

# CSE 190: Virtual Reality Technologies

---

LECTURE #9: LOW-END HMDS

# Announcements

---

Next Monday: Discussion homework project 2

Project 2 due Sunday May 10<sup>th</sup> at 11:59pm

Today's VR app presentations:

- Dominic Simone: Expeditions
- Justin Park: Pistol Whip
- Jeremiah Johnson: Hardcode (at end of lecture)

# Project 3 Smartphone Compatibility

---

## ARCore:

- <https://developers.google.com/ar/discover/supported-devices>

## ARKit:

- <https://developer.apple.com/library/archive/documentation/DeviceInformation/Reference/iOSDeviceCompatibility/DeviceCompatibilityMatrix/DeviceCompatibilityMatrix.html>

# Part time internship at Sensible Media

---

We're now looking for new, talented interns with Unreal programming experience. This will be a paid opportunity as well, and of course, it's part time. In addition there is another internship opening for a graduate student with a background in AI (DNNs).

Contact Stewart Matthew: [s.matthew@sensibletec.com](mailto:s.matthew@sensibletec.com)

# 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

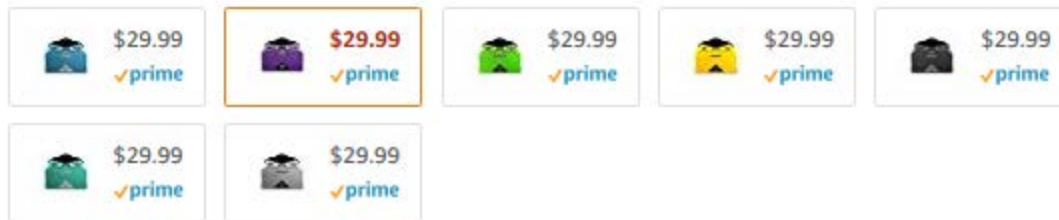
Almost indestructible

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



Pixel 3  
Google



Pixel 2  
Google



Pixel  
Google



Galaxy S9 & S9+  
Samsung



Galaxy S8 & S8+  
Samsung



Galaxy Note8  
Samsung



Moto Z & Z²  
Motorola



LG V30  
LG



ZenFone AR  
ASUS



Mate 9 Pro  
Huawei



Axon 7  
ZTE

	Google Daydream	Samsung Gear VR
<b>Optical Lens</b>	90-degree field of view	101-degree field of view
<b>Display</b>	Depends on device	2560 x 1440 pixel Super AMOLED
<b>Refresh Rate</b>	Depends on device	60 Hz
<b>Required Hardware</b>	Google Pixel, Pixel XL, Huawei Mate 9 Pro, ZTE Axon 7, Motorola Moto Z, Asus Zenfone 3 Deluxe	Galaxy Note 5, Note 7, Galaxy S6, S6 Edge, S6 Edge+, S7, S7 Edge, S8, S8+
<b>Sensor</b>	Accelerator, gyrometer, proximity	Accelerator, gyrometer, proximity
<b>Focal Adjustment</b>	N/A	Focus adjustment wheel
<b>Interpupillary Distance Coverage</b>	~64 mm	54~70 mm
<b>Physical UI</b>	Motion controller (included)	Touchpad, Back button, volume key, and Gear VR controller (included)
<b>Connection</b>	Wireless connection	USB Type-C and MicroUSB
<b>Dimensions</b>	166.8 x 4.18 x 3.88 mm	201.9 x 116.4 x 92.6 mm
<b>Weight</b>	220 grams	310 grams
<b>Color variants</b>	Slate, snow, and crimson	Blue black, orchard gray
<b>Price</b>	\$60 (incl. controller)	\$90 (incl. controller)

# 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 attachments for Nintendo Switch

Includes VR viewer for Switch console

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

Also includes games for the attachments



# Commonalities of LE 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)