

# **IN4MATX 133: User Interface Software**

**Lecture 26:**  
**Designing for**  
**Augmented and Virtual Reality**

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# Class notes

- A3 grades released
  - We had trouble running a couple of submissions
  - We left a note saying to come to office hours so we can see your solution
- A4 grades “soon”
  - In the next few days, we hope
- Quiz 5 tomorrow
  - Covers Devices & Sensors (11/19) through today

# Class notes

- If you like today's topic, the Virtual Reality club has an end-of-quarter VRcade tonight
  - Can play games/projects they have been working on
  - 6:30-11pm, UCI Esports Arena
  - Apparently there's free pizza
  - <https://www.facebook.com/events/500853887089002/>
  - (The course staff is not sponsoring or condoning the event, but it seemed timely)

# Today's goals

By the end of today, you should be able to...

- Differentiate augmented and virtual reality
- Describe some of the history of augmented and virtual reality
- Explain key principles for designing a good augmented reality experience
- Describe novel areas of research within augmented and virtual reality

**What is augmented reality?**  
**What is virtual reality?**  
**How do they differ?**

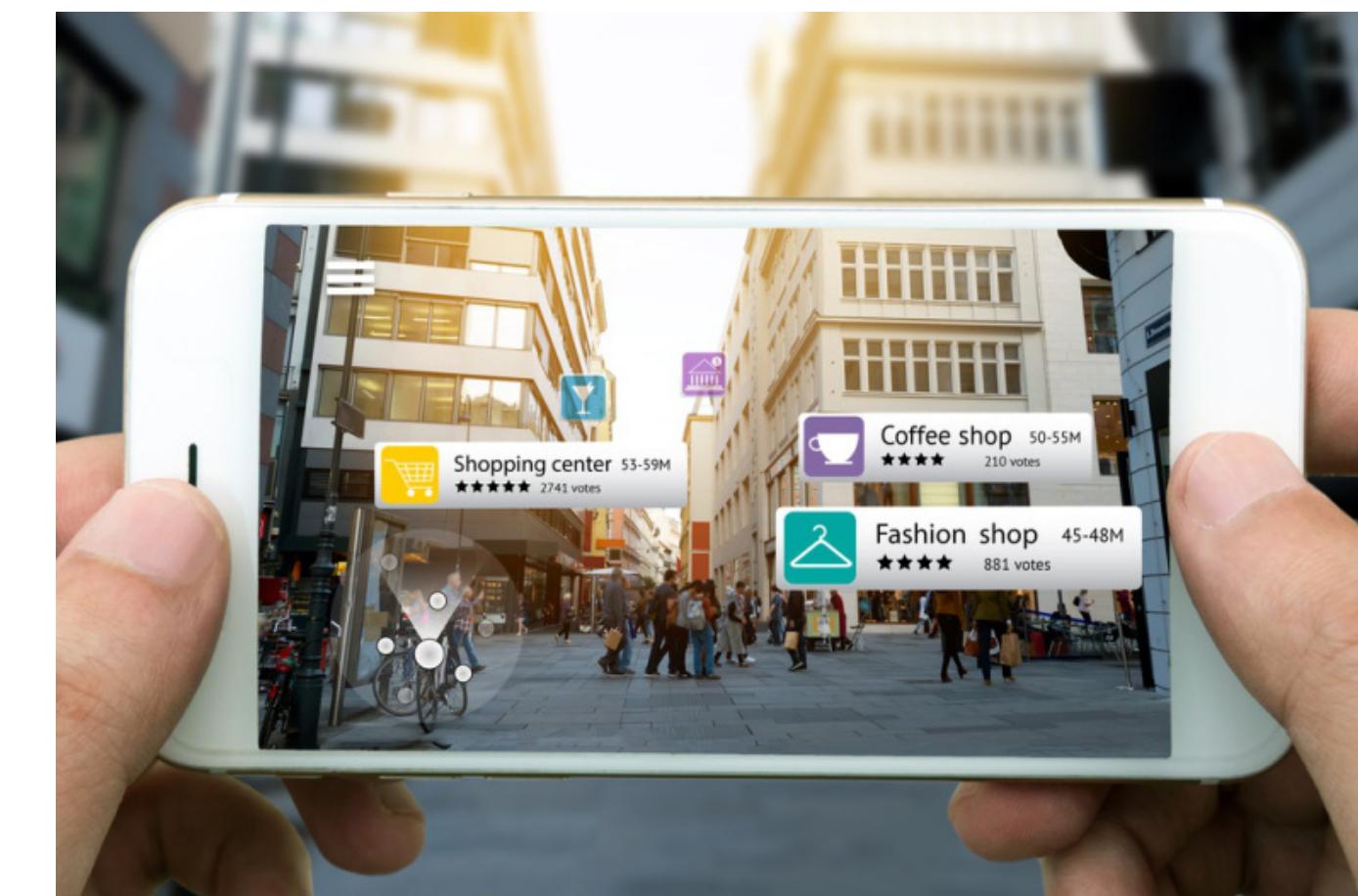
# Augmented reality vs. Virtual reality

- Virtual reality aims to transport a person to an entirely new place by blocking out the real world as much as possible
  - Ideally a full sensory experience



# Augmented reality vs. Virtual reality

- Augmented reality layers digital enhancements on top of a view of the real world
  - Digital content is interactive
  - Digital content is viewable in 3D (or projected 3D)



# Question

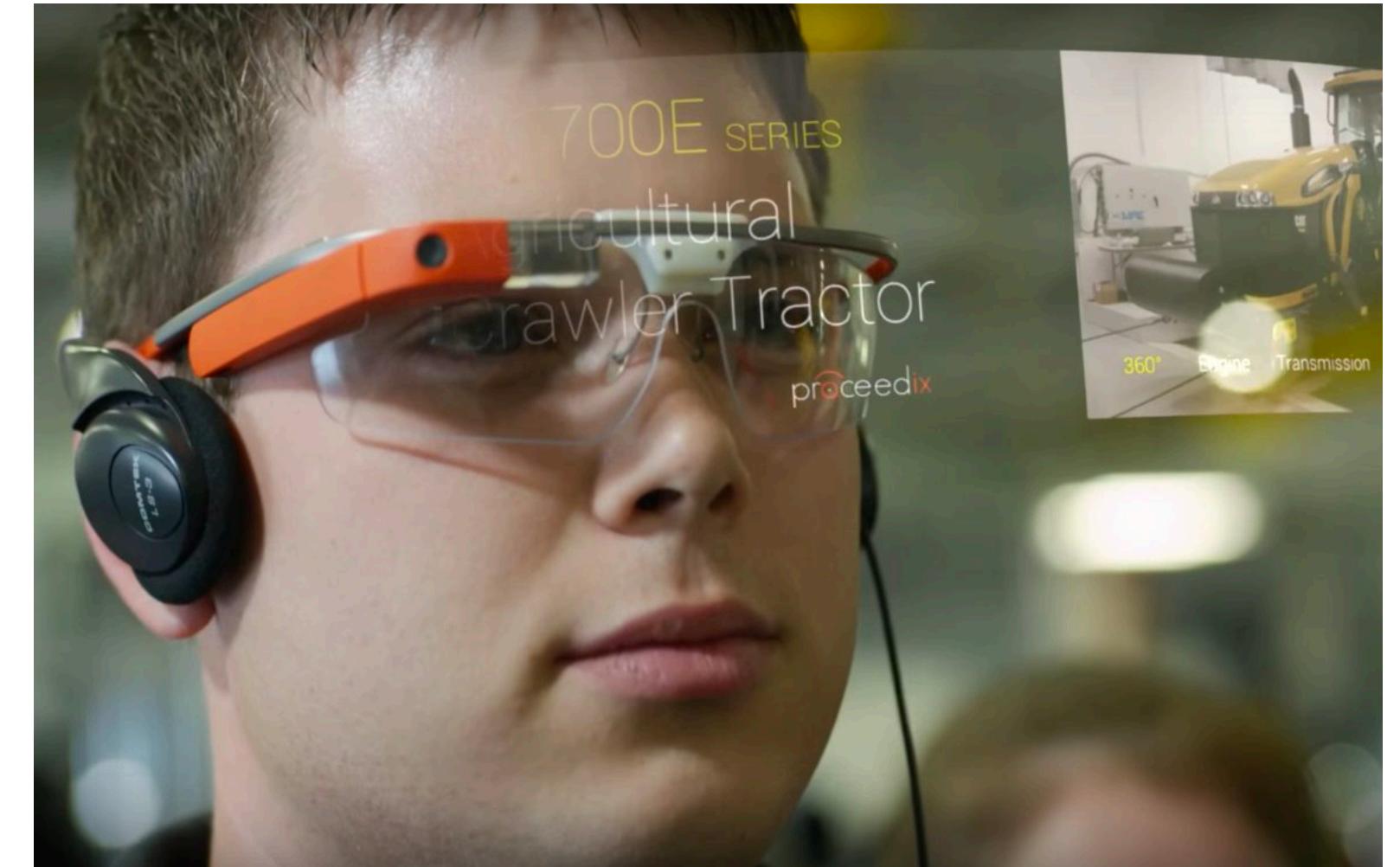


## Augmented or virtual reality?

- A Both are AR
- B Cardboard is AR, Glass is VR
- C Both are VR
- D Cardboard is VR, Glass is AR
- E Both are neither AR nor VR



Google Cardboard



Google Glass

# Mixed reality (hybrid reality)

- Physical objects in the real world can be interacted with in the digital world
  - Kind of a hybrid of AR and VR
- By comparison, VR seeks to immerse a person in a completely artificial environment
- While AR just overlays objects in the real world

# Virtual, Augmented, and Mixed reality

- Virtual reality
  - HTC Vive, Oculus rift
- Augmented reality
  - Apple ARKit, SnapChat lenses, Pokemon Go
- Mixed reality
  - Microsoft HoloLens

# **A very incomplete history of augmented and virtual reality**

# CAVE (1992)



<https://www.youtube.com/watch?v=-Sf6bJjwSCE>

Carolina Cruz-Neira, Daniel J. Sandin, Thomas A. DeFanti, Robert V. Kenyon, and John C. Hart.  
The CAVE: audio visual experience automatic virtual environment. *Communications of the ACM* 35, 6 (June 1992)

# CAVE (1992)

- Viewing headset  
(though it used projection walls)
- Sensors to detect a person's position and orientation in the space
- Audio feedback
- Motion controller



# CAVE (1992)

- Necessitated a specialized setup
  - Large room
  - Four projection walls
  - Expensive wearable displays
- Technology could never be adopted by consumers
  - Who has that kind of space to devote to VR, never mind money?



# Nintendo VirtualBoy (1995)

- VR Headset with a stand
- Not particularly immersive
- Commercial failure
  - Less than 1 million units sold
  - ~15 million Nintendo Switches sold per year



<https://www.youtube.com/watch?v=eYTHmzYNFq8>

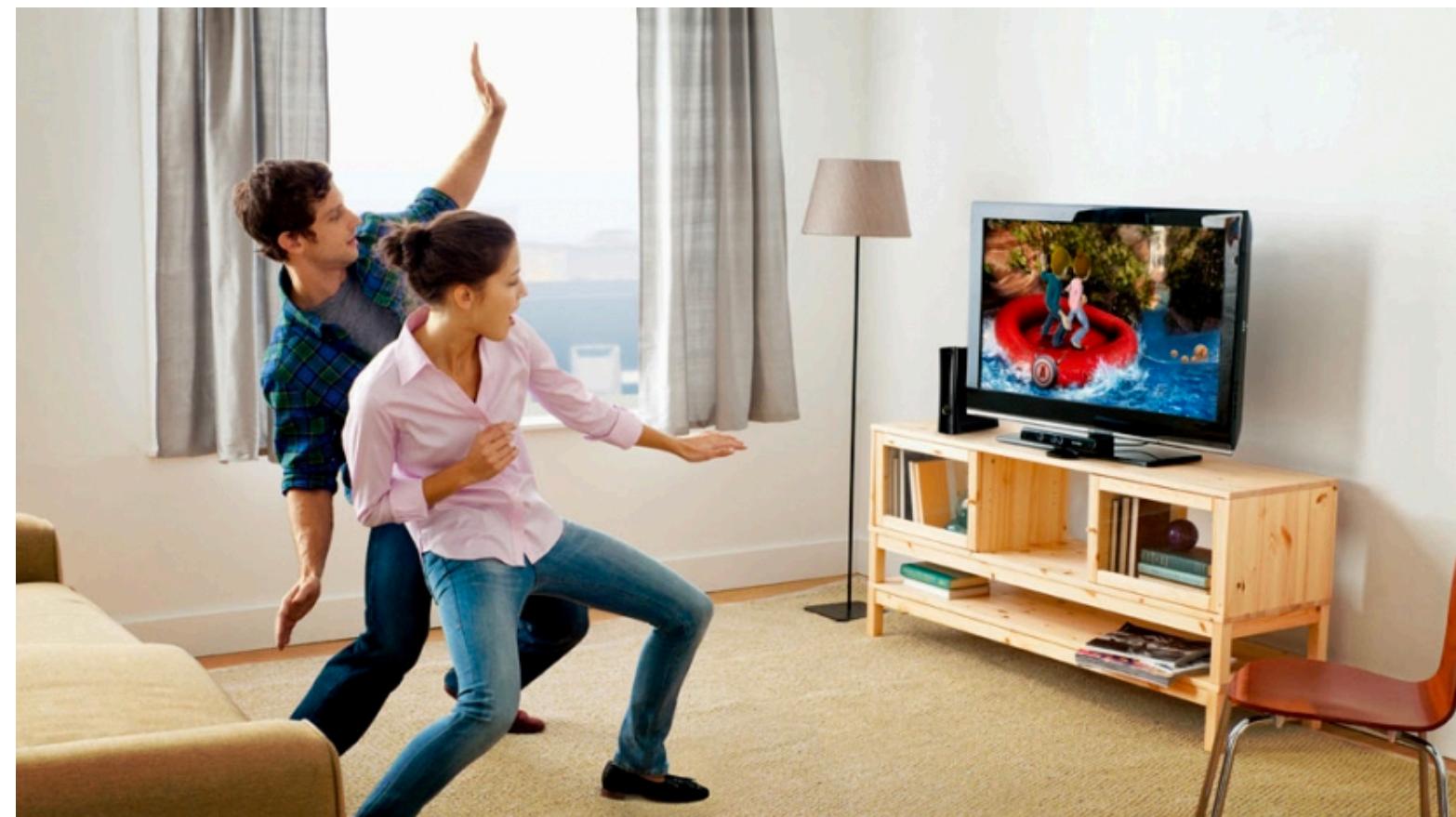
# Nintendo VirtualBoy (1995)



<https://www.youtube.com/watch?v=eYTHmzYNFq8>

# Nintendo Wii & Microsoft Kinect ('06 & '10)

- Immersive input controls
- Worked in a home environment
- Neither AR nor VR
- But demonstrated that some people were willing to set aside space for virtual experiences



# IllumiRoom (2013)



Brett R. Jones, Hrvoje Benko, Eyal Ofek, and Andrew D. Wilson.  
IllumiRoom: peripheral projected illusions for interactive experiences. *CHI* 2013.

# IllumiRoom (2013)

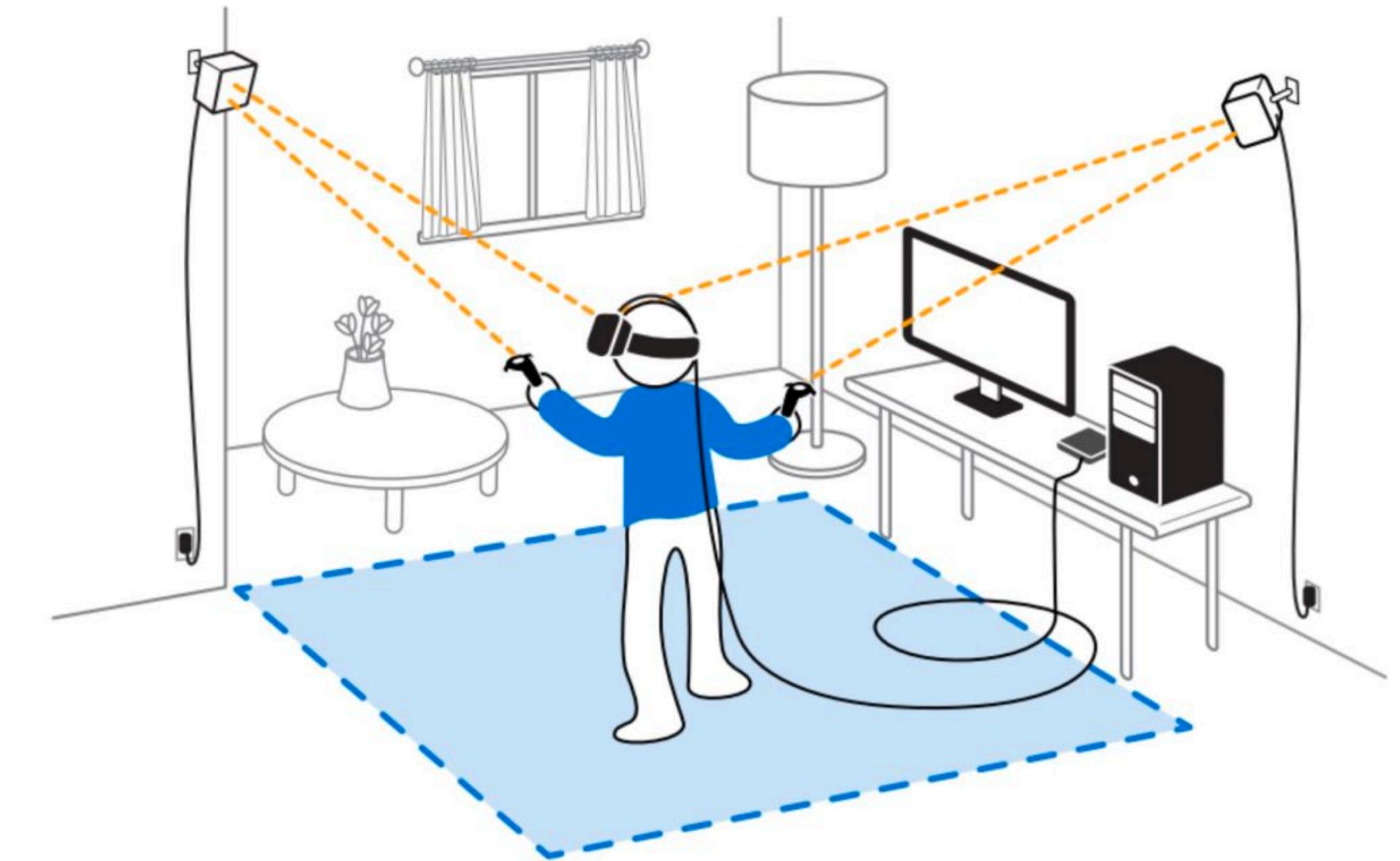
- Work within a room's constraints to create an immersive experience
- AR rather than VR
  - Layers on top of the physical world



Brett R. Jones, Hrvoje Benko, Eyal Ofek, and Andrew D. Wilson.  
IllumiRoom: peripheral projected illusions for interactive experiences. *CHI* 2013.

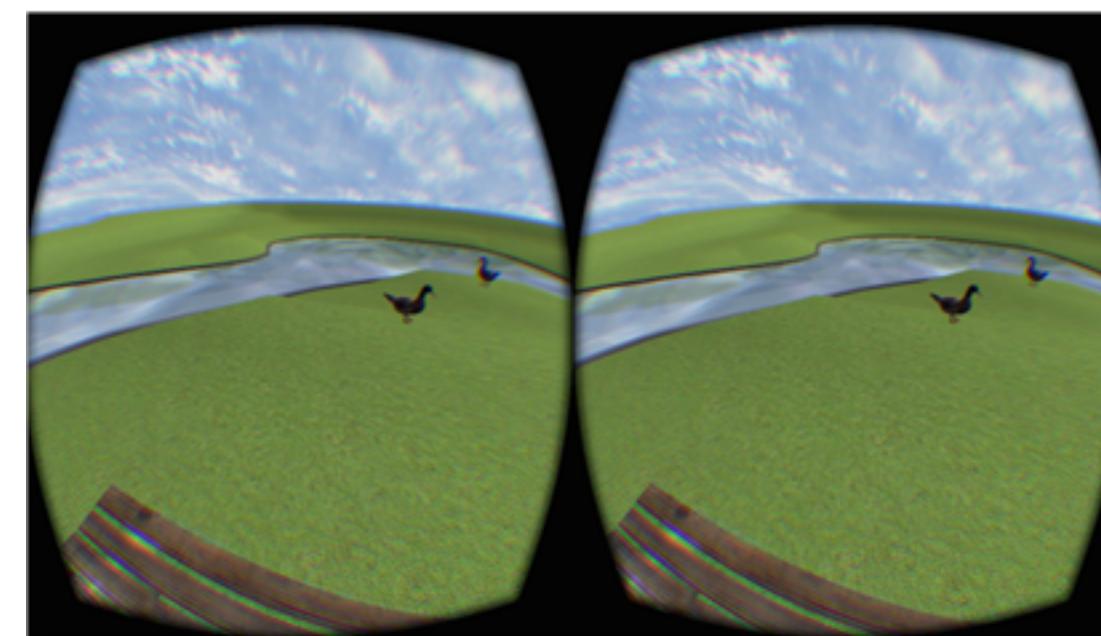
# Oculus Rift & HTC Vive (2016)

- Clear out a play space
- Position sensors around the environment
- Motion controls
- An overlay headset



# Google Cardboard (2014)

- The simplest possible version of VR
  - Explicitly *not* a fully immersive experience
- Uses a phone to generate a screen for each eye
- Uses accelerometer and gyroscope for positioning



# Microsoft HoloLens (2016)



# Microsoft HoloLens (2016)

- Mixed reality system
  - Like AR, adds layers to the real world
  - Some physical objects can be interacted with
- Focused on commercial uses
  - Pricing: \$3000/unit
  - Though there are other videos which demonstrate entertainment applications



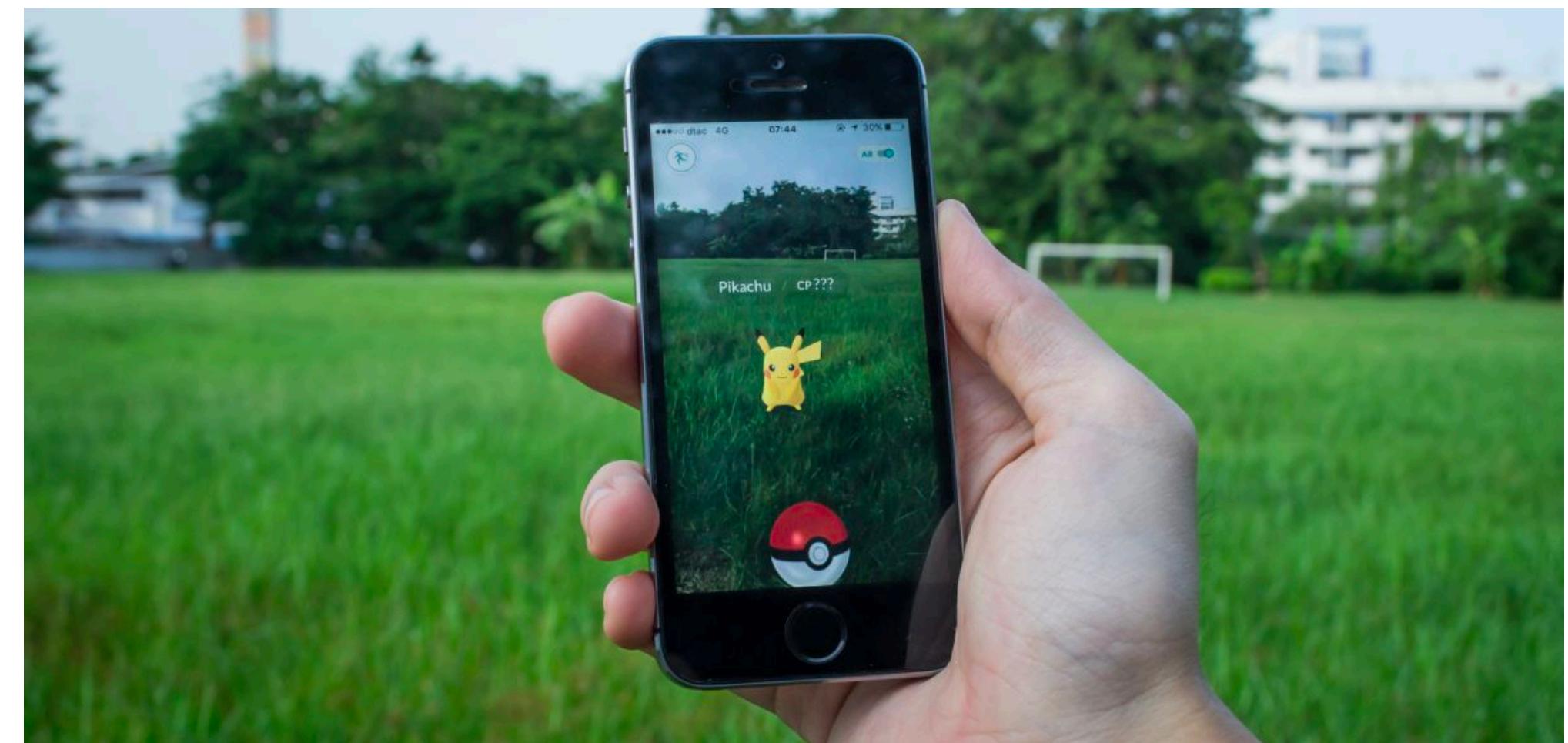
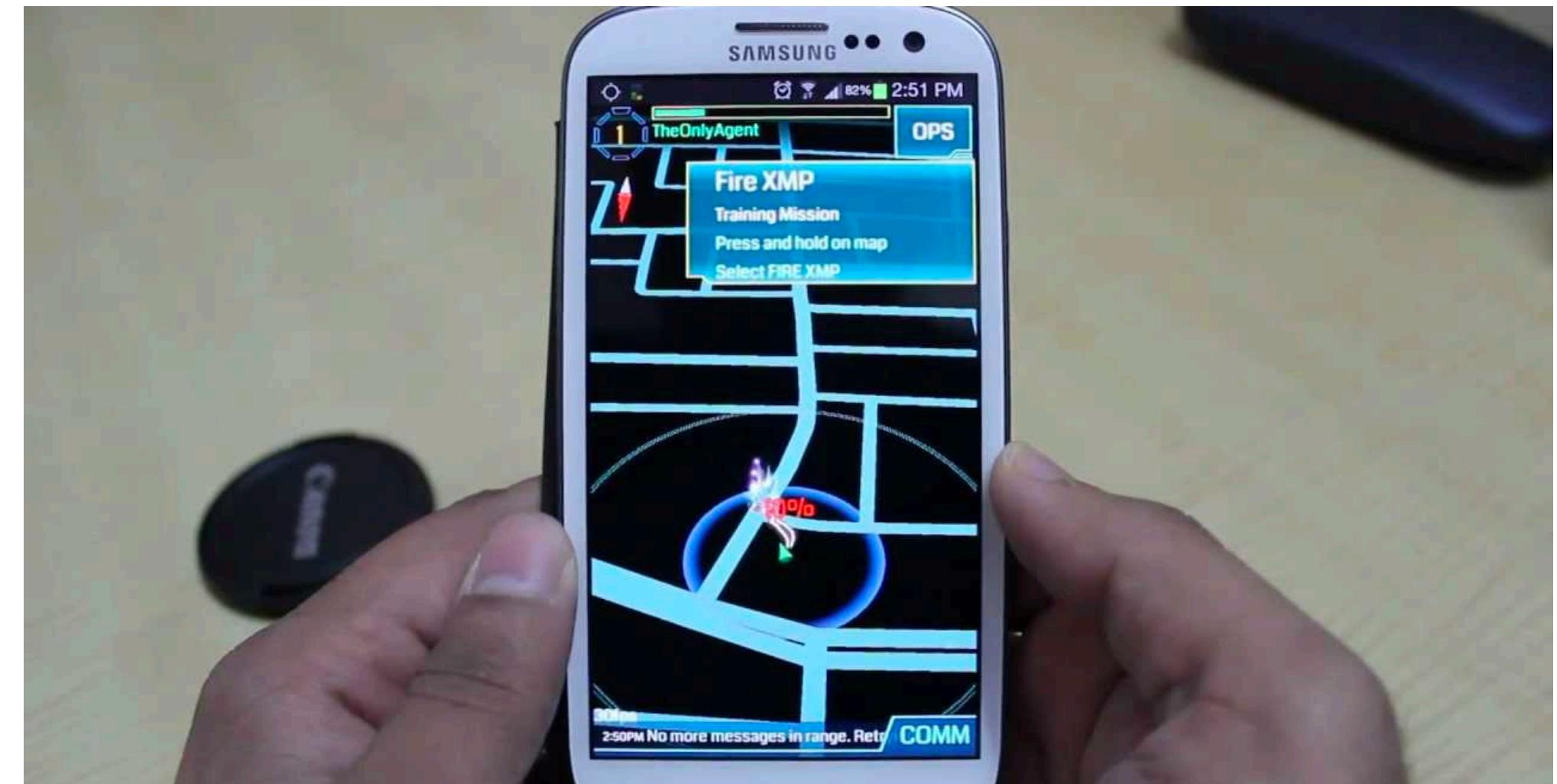
# Snapchat (2011)

- A key component is augmenting the environment in fun ways
  - Mostly known for facial filters (I think? You tell me)
- A “camera company”, not a “social media company”
  - Core product is currently the social network



# Ingress (2012) and Pokemon Go (2016)

- Popular games with millions of users (even today)
- AR aims to augment the real world
  - A layer over the camera is just one sense (vision)
  - Location-based PokeStops, Gyms, etc. add others
  - Location-based gameplay leads to social interactions between players



# VR applications

- Games
- Flight simulators
- Sophisticated testing (car prototypes, etc.)
- Training (military, medical, industry, etc.)
- Recreation (nature hikes, exploring)

# VR challenges remain consistent

- Creating a truly immersive experience is difficult
  - Need to replicate touch, sight, hearing... smell and taste?
- Most people do not have a physical space which can be taken over by a virtual environment
- Requires instrumenting the body, the environment, or both
  - Heavy, bulky, expensive, etc.
- Most practical uses are for enterprises rather than consumers

# AR and Mixed reality avoid some problems

- The experience does not need to be fully immersive
- The physical space is literally part of the environment, and maybe even part of the experience
- Halfway-decent AR is pretty cheap computationally
  - It can run on your phone!
  - Other sensors like Gyroscope, etc. add to the experience
- Low cost makes AR practical for entertainment, etc.
  - Mixed reality is still very expensive

# **Implementing Augmented and Virtual Reality**

# VR Implementation

- Many common 3D development environments can be used
  - VR changes the rendering and the input
- Unity VR (and AR)
  - <https://unity3d.com/learn/tutorials/s/xr>
- Unreal VR (and AR)
  - <https://www.unrealengine.com/en-US/vr>
- Google cardboard
  - <https://developers.google.com/vr/develop/unity/get-started-android>

# AR Implementation

## Hybrid Development

- React 360
  - <https://github.com/facebook/react-360>
- Argon JS
  - <https://github.com/argonjs/argon>
- AFrame
  - <https://aframe.io/>

# AR Implementation

## Native Development

- Google ARCore
  - <https://developers.google.com/ar/>
- Apple ARKit
  - <https://developer.apple.com/arkit/>

# **A few AR design recommendations**

# Label surfaces during set-up phase

- Highlight surfaces where objects can be placed
  - No visual cues can create confusion when a person goes to place an object
- Differentiate multiple surfaces
  - Update surfaces as a person moves their phone around



<https://designguidelines.withgoogle.com/ar-design/>

# Provide guidance on interactions

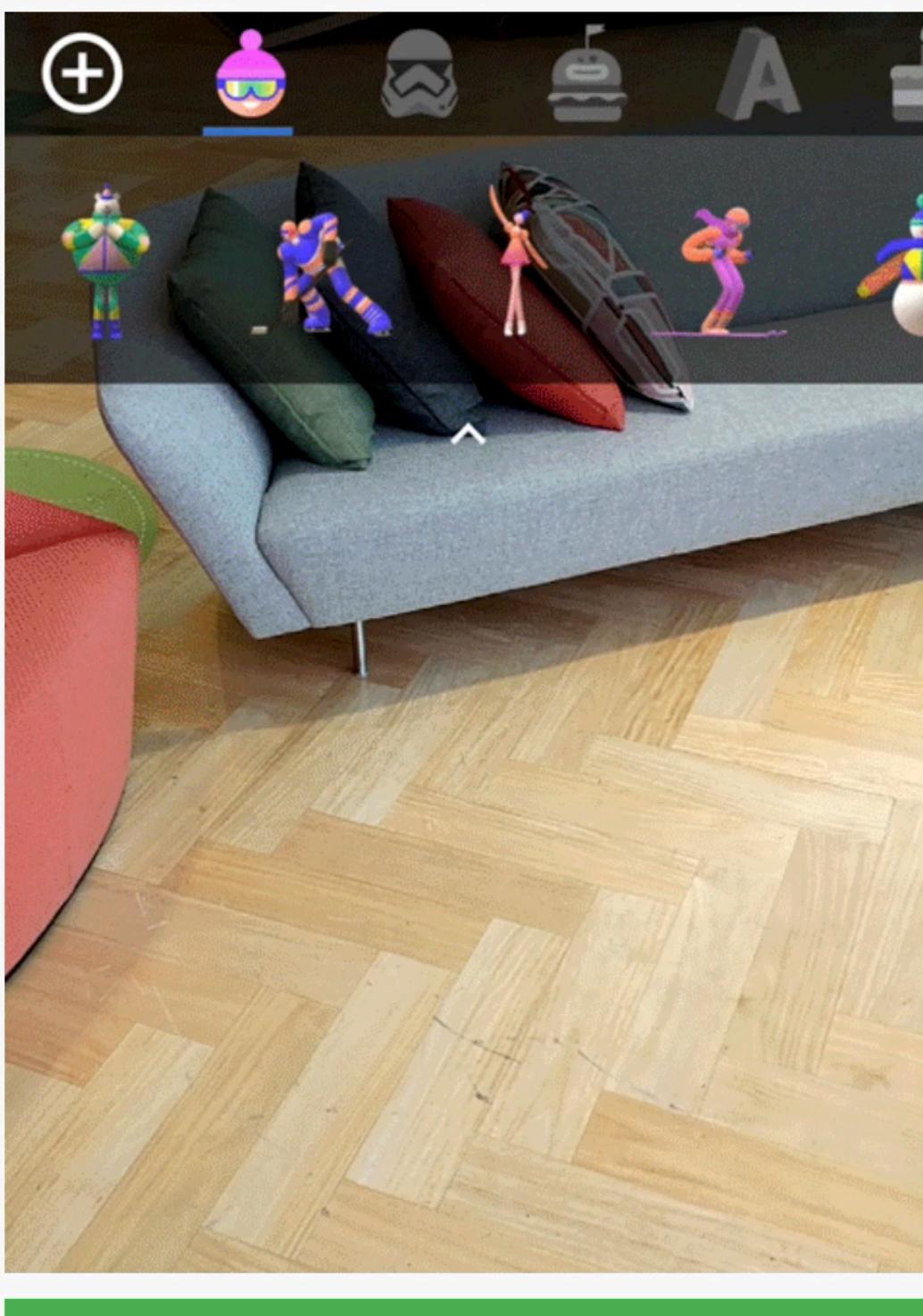
- There gestures and interactions in AR are not standardized
  - Standards will come as the platform matures
- Use a combination of visual cues and text explanations to guide interactions
  - Dismiss hints when they have been performed successfully



<https://designguidelines.withgoogle.com/ar-design/>

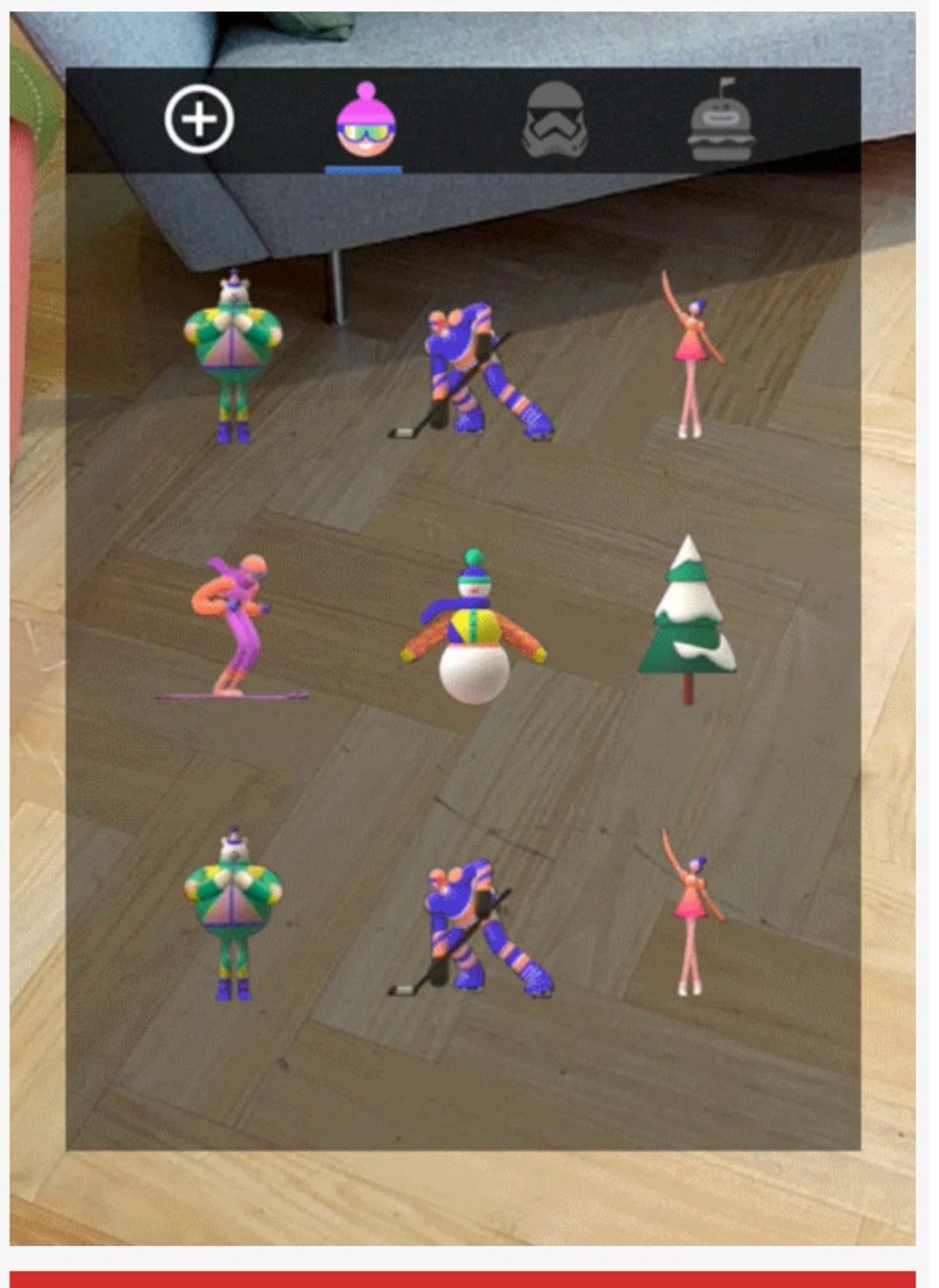
# Keep users in the scene

- Avoid menus, etc. which take over the screen
  - Pulls people out of the AR experience
- Use concise menus which keep the screen visible
- Alternatively, place controls in the scene itself
  - e.g., physical buttons in the environment



Do.

Use a simple docked menu to avoid distraction



Don't.

Don't force the user to keep switching between scene and screen

# Anticipate space limitations

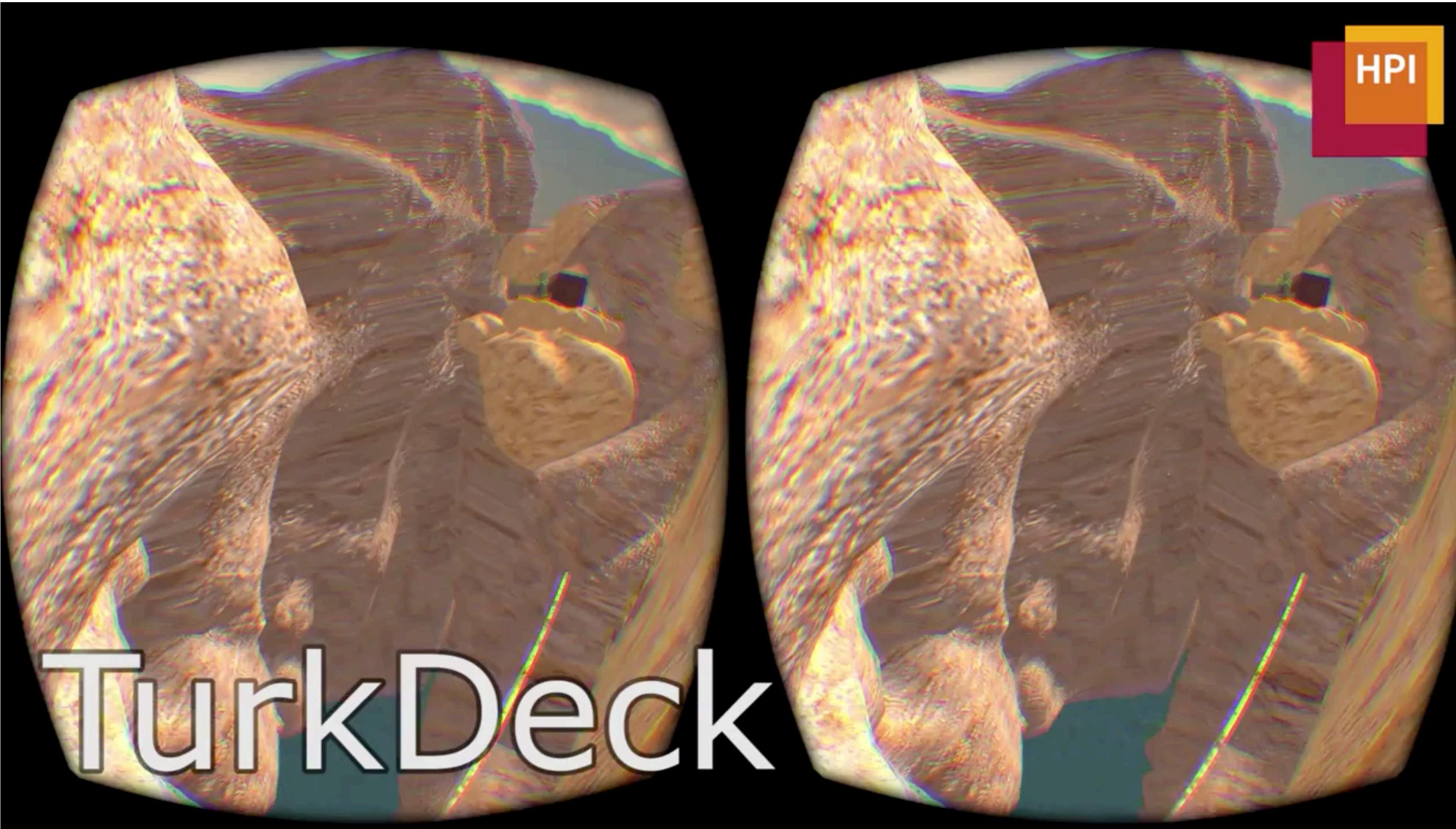
- Do not require a user to walk backward or make quick sweeping motions
- Give a clear idea of the amount of space needed for an interaction
- Avoid putting large objects close to the user on the screen
  - They will instinctively back up



<https://designguidelines.withgoogle.com/ar-design/>

# **Research in AR and VR**

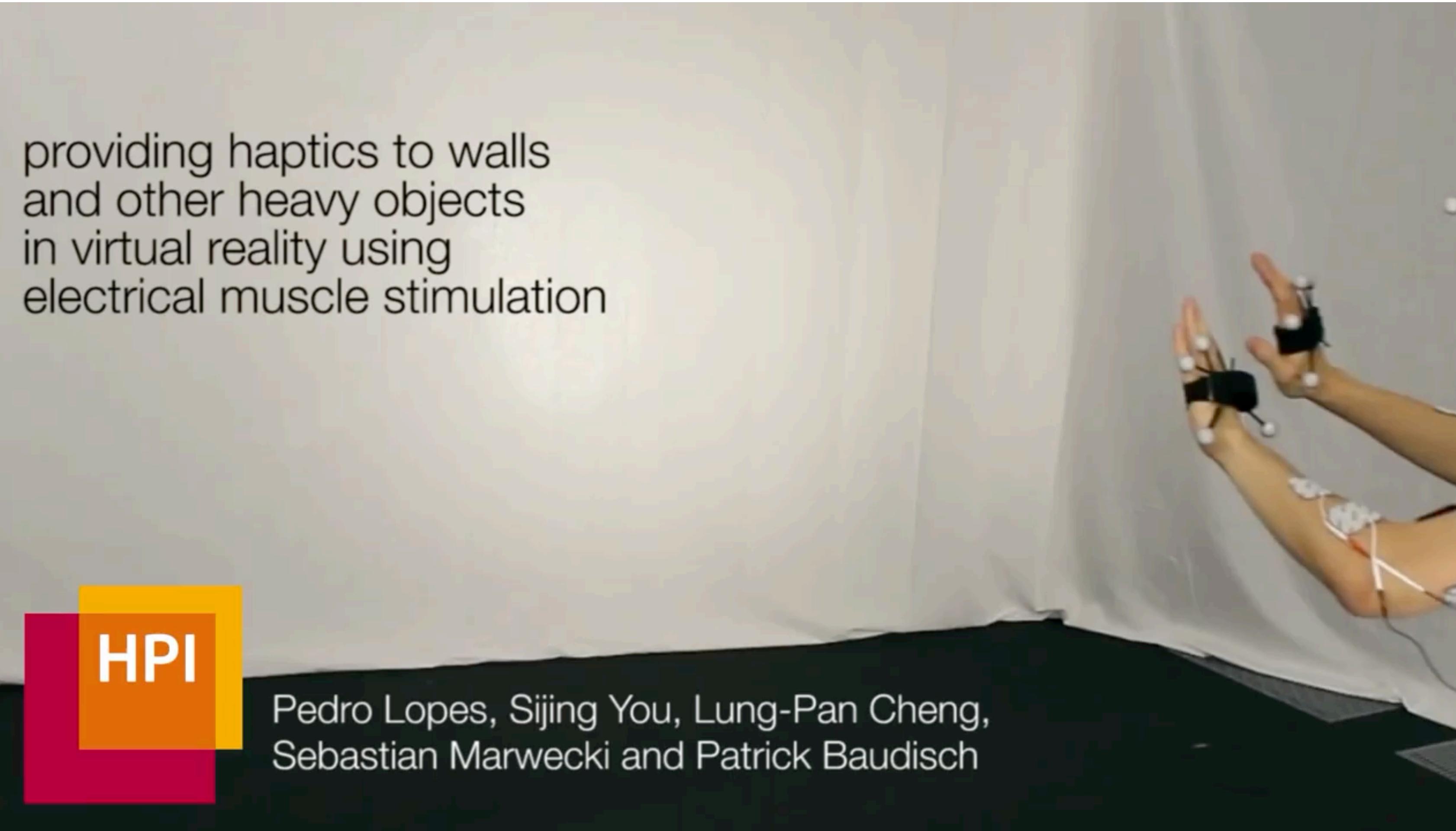
# Making more immersive experiences



[https://www.youtube.com/watch?v=8ZaC\\_kyF6wo](https://www.youtube.com/watch?v=8ZaC_kyF6wo)

Lung-Pan Cheng, Thijs Roumen, Hannes Rantzsch, Sven Köhler, Patrick Schmidt, Robert Kovacs, Johannes Jasper, Jonas Kemper, and Patrick Baudisch. TurkDeck: Physical Virtual Reality Based on People. *UIST 2015*.

# Making more immersive experiences



providing haptics to walls  
and other heavy objects  
in virtual reality using  
electrical muscle stimulation

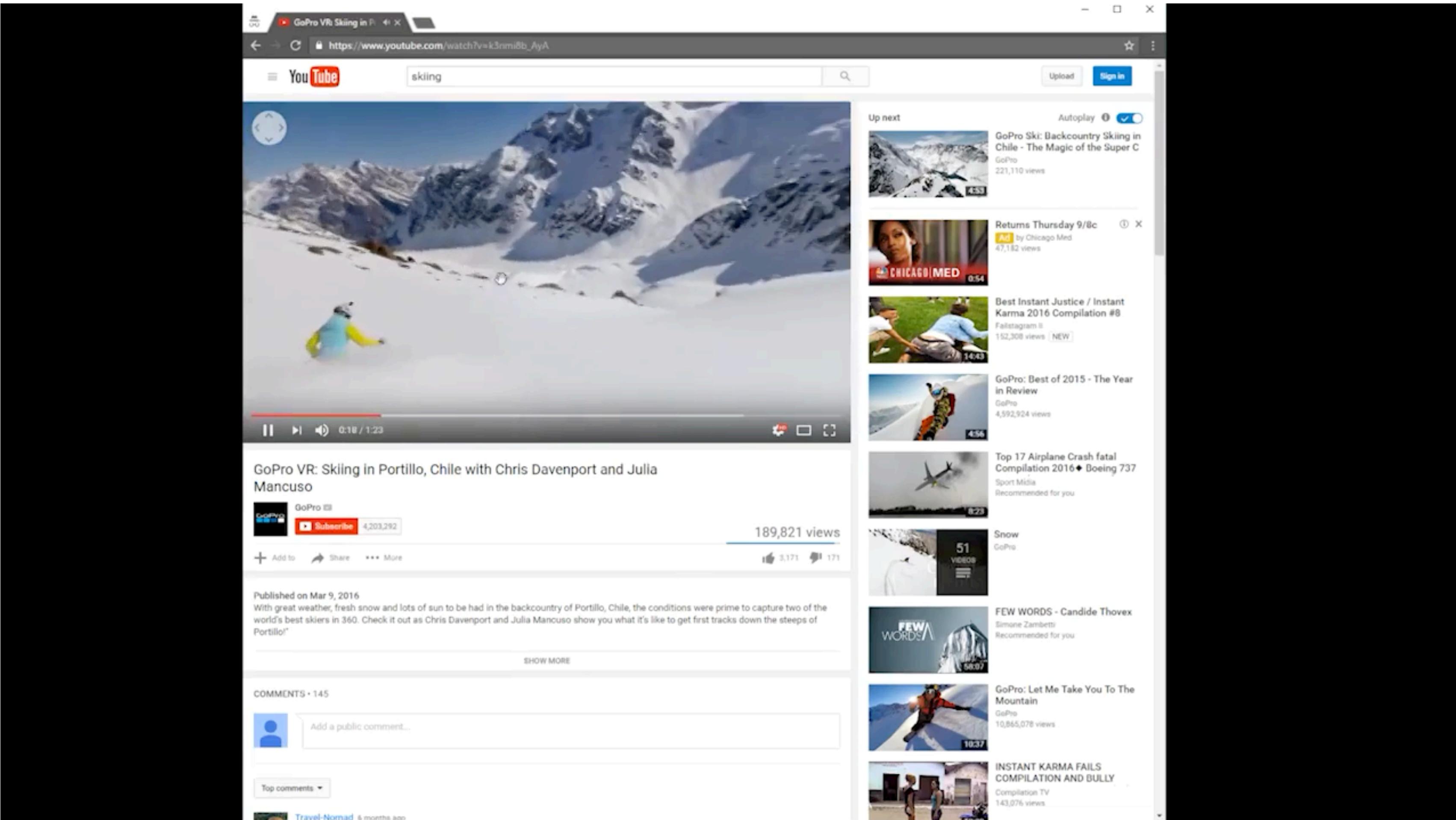
Pedro Lopes, Sijing You, Lung-Pan Cheng,  
Sebastian Marwecki and Patrick Baudisch

<https://www.youtube.com/watch?v=OcSmCamMKfs>

Pedro Lopes, Sijing You, Lung-Pan Cheng, Sebastian Marwecki, and Patrick Baudisch.

Providing Haptics to Walls & Heavy Objects in Virtual Reality by Means of Electrical Muscle Stimulation. CHI 2017.

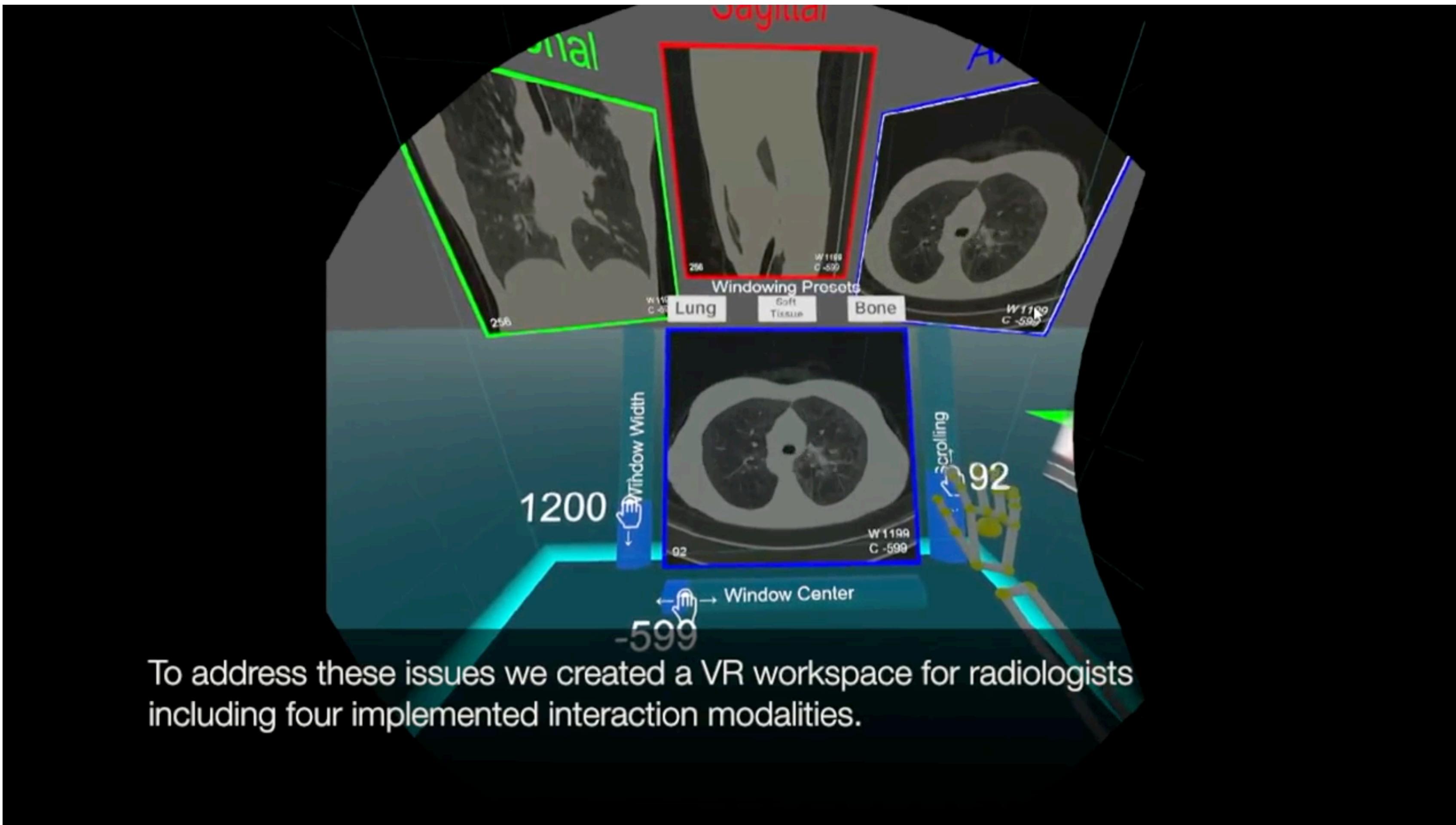
# New applications



<https://www.youtube.com/watch?v=S1lblwrv2X0>

Cuong Nguyen, Stephen DiVerdi, Aaron Hertzmann, and Feng Liu. 2017.  
Vremiere: In-Headset Virtual Reality Video Editing. CHI 2017.

# New applications



To address these issues we created a VR workspace for radiologists including four implemented interaction modalities.

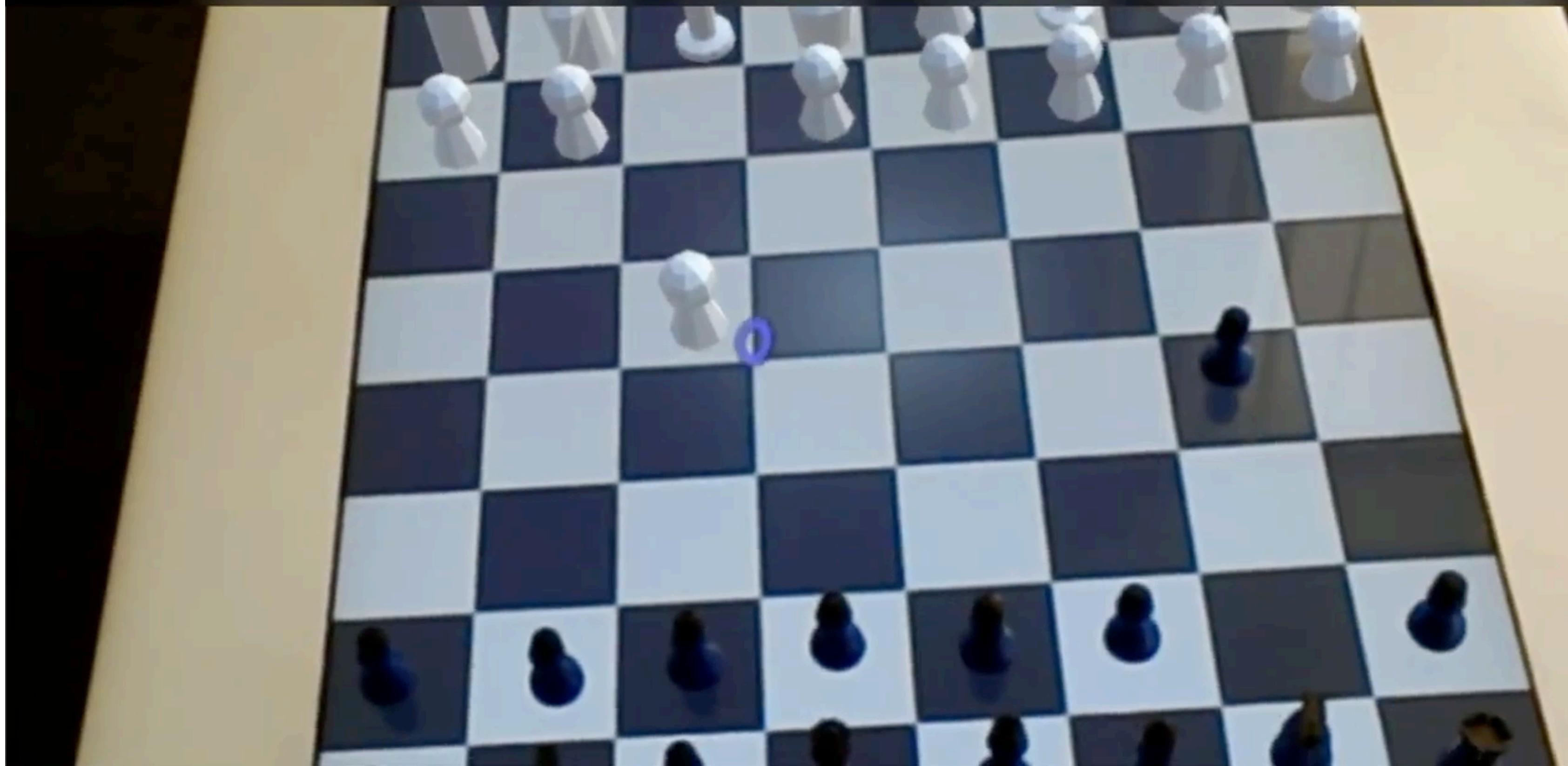
<https://www.youtube.com/watch?v=FOTGv2WxhXQ>

Markus Wirth, Stefan Gradl, Jan Sembdner, Soeren Kuhrt, and Bjoern M. Eskofier.

Evaluation of Interaction Techniques for a Virtual Reality Reading Room in Diagnostic Radiology. UIST 2018.

# Connecting people across distances

This enables a tangible experience for local users



<https://www.youtube.com/watch?v=ZjG8n9P5sD8>

Sebastian Günther, Florian Müller, Martin Schmitz, Jan Riemann, Niloofar Dezfuli, Markus Funk, Dominik Schön, and Max Mühlhäuser. CheckMate: Exploring a Tangible Augmented Reality Interface for Remote Interaction. CHI EA 2018.

# Connecting people across distances



<https://www.youtube.com/watch?v=tRzOqTRxoek>

Tomislav Pejsa, Julian Kantor, Hrvoje Benko, Eyal Ofek, and Andrew Wilson.

Room2Room: Enabling Life-Size Telepresence in a Projected Augmented Reality Environment. CSCW 2016.

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