ECE 590/COMPSI 590
Special Topics: Edge Computing

Augmented Reality and Edge Computing

January 29th, 2020

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Last Class: Recap

- Edge helping cloud
  - Why edge makes sense for the cloud
  - Background: latency and jitter
  - Challenges in supporting low-latency low-jitter solutions with modern cloud architectures
- Telecom vision for the edge
  - An infrastructure view of edge computing
  - 5G and ETSI MEC

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This Lecture

- Quiz
- Lecture:
  - AR/VR and edge computing: an introduction
  - AR Demo
  - Mobile devices for AR
  - Edge for AR: promising directions

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Quiz

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Augmented Reality (AR): A Definition

- The [virtual] content is laid out around a user **in the same spatial coordinates as the physical objects surrounding her/him***

*From: Baldassi et al, Challenges and New Directions in Augmented Reality, Computer Security, and Neuroscience, June 2018.

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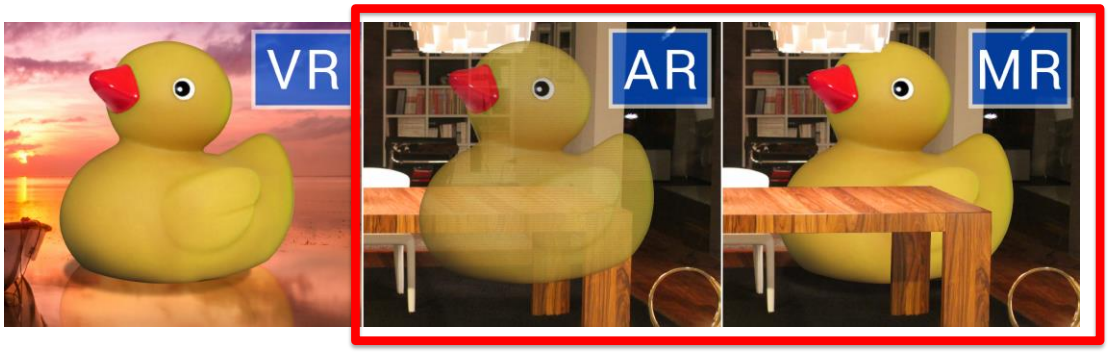
Virtual, Augmented, Mixed Reality: Are They The Same?

- Focus on AR/MR in this lecture



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Where Does Edge Computing Fit In? (1/3)

- Same principles as for other high-end mobile devices
- **Latency**, **bandwidth** requirements among the most demanding for consumer mobile applications
  - Edge computing as means for achieving these
- Conflicting needs:
  - Experience complexity
  - Speed of operation

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Where Does Edge Computing Fit In? (2/3)

- Ultra-low-latency is critical for high-quality experiences
  - ➢ High latency **literally** makes you sick
- Popular use case in telecom edge computing deployments

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Where Does Edge Computing Fit In? (3/3)

- Opportunities for helping **multiple** co-located AR/VR devices
  - ➢ Supporting experiences that are similar, but not identical

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AR Demo

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Specialized AR Hardware: Origins

- Ivan Sutherland's research group, 1968: Sword of Damocles

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Battlefield Augmented Reality Systems

- From late 1990s

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Modern AR: Multiple Device Options

- Google ARCore (2018), Apple ARKit (2017)
  - Vast majority of modern phone models support it

Microsoft HoloLens (2016)

Magic Leap One (2018)

Smart Glasses

- A wide range at CES every year
- Many glasses are not “true” AR

VUZIX®

Promising Directions

- nReal AR glasses
  - **USB-connected to a mobile phone** to enable true 3D AR
  - Supposedly only $500

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Holograms in Black Mirror

- We are *very* far from it

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Specialized Hardware: Challenges (1/2)

- Heavy, bulky, uncomfortable
- Currently expensive to the point of being impractical
  - Microsoft Hololens: $3,000
  - Magic Leap: $2,300
- Technology in the making

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Specialized Hardware Challenges: Motion Sickness

- Can be a major issue
- Mismatch between what you see and what your body perceives
  - Complex associated phenomena
- Latency one of major causes
  - **Motion-to-photon** latency

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Specialized Hardware Challenges: Safety and Security

- Completely new interface category. Threats include:
  - Blocking your view
  - Motion
  - Binocular disconnections
  - Multisensory disconnections

From: Baldassi et al, Challenges and New Directions in Augmented Reality, Computer Security, and Neuroscience, June 2018.

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Lecture Outline

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Edge for AR: Mobile Offloading

- Can be to the point of full **wireless tethering**
- Semi-independent modes are potentially promising:
  - Low-quality experiences: on the device
  - Higher-quality experiences: with edge support where available
    - Requires re-thinking AR application design

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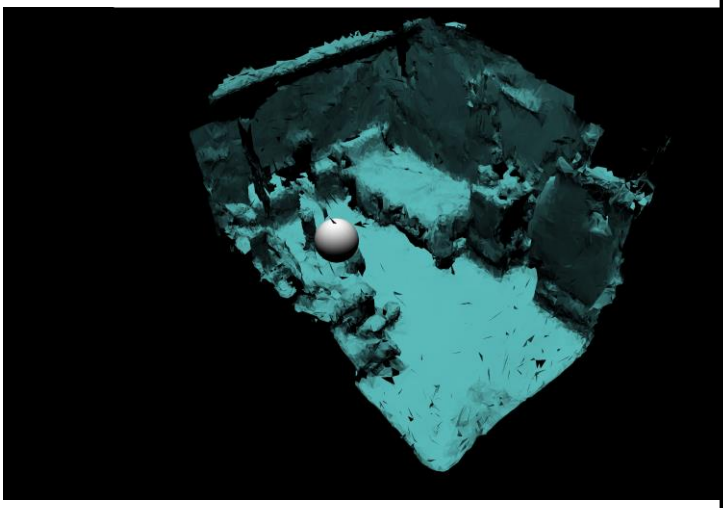
Edge for AR: Local Awareness

- Maps
- Persistent knowledge of environmental properties
- Interfacing with **smart objects**



Mesh representing a student dorm room

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Edge for AR: Content Delivery

- Current approach: stovepiped applications
  - ➢ Does not scale
- Promising: edge for delivering similar but not identical experiences