IN4MATX 133: User Interface Software

Lecture 26: Designing for Augmented and Virtual Reality

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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

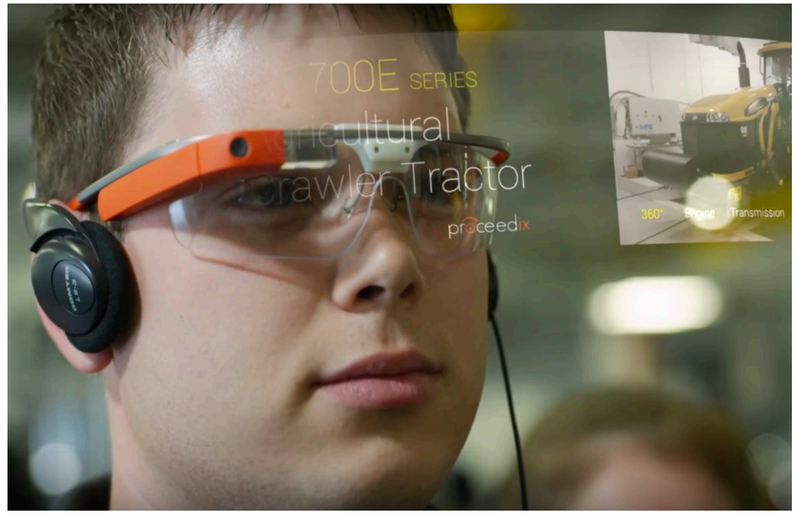
B. Cardboard is AR, Glass is VR

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

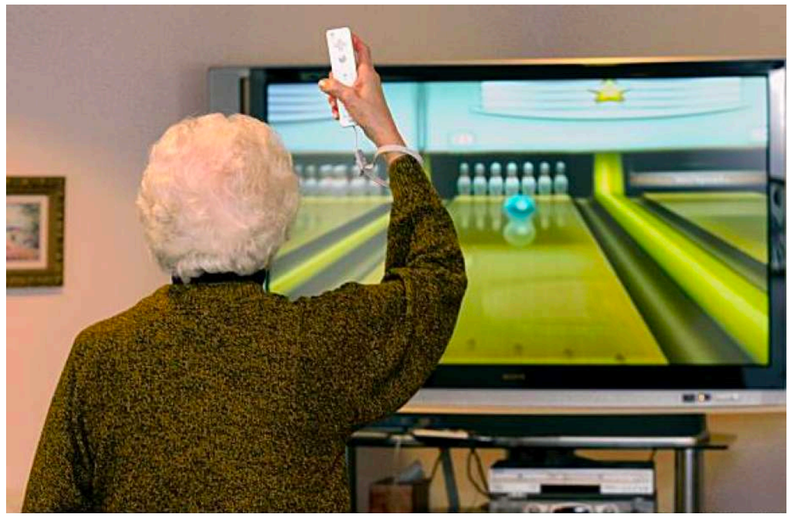
https://www.youtube.com/watch?v=eYTHmzYNFq8

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*.

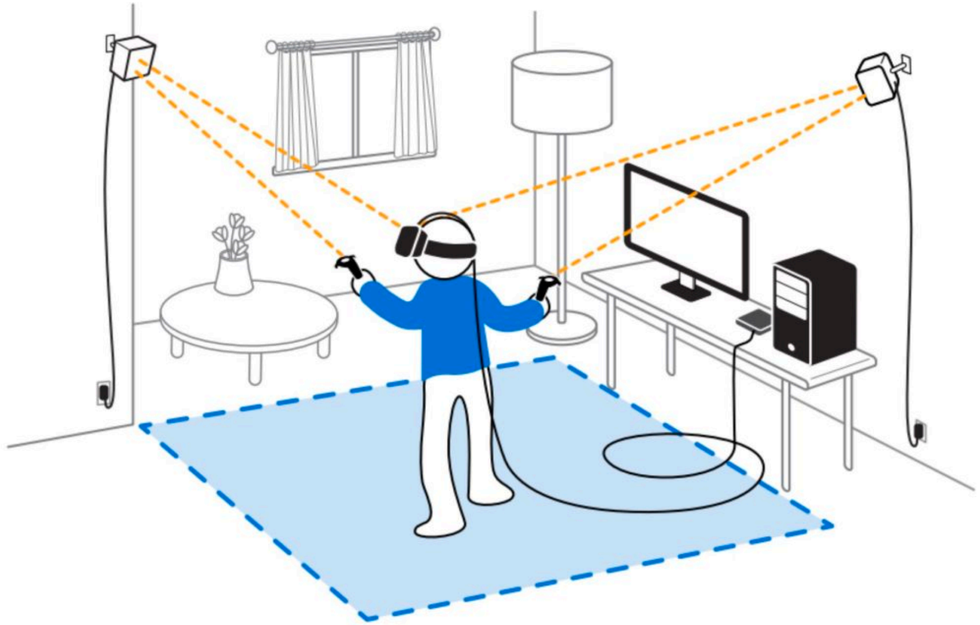
IllumiRoom (2013)

- 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*.

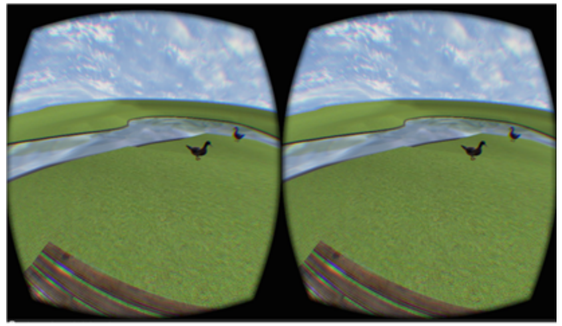
Oculus Rift & HTC Vive (2016)

- 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)

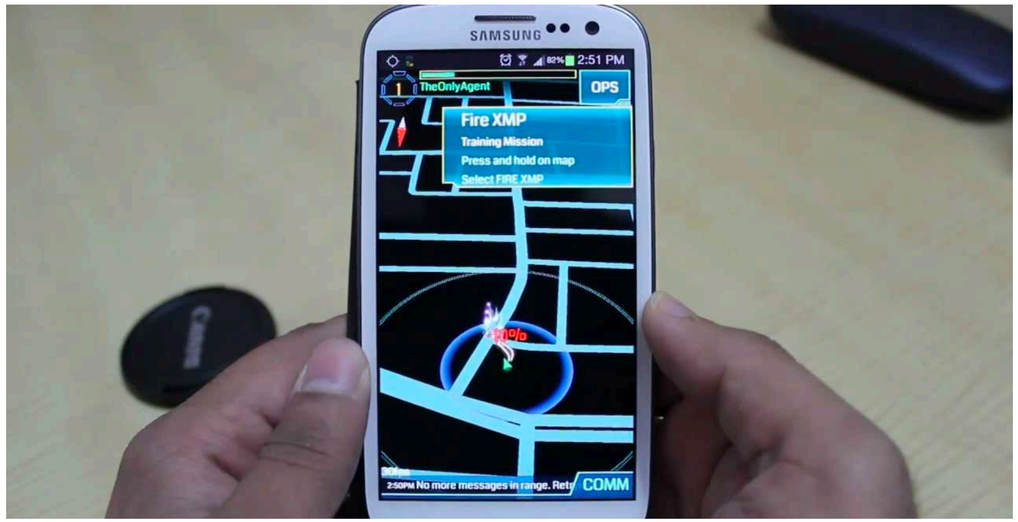
- Mixed reality system
  - Like AR, adds layers to the real world
  - Some physical objects can be interacted with
- Focused on commercial uses
  - Pricing: $3000/unit
- Though there are other videos which demonstrate entertainment applications

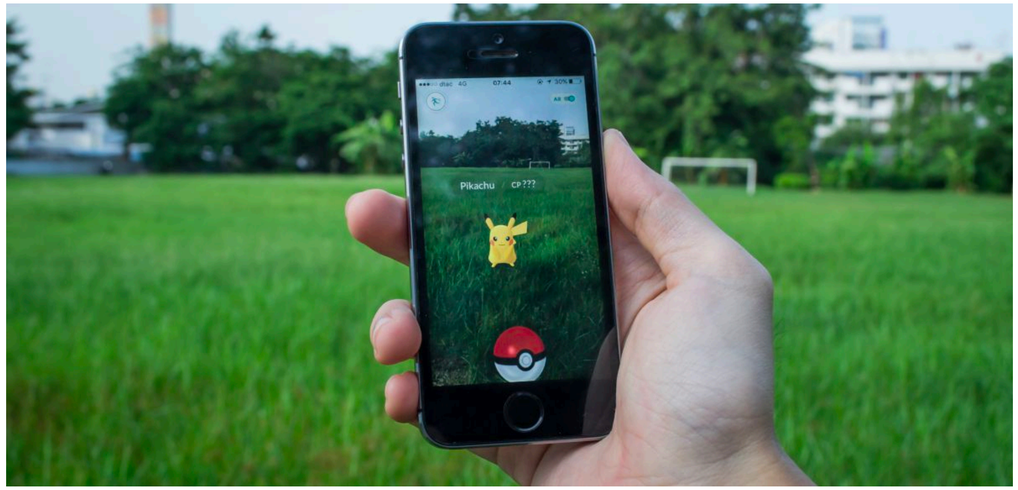
Snapchat

- 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

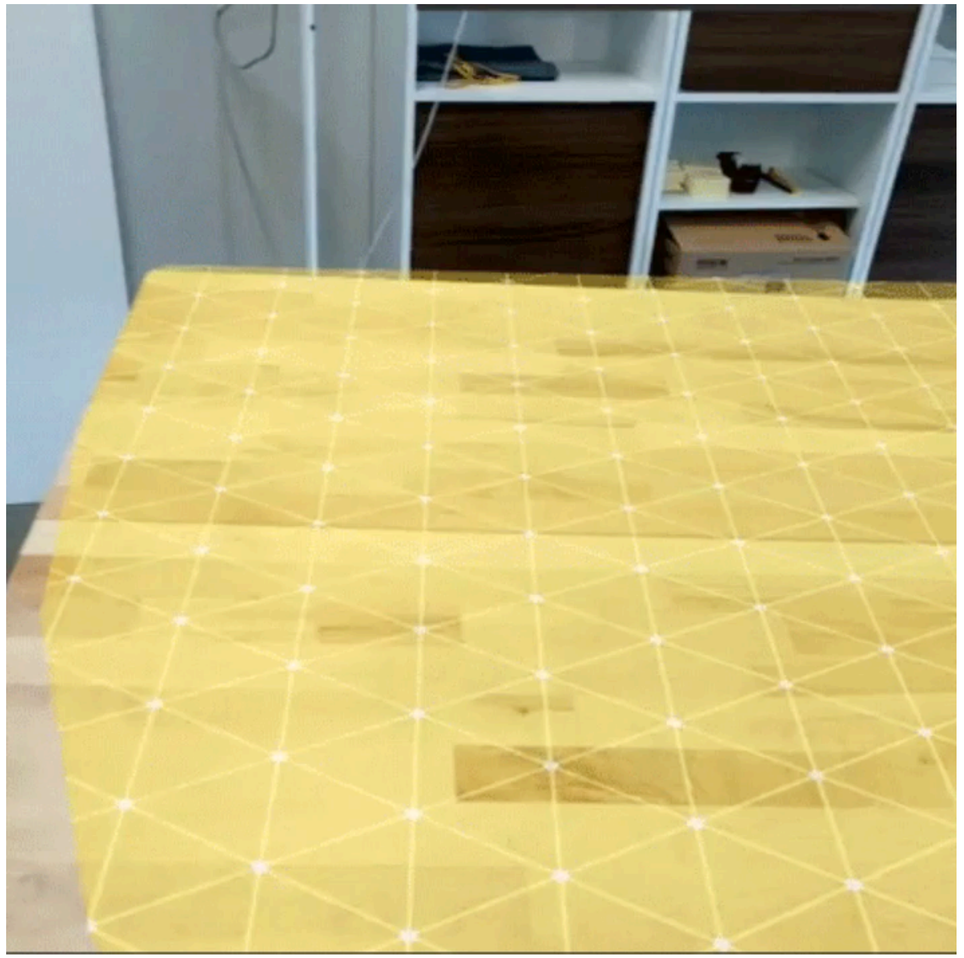
Native Development

- 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/

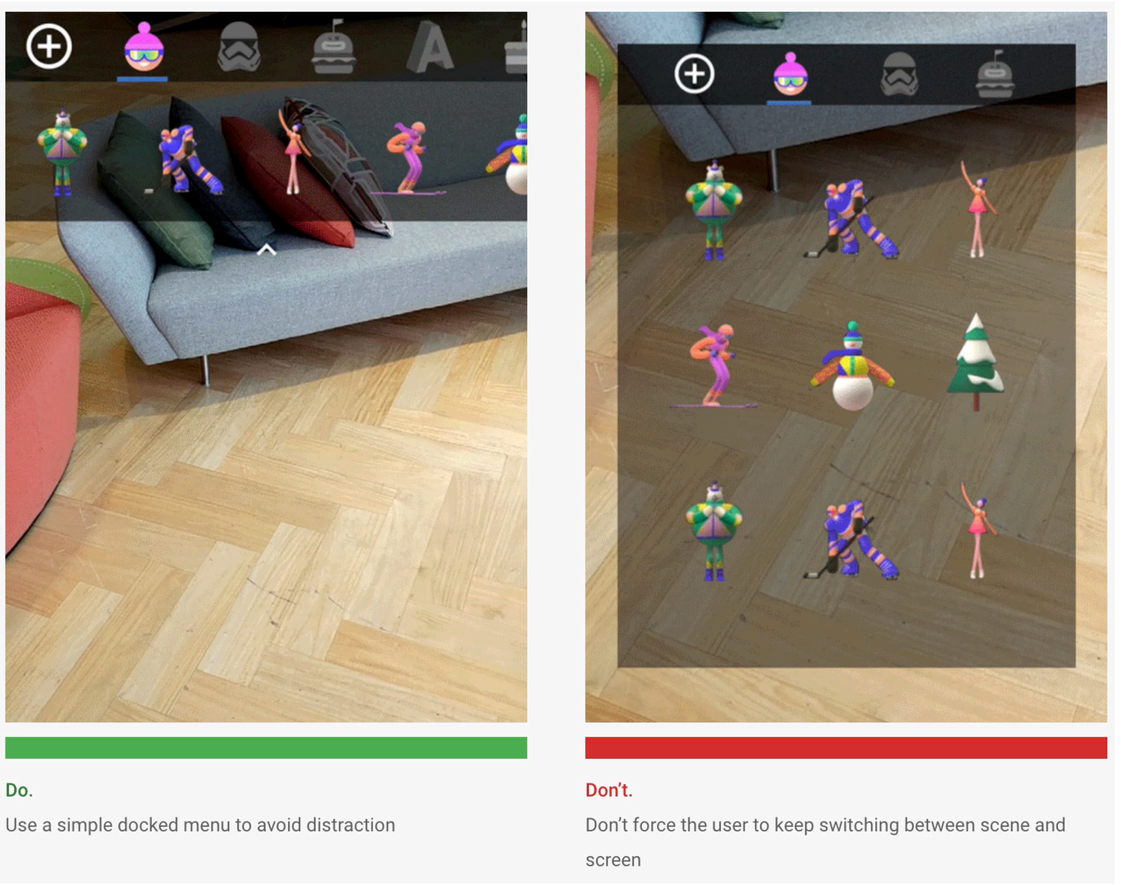
Provide guidance on interactions

- 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

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

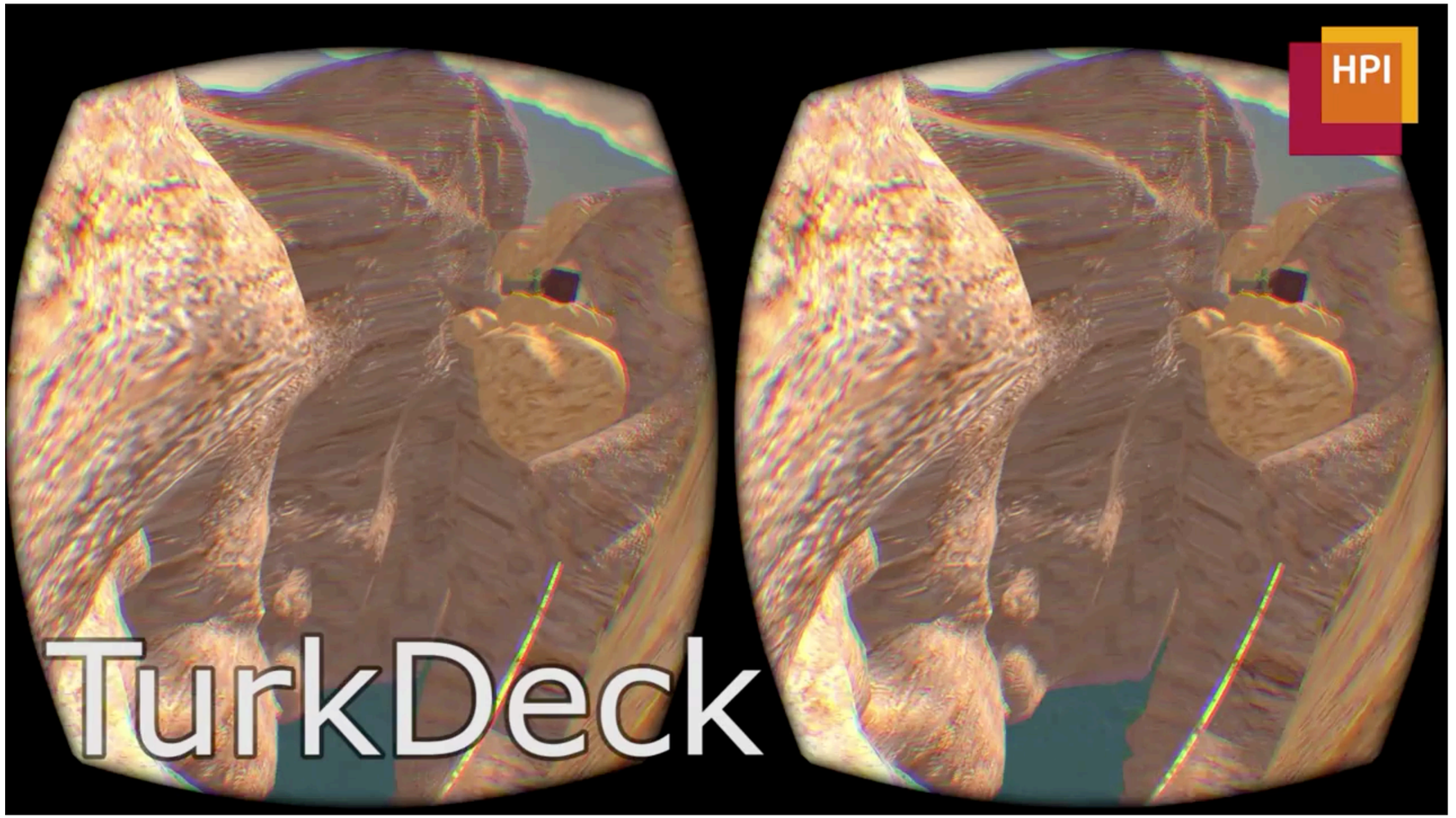
Anticipate space limitations

- 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 on the screen
  - They will instinctively back up

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

Research in AR and VR

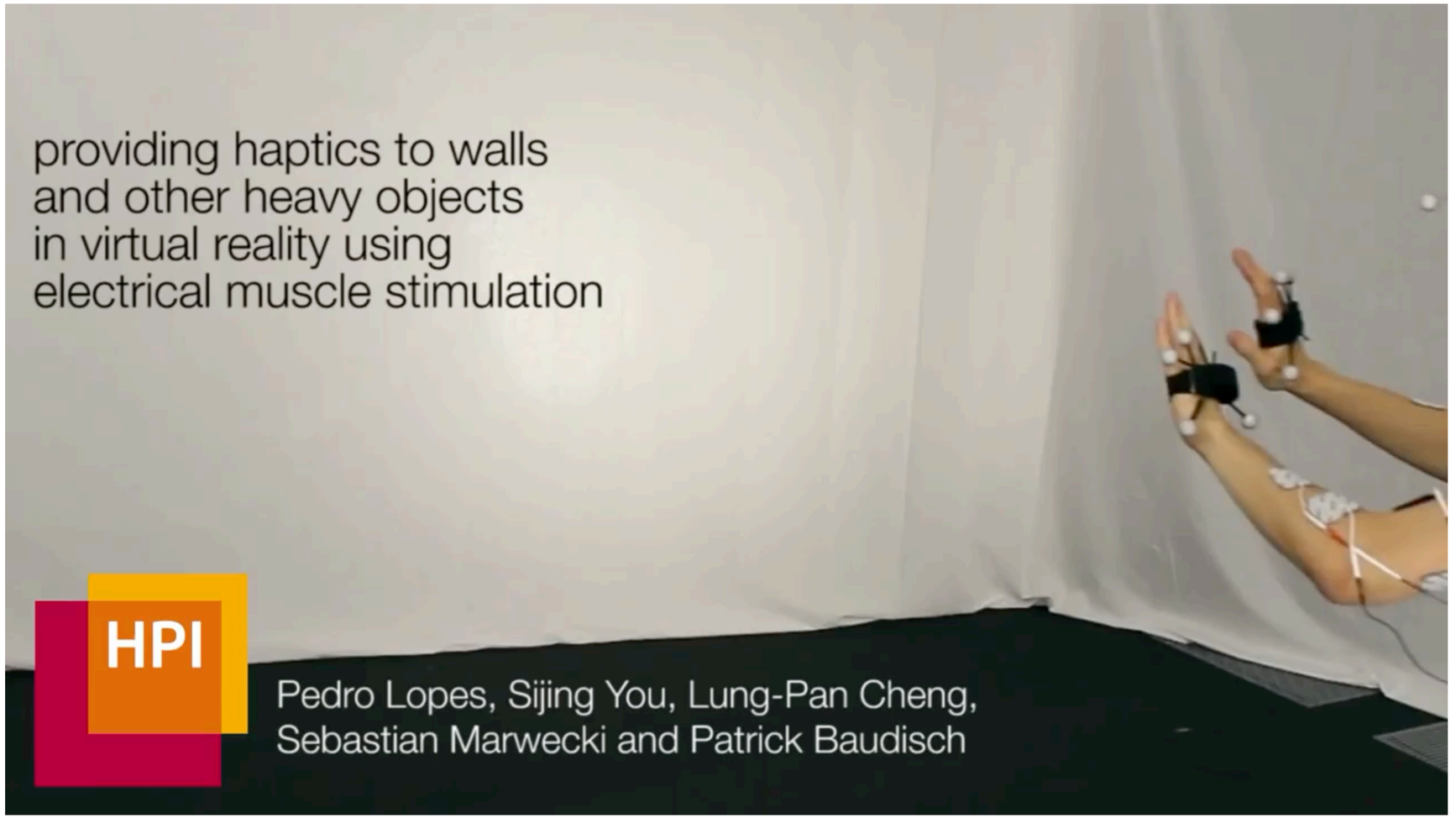
Making more immersive experiences



https://www.youtube.com/watch?v=8ZaC_kyF6wo

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*.

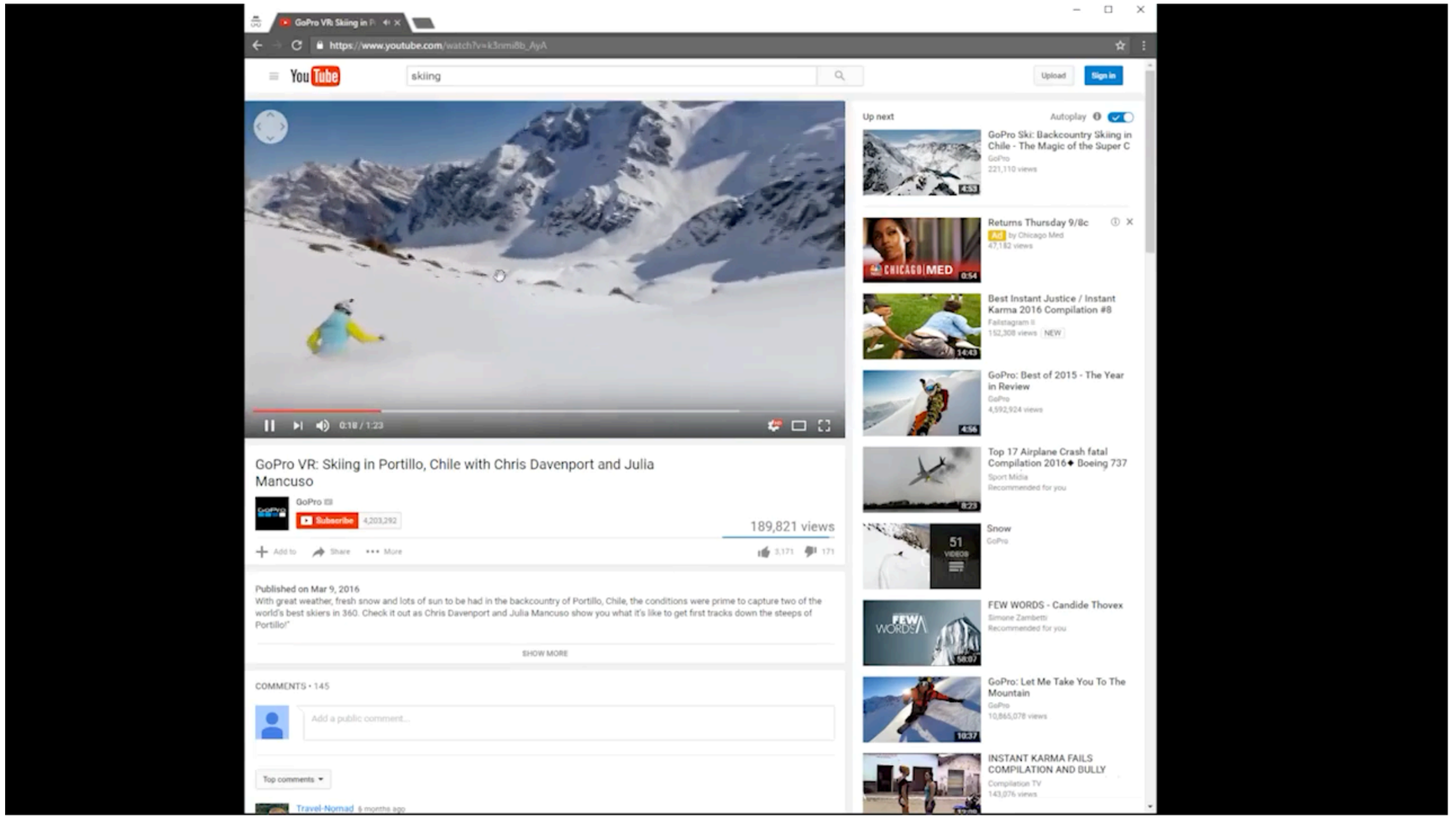
Making more immersive experiences



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*.

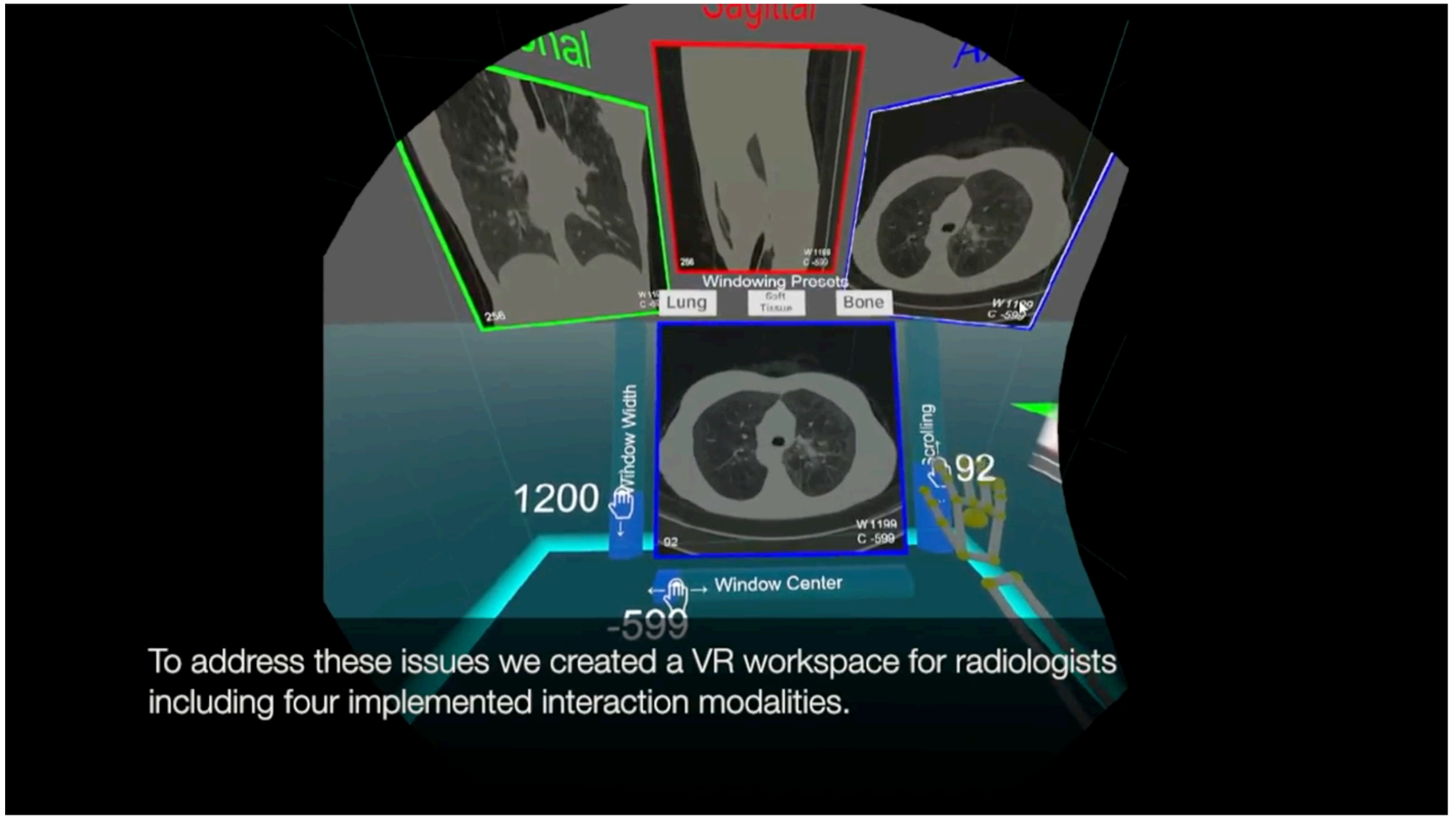
New applications



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



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

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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