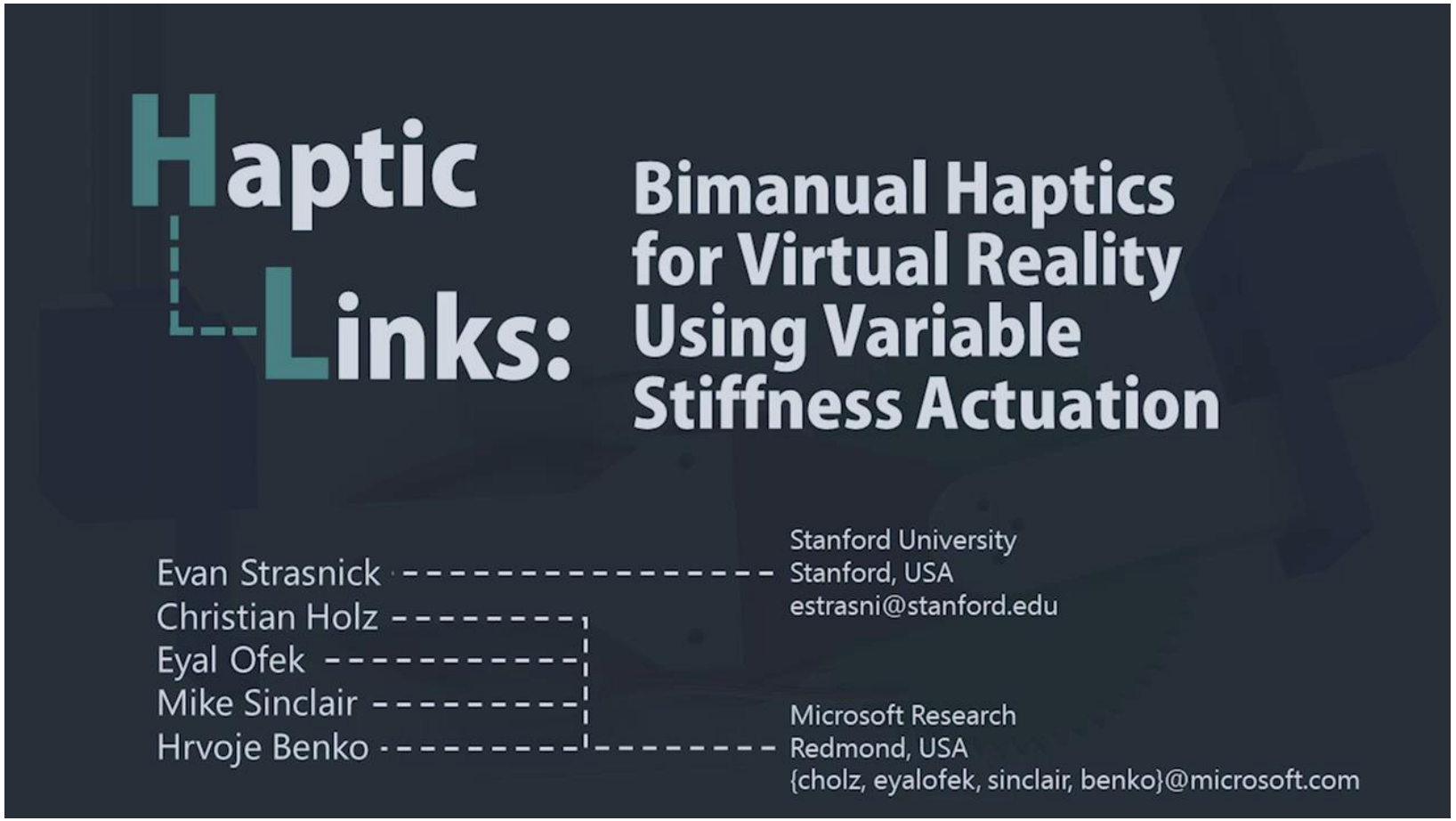
Haptic Revolver

Whitmire, E., Benko, H., Holz, C., Ofek, E. and Sinclair, M. Haptic Revolver: Touch, Shear, Texture, and Shape Rendering on a Reconfigurable Virtual Reality Controller. To appear in *Proc. of ACM CHI '18*. Honorable mention.

#4

Haptic rendering *between* devices.

Haptic Links

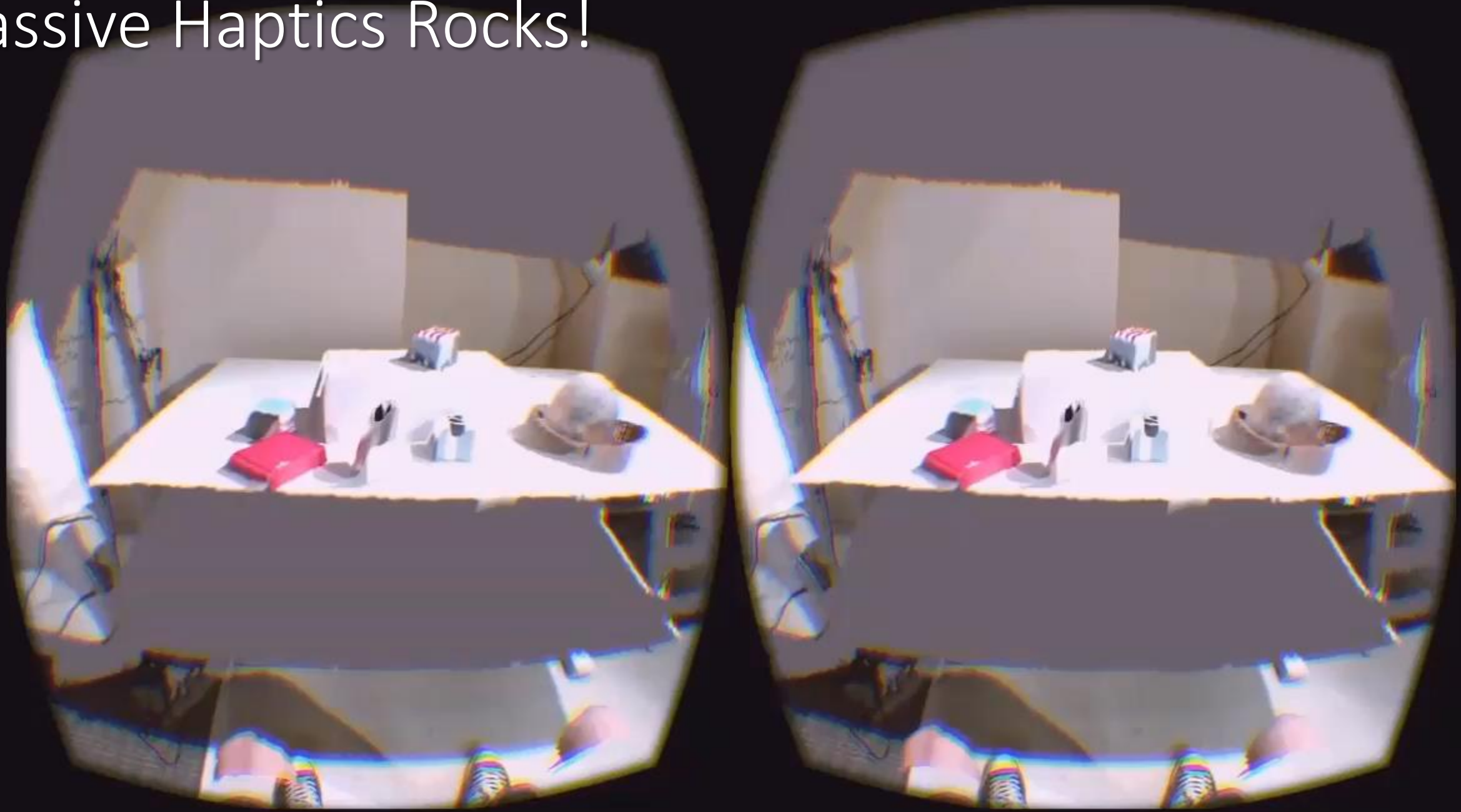


Strasnick, E., Holz, C., Ofek, E., Sinclair, M. and Benko, H. Haptic Links: Bimanual Haptics for Virtual Reality Using Variable Stiffness Actuation. To appear in *Proc. of ACM CHI '18.*

#5

Reuse existing objects as haptic tools.

Passive Haptics Rocks!



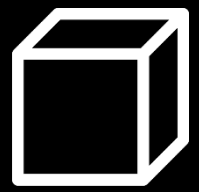
But, passive haptics approach doesn’t scale!

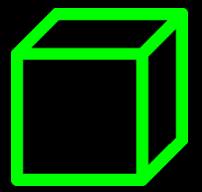
Haptic Retargeting

Azmandian, M., Hancock, M., Benko, H., Ofek, E., and Wilson, A. *Haptic Retargeting: Dynamic Repurposing of Passive Haptics for Enhanced Virtual Reality Experiences. In Proc. of* ACM CHI 2016.

Body Warping

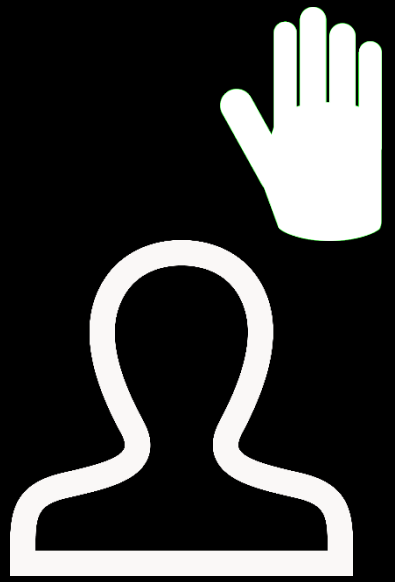
physical cube



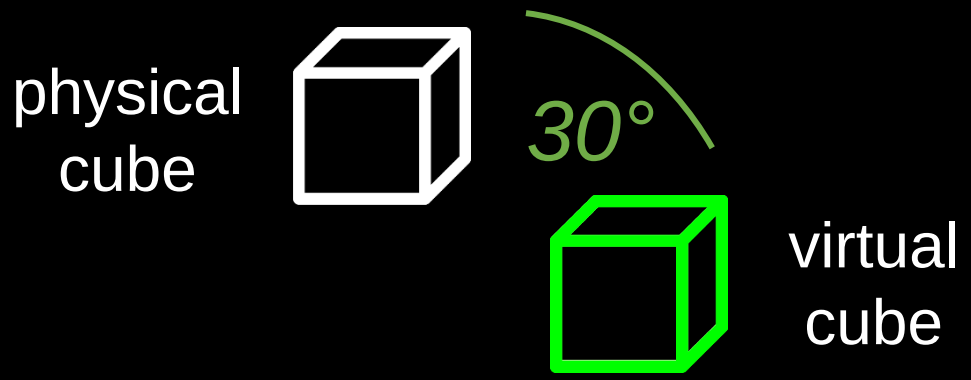


virtual cube

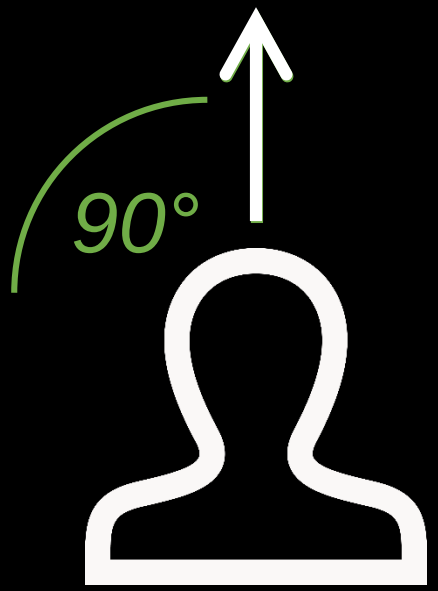
The Rendered Body Shifts to The Right



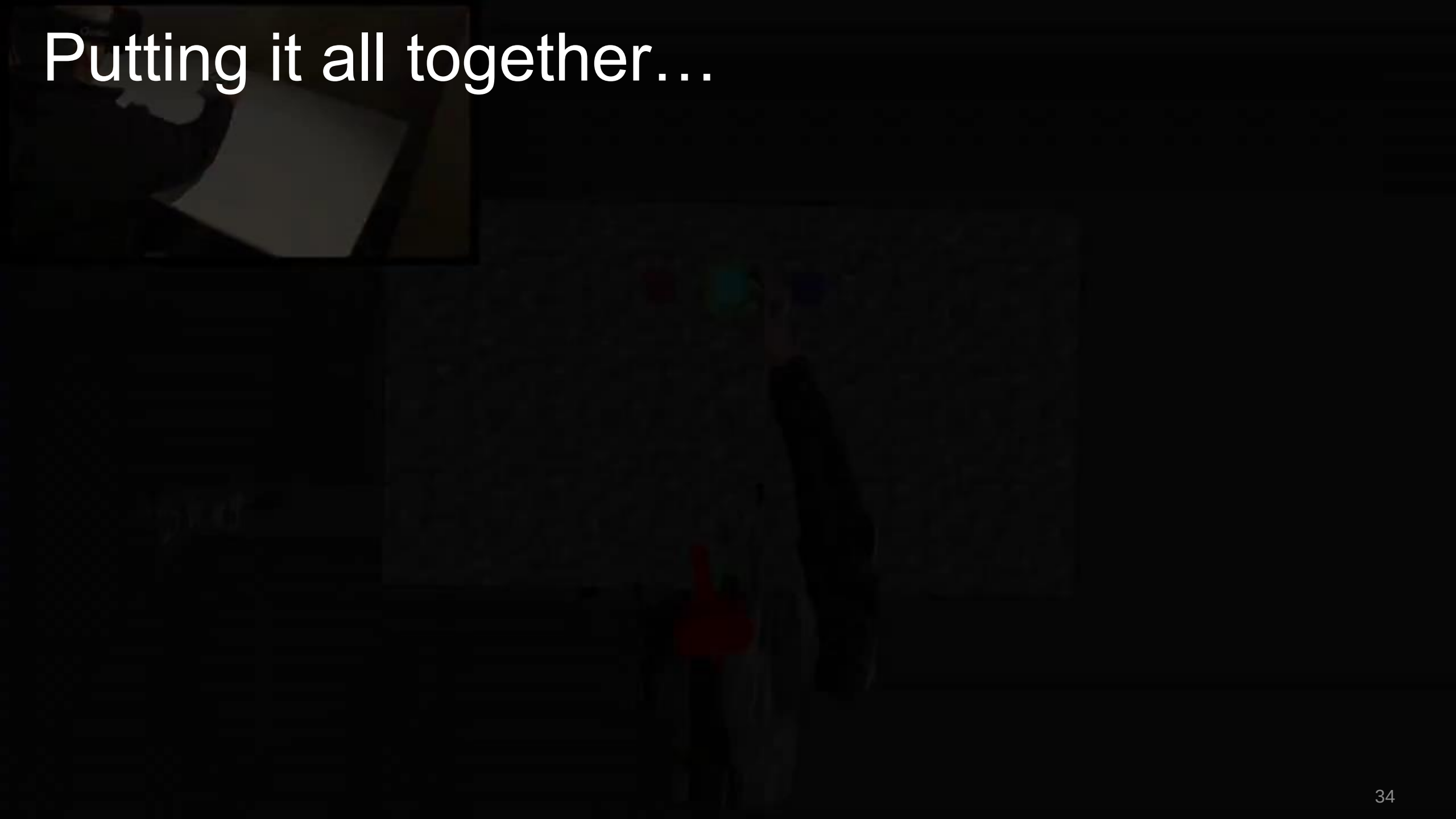
World Warping



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 single prop can be repurposed to allow movement and stacking of a virtual space with a multitude of virtual objects.

5 Ideas for VR Haptic Controller Toolbox

1. Provide *force feedback* rendering on *ungrounded* devices.
2. Design *multi-purpose* haptic devices that *adapt* to the context of use.
3. Design *user-customizable* haptic controllers.
4. Don’t ignore haptics *between* devices.
5. Enable *reuse* of existing objects as haptic tools.

Thanks to my collaborators

Andy Wilson (MSR)

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Inrak Choi (Stanford)

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