CSE 190: Virtual Reality Technologies

LECTURE #11: LOW-END HMDS

Upcoming Deadlines

Sunday, May 9: Project 2 late deadline

Monday, May 10: Discussion Project 3

Sunday, May 16: Project 3 due

Monday, May 17: Discussion Project 4

Sunday, May 23: Project 3 late deadline

App Presentations

Samarth Arora
- Half-Life: Alyx

Tsung-Lin Shen
- Boneworks

Winston Durand
- Walkabout mini golf

Head-Mounted Displays (HMDs)

Head Mounted Displays

Head-worn displays with special optics in front of the eyes

Provide a stereoscopic view that is updated with the user's head motion

VR HMDs occlude the real world

AR HMDs can be translucent

Oculus Rift

Microsoft Hololens 2

High-End Example: Pimax Vision 8K X

HMD with one 4k screen (3840x2160 pixels) for each eye

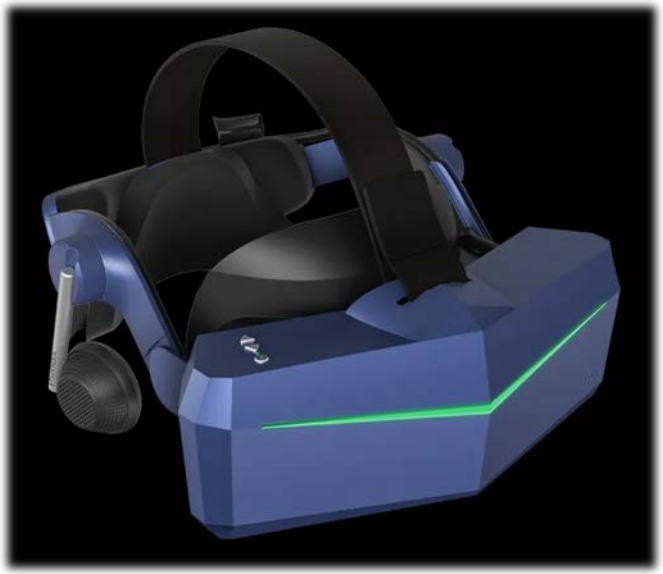
200 degree FOV

90 Hz refresh rate

Kickstarter project, funded in December 2019 with $4M

Headset only: $1,300

Requires Vive tracking system and controllers



HMDs – Advantages

Provide an immersive experience by allowing a 360 degree FOR

Easy to transport and to set up

Do not restrict user from moving around in the real world

Inexpensive

High quality stereo without ghosting

Only one computer needed, some are stand-alone

HMDs – Disadvantages

Limited resolution and field of view (FOV)

Do not take advantage of peripheral vision

Can be heavy and uncomfortable, cumbersome to put on

Isolating, collaboration best done virtually (users in same room can't see each other)

Risks related to not seeing the real world (e.g., stumbling)

Low-End HMDs

The new wave of HMDs

Cell phone technology has matured

- High resolution screens (~3k since Galaxy S6)
- Integrated fast gyroscopes, accelerometers, magnetometers

Games use real 3D coordinate spaces

Graphics cards support 3D because of 3D monitors

Real-time rendering quality close to photo-realistic

Google Cardboard

Requires smart phone

Compatible with Android and iOS

Built-in magnet serves as button

Inexpensive: <$10

Standardized QR code system to customize rendering

Cardboard and plastic versions available

Sometimes used for promotions

Merge VR

Price point: ~$30

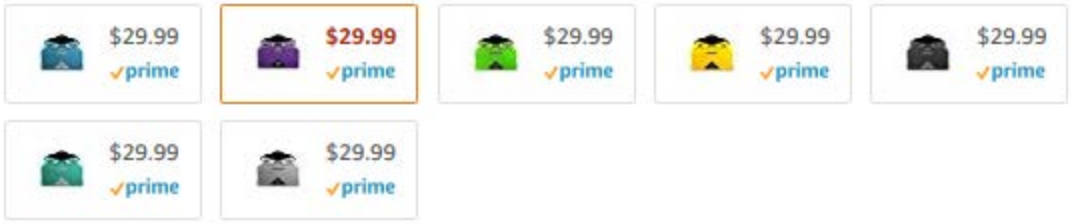
Almost indestructible

Cutout for camera

Bracket for controller

Not big enough for plus sized phones

Many color options



Gear VR

First version released 2015

Requires Galaxy Note 5/8 or Galaxy S 6-9
- Different versions of HMD available

100 degrees field of view

Built-in low latency IMU (Internal Measurement Unit) with accelerometer and gyroscope

Head proximity sensor

Touch pad on right side

Phone:
- 60 Hz screen update rate
- Resolution: 2560x1440
- Low motion-to-photon latency: <20ms
  - Oculus (John Carmack) worked with Samsung to optimize graphics driver

Optional 3 DOF controller available

Google Daydream

Released November 2016

Requires Daydream-ready phone (e.g., Pixel 1-3, Samsung Galaxy S8, S9)

90 degrees field of view

Built-in IMU

Proximity sensor

Lightweight fabric material (261g)

Phone specs determine VR display
- Some have up to 2,560 x 1,440 pixels at 60Hz

Includes 3DOF controller
- Dedicated storage space in front cover

Oculus Go

Released May, 2018

Qualcomm Snapdragon 821

2,560 × 1,440 pixel LCD display at 60 or 72Hz

Apps compatible with Gear VR

Fresnel lenses

Built-in stereo speakers for spatial audio

Headphone jack

3 DOF controller included

Flash memory: 32GB ($200) or 64GB ($250)

Nintendo Labo VR Kit

Cardboard VR viewer and attachments for Switch console

- Resolution: 1280 x 720 pixels (640 x 720 for each eye) at 60fps

Also includes games for the attachments

Commonalities of Low-End HMDs

Controller
- Either not available (controlled by button(s) on headset)
- Or single controller with 3 DOF

Varying display resolution, can be higher than some high-end HMDs

Lower refresh rate (often 60Hz)

Rendering quality depends on smartphone's GPU

Cumbersome to use when smartphone based

Battery-driven, phones discharge quickly when rendering VR

Smartphone overheat easily → limits session duration

Difficult to write software for systems with wide variety of supported phones:
- differences in smartphone performance
- differences in display resolution, latency, brightness
- differences in operating systems (Android, iOS)