AR over Wireless Networks: Challenges and Opportunities

Maria Gorlatova September 3rd, 2020









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- Next-generation pervasive wireless and mobile platforms
 - Connecting everyday objects to enable true Internetworking of Things (IoT)
 - Using edge computing to enable the next level of intelligence in the IoT
 - Developing semantically and spatially aware pervasive mobile augmented reality platforms



Architecture: Fog/Edge in Support of Intelligent AR





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

Focus on AR/MR in this presentation





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*



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

Modern AR: Multiple Device Options

- Google ARCore (2018), Apple ARKit (2017)
 - Vast majority of modern phone models support it
- Constantly expanding in devices and capabilities



Microsoft HoloLens (2016)

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Magic Leap One (2018)

Core Mobile Technology of the Future



"AR will redefine our relationship with technology"

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"It is the next big thing, and will pervade our entire lives"



Falls Far Short of Expectations

- Resource consumption
- Semantic and spatial awareness
- Adaptiveness

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• Multi-user capabilities

Where does *AR over wireless* come into play?

Network-supported AR: Multi-User Experiences



- Network use: understanding each other's position in space
- Lots of room for improvement





Apple SwiftShot

X. Ran, C. Slocum, M. Gorlatova, J. Chen, ShareAR: Communication-efficient Multi-User Mobile Augmented Reality, *Proc. ACM HotNets'19*, Nov. 2019. Network-supported AR: Semantic Awareness

- Uplink transmissions of extensive amount of information
- Privacy is a major concern



Magic Leap World Understanding



Network-supported AR: Contextual AR

- Most AR apps load 3D models onto user devices at the time the app is downloaded
 - Akin to loading all Internet content onto a PC at the time of browser installation
- Challenge: high-quality 3D models are 100Mb+
 - Much larger than traditional Internet content provisioned on demand
- M. Glushakov, Y. Zhang, Y. Han, T. Scargill. G. Lan, M. Gorlatova, Edge-based Provisioning of Holographic Content for Contextual and Personalized Augmented Reality, *Proc. IEEE Workshop* on Smart Edge Computing and Networking, Mar. 2020 (invited paper).

Network-supported AR: Highly Detailed Experiences Through Remote Rendering

• Azure Remote Rendering: "3D without compromise"





Mobile AR and COVID-19



Thailand Cave Rescue

- Access to world's treasures
- Mobile AR is exceptional at demonstrating scale



Duke basketball players

Students Code Alternate Realities, <u>https://pratt.duke.edu/about/news/students-code-alternate-realities</u>, Aug. 2020

Questions?

• Contact e-mail: maria.gorlatova@duke.edu

• We are hiring:

ECE and CS PhD positions in next-generation mobile AR

