Communication 115S
Introduction to Augmented Reality
Summer, 2020
Tuesday/Thursday 1:30-3:20

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Office Hours: by appointment

Course Description

Augmented reality is a medium which allows people to overlay digital objects, people, and information onto the real world. The technology is being developed urgently by most large technology companies including Apple, Google, and Facebook. This course will discuss the social science theories which are relevant to AR, the engineering challenges both in terms of hardware and software, and the potential applications and downsides of the medium.

For each class, students will watch recorded lectures prepared before the class hours. During our class hours, we will meet via Zoom or the virtual reality platform Mozilla Hubs to have discussions and conduct group activities. Readings will be required before our discussion.

Course Requirements

Final grades will be based on participation (20%), assignments (30%), a midterm exam (25%), and another final paper (25%).

During the course, you will follow a tutorial website for Unity3D to foster our understanding of augmented reality and virtual environments. The goal of the tutorials will be having hands-on experience to accompany the theoretical portion of the course. While finishing the tutorial is highly recommended for learning purposes, a 600-word reaction paper to that week's topic can be submitted instead.

The midterm exam will have multiple-choice and short-answer questions that cover the lectures and readings. The goal of the exam will be to understand how augmented reality technology works and other fundamental theories.

The final paper will be a review paper of the current state of augmented reality and your prediction of its future with a suggestion of an augmented reality application to create. The paper will be due on August 15.

Course Materials

Oshii, M. (1996). Ghost in the Shell.

Flick, J. (2020). Catlike Coding Unity Tutorials. https://catlikecoding.com/unity/tutorials/

Optional:

LaValle, S. (2016). Virtual reality. http://lavalle.pl/vr/

Wachowski, L. & Wachowski, L. (1999), The Matrix.

Course Calendar and Readings

Tue, 6/23. What is Augmented Reality?

Azuma, R. T. (1997). 1. Introduction, *A survey of augmented reality*. Presence: Teleoperators & Virtual Environments, 6(4), 355-385.

Augmented Reality. Wikipedia. https://en.wikipedia.org/wiki/Augmented_reality

Microsoft. What is mixed reality? https://docs.microsoft.com/en-us/windows/mixed-reality/mixed-reality

Optional:

Billinghurst, M., Clark, A., & Lee, G. (2015). Chapter 2: Definition and Taxonomy, *A survey of augmented reality*. Foundations and Trends® in Human–Computer Interaction, 8(2-3), 73-272.

LaValle (2016). Chapter 1.

Thur, 6/25. History and a Brief Forecast of AR

Billinghurst, M., Clark, A., & Lee, G. (2015). Chapter 3: History. *A survey of augmented reality*. Foundations and Trends® in Human–Computer Interaction, 8(2-3), 73-272.

Optional:

Azuma, R. T. (1997). 2. Applications, *A survey of augmented reality*. Presence: Teleoperators & Virtual Environments, 6(4), 355-385.

Billinghurst, M., Kato, H., & Poupyrev, I. (2001). The MagicBook: a transitional AR interface. *Computers & Graphics*, 25(5), 745-753.

Demo:
Warby Parker's Virtual Try-on (and Snapchat)

Tue, 6/30. Overview of AR as a Technology

Catlike Coding Unity Tutorial. Game Objects and Scripts: Creating a Clock.
https://catlikecoding.com/unity/tutorials/basics/game-objects-and-scripts/

Demo:
IKEA Place

Optional:
LaValle (2016). Chapter 2.1 and 2.2.

Thur, 7/2. Artwork and Thoughts on Reality and Virtuality

Oshii, M. (1996), *Ghost in the Shell*.

Demo: Mozilla Hubs. https://hubs.mozilla.com/

Optional:
Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1995, December). Augmented reality: A class of displays on the reality-virtuality continuum. In *Telemanipulator and telepresence technologies* (Vol. 2351, pp. 282-292). International Society for Optics and Photonics.

Mann, S., Furness, T., Yuan, Y., Iorio, J., & Wang, Z. (2018). All reality: Virtual, augmented, mixed (x), mediated (x, y), and multimediated reality. *arXiv preprint* arXiv:1804.08386.

Wachowski, L. & Wachowski, L. (1999), *The Matrix*.

Tue, 7/7. Human Sensory Systems and AR Headsets

LaValle (2016). Chapter 6.1 & 6.3.

Video:

        Ignition Immersive. *What is Spatial Audio?*
https://www.youtube.com/watch?v=tIRcUlpWoh4

Optional:

        Kress, B., & Starner, T. (2013, May). A review of head-mounted displays (HMD) technologies and applications for consumer electronics. In *Photonic Applications for Aerospace, Commercial, and Harsh Environments IV* (Vol. 8720, p. 87200A). International Society for Optics and Photonics.

Thur, 7/9. Communication and Media

Chapter 2.1 & 2.2 of

        McQuail, D., & Windahl, S. (1993). Chapter 2: Basic Models. *Communication models for the study of mass communications*. Routledge.

Optional:

        McLuhan, M. (1964). Chapter 1: Medium is the Message. *Understanding media: The extensions of man*. MIT press.

        Rest of McQuail & Windahl (1993)

        Walther, J. B. (1996). Computer-mediated communication: Impersonal, interpersonal, and hyperpersonal interaction. *Communication research*, *23*(1), 3-43.

Tue, 7/14. Graphics and Vision for AR

Catlike Coding Unity Tutorial. Sliding a Sphere: Player-Controlled Motion.
https://catlikecoding.com/unity/tutorials/movement/sliding-a-sphere/

Demo:

        Google Lens (included in Google Photos for iOS)

Optional:

        LaValle (2016). Chapter 3.

Thur, 7/16. Presence and the Media Equation

Section 2 of
Slater, M., & Wilbur, S. (1997). A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments. Presence: Teleoperators & Virtual Environments, 6(6), 603-616.

Optional:
Rest of Slater & Wilbur (1997).

Lee, K. M. (2004). Why presence occurs: Evolutionary psychology, media equation, and presence. Presence: Teleoperators & Virtual Environments, 13(4), 494-505.

Cummings, J.J., Bailenson, J.N. (2016). How immersive is enough? A meta-analysis of the effect of immersive technology on user presence. Media Psychology. 19:2, 272-309, doi:10.1080/15213269.2015.1015740

Tue, 7/21. Rendering and Tracking of AR

Catlike Coding Unity Tutorial. Frames Per Second: Measuring Performance. https://catlikecoding.com/unity/tutorials/frames-per-second/

Demo:
iOS Animoji (or an equivalent)

Optional:
LaValle. (2016). Chapter 7.

Thur, 7/23. Psychology of AR (and VR)

Study 2 of
Miller, M. R., Jun, H., Herrera, F., Villa, J. Y., Welch, G., & Bailenson, J. N. (2019). Social interaction in augmented reality. *PloS one*, 14(5).

Optional:
Rest of Miller et al. (2019).

Yee, N. & Bailenson, J.N. (2007). The Proteus Effect: The Effect of Transformed Self-Representation on Behavior. *Human Communication Research, 33 (3),* 271-290.

Tue, 7/28. Exam

Thur, 7/30. The Current Generation of AR

Levy, S. (2017). The Race for AR Glasses Starts Now.
https://www.wired.com/story/future-of-augmented-reality-2018/

Barrett, B. (2018). The Quiet, Steady Dominance of Pokémon Go.
https://www.wired.com/story/pokemon-go-quiet-steady-dominance/

Demo:
        Pokemon Go
        Google Translate

Optional:
Kelly, M. (2018). Microsoft secures $480 million HoloLens contract from US Army.
https://www.theverge.com/2019/4/6/18298335/microsoft-hololens-us-military-version

Matney, L. (2019). Report: Magic Leap's early device sales aren't looking good.
https://techcrunch.com/2019/12/06/report-magic-leaps-early-device-sales-arent-looking-good/

Microsoft. Browse all HoloLens apps.
https://www.microsoft.com/en-us/store/collections/hlgettingstarted/hololens

Guttag, K. (2019). Hololens 2 Is Shipping, But Not Really That Many.
https://www.kguttag.com/2019/11/08/hololens-2-is-shipping-but-not-really/

Guttag, K. (2019). Hololens 2 (HL2): "Scan Lines" Making Text Hard to Read and Quality Issues with Waveguides.
https://www.kguttag.com/2019/12/03/hololens-2-hl2-scan-lines-making-text-hard-to-read-and-quality-issues-with-waveguides/

Tue, 8/4. (Depth) Cameras and Calibration

Optional:

Grubert, J., Itoh, Y., Moser, K., & Swan, J. E. (2017). A survey of calibration methods for optical see-through head-mounted displays. *IEEE transactions on visualization and computer graphics*, *24*(9), 2649-2662.

Zhang, Z. (2000). A flexible new technique for camera calibration. IEEE Transactions on pattern analysis and machine intelligence, 22(11), 1330-1334.

Thur, 8/6. Telepresence Systems

Fink, C. (2017). The Trillion Dollar 3D Telepresence Gold Mine. https://www.forbes.com/sites/charliefink/2017/11/20/the-trillion-dollar-3d-telepresence-gold-mine/

Videos:

Orts, S. et. al. (2016). Holoportation: Virtual 3D Teleportation in Real-time. https://www.youtube.com/watch?v=84ngPFBWLVI

Kowalski, M. (2017). Open-source telepresence on HoloLens. https://www.youtube.com/watch?v=Wc5z9OWFTTU

Optional:

Minsky, M. (1980). Telepresence. https://web.media.mit.edu/~minsky/papers/Telepresence.html

Dickinson, J. (2007). Telepresence: Finally, videoconferencing that works. https://www.computerworld.com/article/2542756/telepresence--finally--videoconferencing-that-works.html

Tue, 8/11. Design and HCI

Microsoft. Start designing and prototyping. https://docs.microsoft.com/en-us/windows/mixed-reality/design

Demo: GIPHY World

Optional:

Google. Design - Material Design. https://material.io/design

Google. Augmented Reality Design Guideline.
https://designguidelines.withgoogle.com/ar-design/

Thur, 8/13. Future directions of AR

Kelly, K. (2019). AR Will Spark the Next Big Tech Platform—Call It Mirrorworld.
https://www.wired.com/story/mirrorworld-ar-next-big-tech-platform/

Demo: WebXR Viewer

Optional:

Bailenson, J. (2018). Protecting nonverbal data tracked in virtual reality. JAMA pediatrics, 172(10), 905-906.