CSE 190: Virtual Reality Technologies

LECTURE #15: AUGMENTED REALITY SYSTEMS

Upcoming Deadlines

Sunday, May 23: Project 3 due

Monday, May 24: Discussion Project 4

Sunday, May 30: Project 4 original due date

Monday, May 31: Memorial Day (no discussion)

Sunday, June 6: Project 4 due

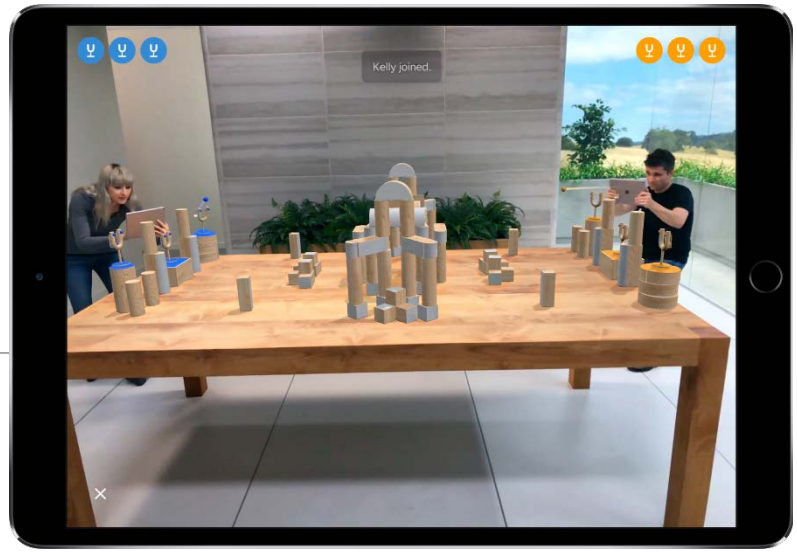
App Presentations

Manxin Zhang
- Multibrush

Haozhe Luo
- Google Earth

Edward Xie
- Hand Physics Lab

Apple ARKit



ARKit 1 supported by any device with iOS 11

ARKit 2 available since iOS 12

Persistent AR Experiences:

- Provide AR experiences that persist between sessions, and can be resumed at a later time

Shared AR Experiences:

- Multiple users can use their iOS device to simultaneously view AR experiences or play multiplayer games. Bystanders can spectate AR games being played by multiple participants.

Object Detection and Tracking:

- ARKit 1.5 added support for 2D image detection, letting you trigger an AR experience based on 2D images like posters, artwork, or signs. ARKit 2 offers full 2D image tracking, so you can incorporate movable objects like product boxes or magazines into your AR experiences. ARKit 2 also adds the ability to detect known 3D objects like sculptures, toys, or furniture.

ARKit Video

https://www.youtube.com/watch?v=-o7qr1NpeNI

Google ARCore

Motion tracking:

- understand and track the phone’s position relative to the world

Environmental understanding:

- detect the size and location of all type of surfaces: horizontal, vertical and angled surfaces like the ground, a coffee table or walls

Light estimation:

- estimate the environment's lighting conditions

ARCore Video

https://www.youtube.com/watch?v=ttdPqly4OF8

AR Headsets: Examples

HoloLens 2

Mira Labs

Metavision Meta

Apple Glass?

Magic Leap One

Google Glass: Almost AR

Small see-through display in front of one eye

- Overlay image, size similar to rear-view mirror in car

Android 4.4 on ARMv7 CPU

Single display: 640x360 pixels, right eye only

5 MP camera, 720p video recording

Wi-Fi, Bluetooth

2 GB RAM, 16 GB flash memory

Gyroscope, accelerometer, compass, light sensor

“Bone conduction” speaker

579 mAh battery (2-3 hours of use)

Sold April 2013 until January 2015 for $1,500

Since July 2017: Enterprise Edition

- 32GB, 780 mAh battery, GPS, barometer, Intel Atom

Glass Enterprise Edition 2

Announced May 20, 2019

Price: $999

Qualcomm Snapdragon XR1

Supports computer vision and advanced machine learning capabilities

Safety frames from Smith Optics

Bigger battery and “other upgraded components”

Runs on Android, with support for Android Enterprise Mobile Device Management

Epson Moverio BT-300

Released 2016

Price: $699

1280 x 720 pixel OLED display

5 MP camera

Drone edition provides FPV to operate drones

Dedicated controller

32GB microSD card

FOV: 23 degrees

Video: https://www.youtube.com/watch?time_continue=49&v=hhYPqF3aHUs

Meta 2 by Meta

Released Dec 2016 for $1,500

Requires Windows PC with Nvidia GTX 960+

90 degrees field of view

2560 x 1440 pixels at 60Hz

Inside-out tracking with IMU and cameras

- In practice tracking is not as good as HoloLens

720p RGB camera

9 ft cable for video, data & power

4 surround sound speakers

3 microphones

Weight: 1.1 lbs

Meta became insolvent in January 2019, sold to unknown buyer

Osterhaut Design Group ODG R-9

Pre-orders went for $2,000, but never shipped

Qualcomm Snapdragon 835

Dual 1920x1080 pixels at 60Hz

50° FOV

GNSS (GPS/GLONASS)

IMU

Sensors for: humidity, altitude, ambient light

13MP autofocus camera (1080p @ 120fps, 4k @ 60fps)

Dual 5MP cameras for depth tracking

Fisheye camera for tracking

2 microphones (Environment & User)

Built-In stereo speakers

Company went out of business in 2019

Magic Leap One: Creator Edition

Released August 2018

Stereo goggles “Lightwear” using multi-focal lightfield technology

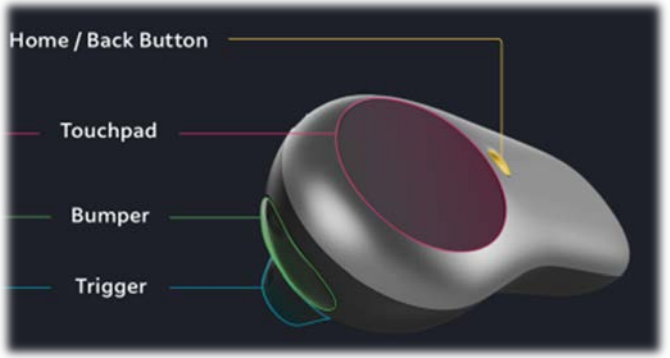
Wired to compute+battery box “Lightpack”

Includes 6 DoF controller called “Control”

Magic Leap: Video

https://www.youtube.com/watch?v=HD9jeo9M8vo

Magic Leap One Specs based on API



Operating System: Lumin OS

Eye Tracking: Fixation point position and eye centers, blinks

Graphics: OpenGL ES and Vulkan

Hand Gestures & Key Point Tracking: Hand poses (gestures) and position of identifiable points on hands such as tip of index fingers

Head Tracking: Headpose is tracked in full six degrees of freedom (DOF).

Image Tracking: Track position and orientation of specified image targets (markers)

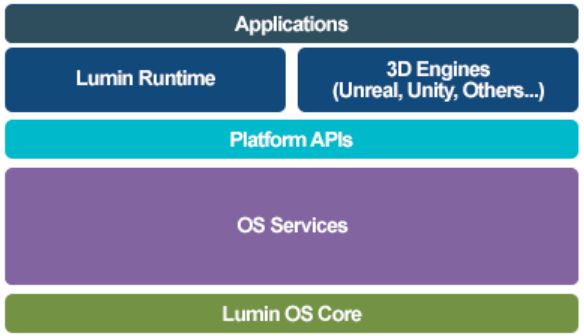
Input: Full 6 DOF from controller: trigger (analog), 2 buttons, touchpad, haptic vibration, LED ring feedback

Light Tracking: Detects luminance and global color temperature of user's environment

Meshing: Converts depth data into triangle mesh

Occlusion: Interface for using depth data for hardware occlusion

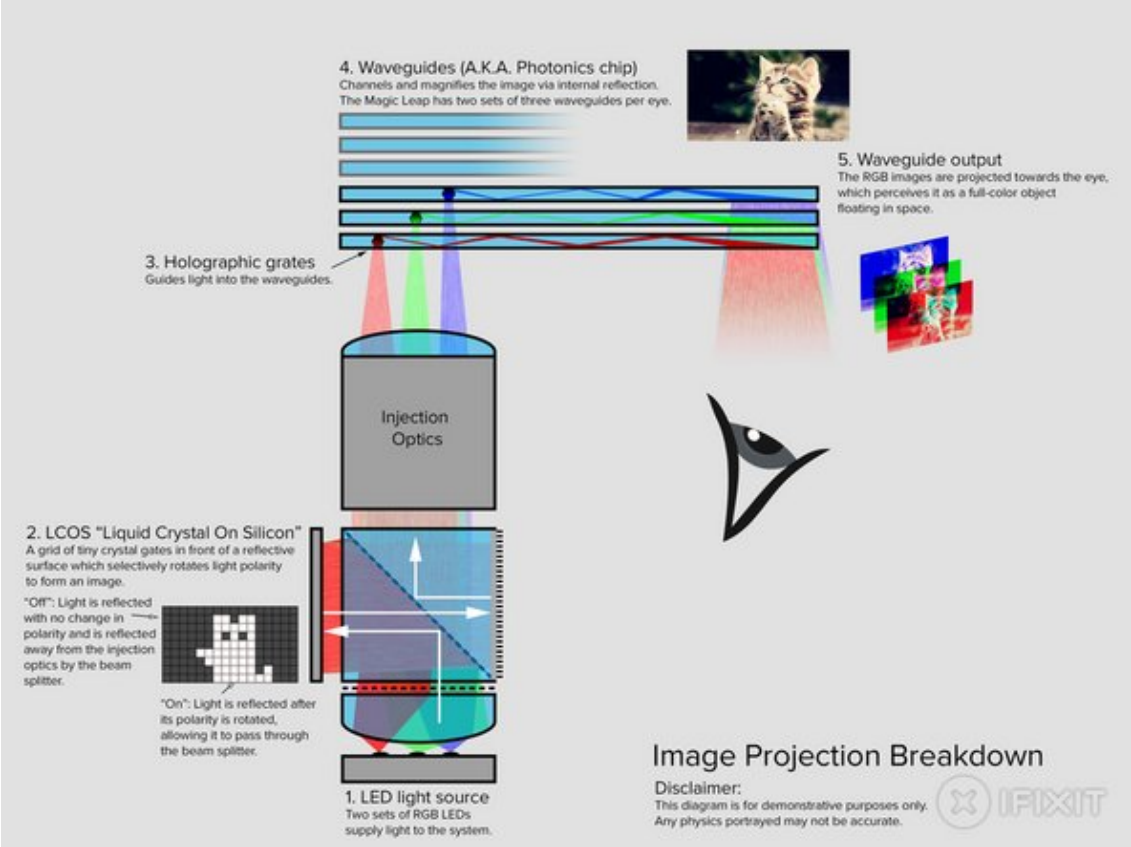
Planes: Recognizes planar surfaces for placing content. Includes semantic tagging for ceilings, floors, walls



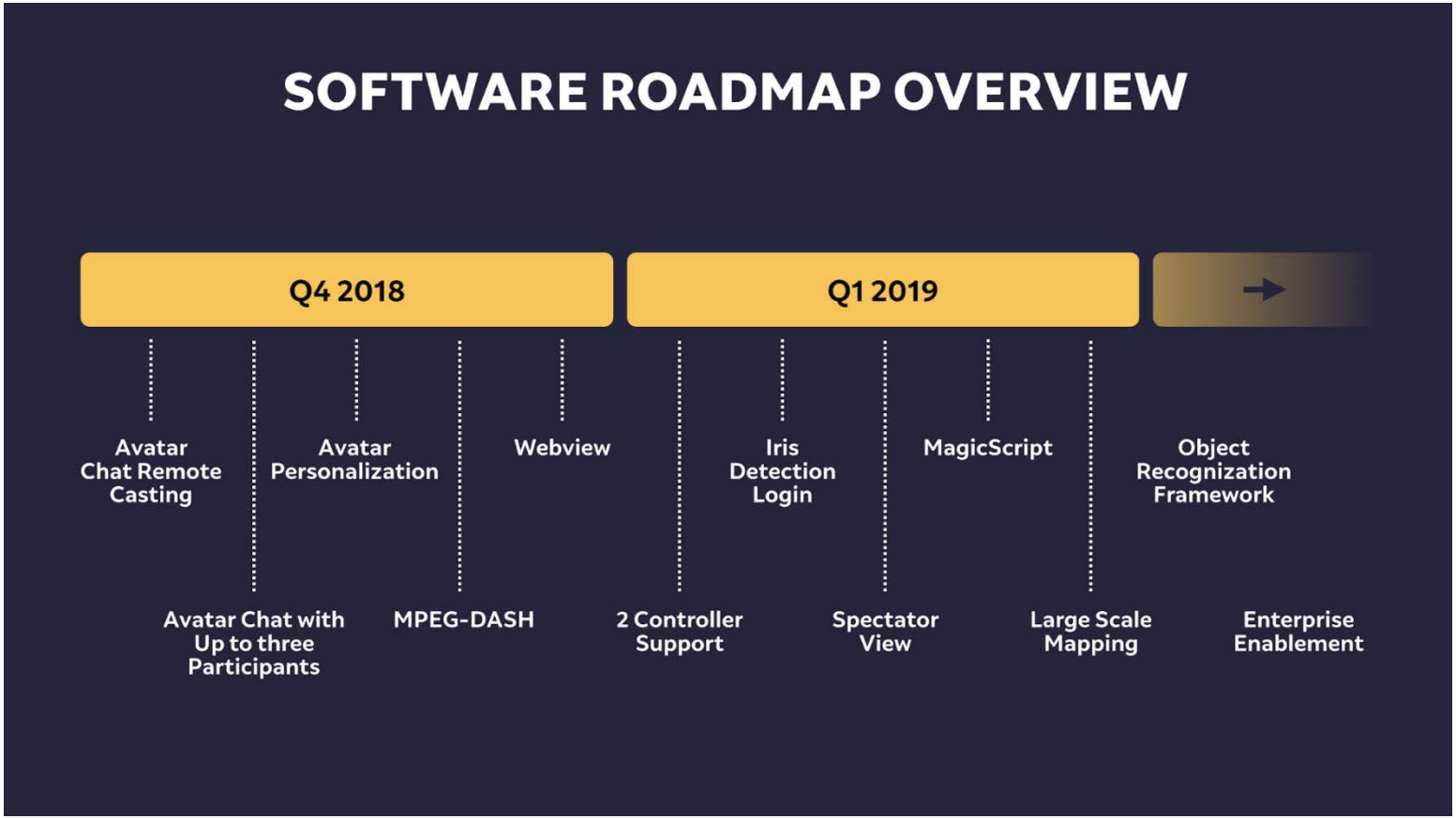
Waveguides

Six layers: separate waveguides for each color channel (red, green, and blue) on two focal planes

Without color-specific waveguides, each color would focus to a slightly different point and deform the image.



Software Roadmap



Software roadmap presented at L.E.A.P. Conference in October 2018

Microsoft HoloLens 1

Released March 2016 for $3,000
True AR: superimposes images onto real world
Wireless, self-contained
Stereo displays, 30x17 degrees FOV (34 degrees diagonal)
Angular resolution: 47 pixels per degree
2-3 hours battery life
6 DoF tracking with IMU and 120x120 degrees depth camera
2.4MP RGB camera
4-microphone array
Ambient light sensor
Intel CPU with integrated GPU and 1GB RAM
Custom Microsoft Holographic Processing Unit (HPU) with 1GB RAM and 28 custom DSPs for inside-out tracking and mapping
8GB RAM, 64GB flash memory

HoloLens Clicker

HoloLens: Videos

https://www.youtube.com/watch?v=QRQv74J7oSk

https://www.youtube.com/watch?v=SkVpdl-WcD0

Microsoft HoloLens 2

Released in late 2019

Price: $3,500

Qualcomm Snapdragon 850 with Adreno 630 GPU

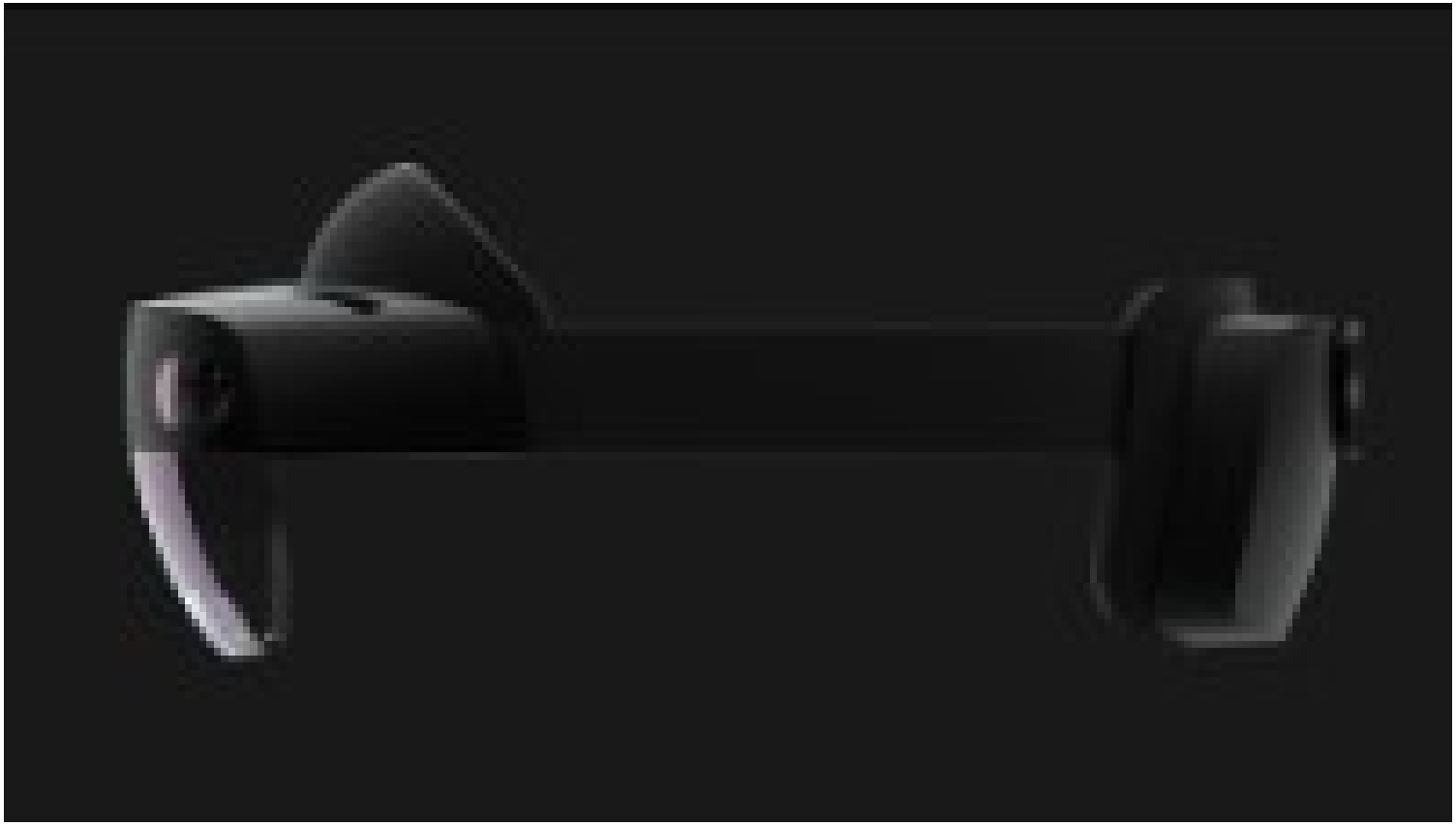
OS: Windows 10 Holographic

Field of view: 52 degrees (diagonal)

Angular resolution: 47 pixels per degree

USB-C connection

HoloLens 2: Video



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

Lenovo ThinkReality A6

Announced May 2019

Stand-alone headset, for business applications

HMD + tethered compute unit

Includes 3 DOF controller

Qualcomm Snapdragon 845 in compute unit

Android OS

Intel Movidius VPU on the headset

1920x1080 pixels per eye

40 degrees diagonal field of view

Weight <380 grams

VR/AR Headset Comparison

https://www.aniwaa.com/comparison/vr-ar/