

# Virtual Reality Systems

EPFL Immersive Interaction Group

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# Outline

- Head mounted display (HMD)
- Screen limitations
- Tracking System
- Input Devices
- Software Environment

RTIE DE  
COURS →

VIRTUAL HUMANS



# Head Mounted Display

- Oculus Series (Rift, Rift S, Quest & Go)
- HTC Series (Vive, Vive pro eye, Cosmos)
- Samsung Gear VR
- Pimax (5k Plus, 8K X and Plus)
- Playstation VR
- Google Cardboard
- Nintendo Labo VR
- Valve Index



# Oculus Quest

- All-In-One VR Gaming
- Oculus Insight Tracking
- OLED Display, 1440x1600 pixel per eye resolution and a refresh rate of 72 Hz.
- Field of View = 95 degree  
Selling point: No PC, No wire, No limits



Device	Oculus Quest 2	Oculus Quest
Starting Price	\$299	\$399
Pixels per eye	1832 x 1920	1440 x 1600
Screen refresh rate	72Hz at launch, 90Hz to come	72Hz

# HTC Vive Pro Eye

- PC powered
- 360 motion tracking with base stations
- OLED Display, 1440x1600 pixel per eye resolution and a refresh rate of 90 Hz.
- Field of View = 110 degree



Selling point: Embedded Tobii Eye tracker / Gaze-based / Blink-based interactions





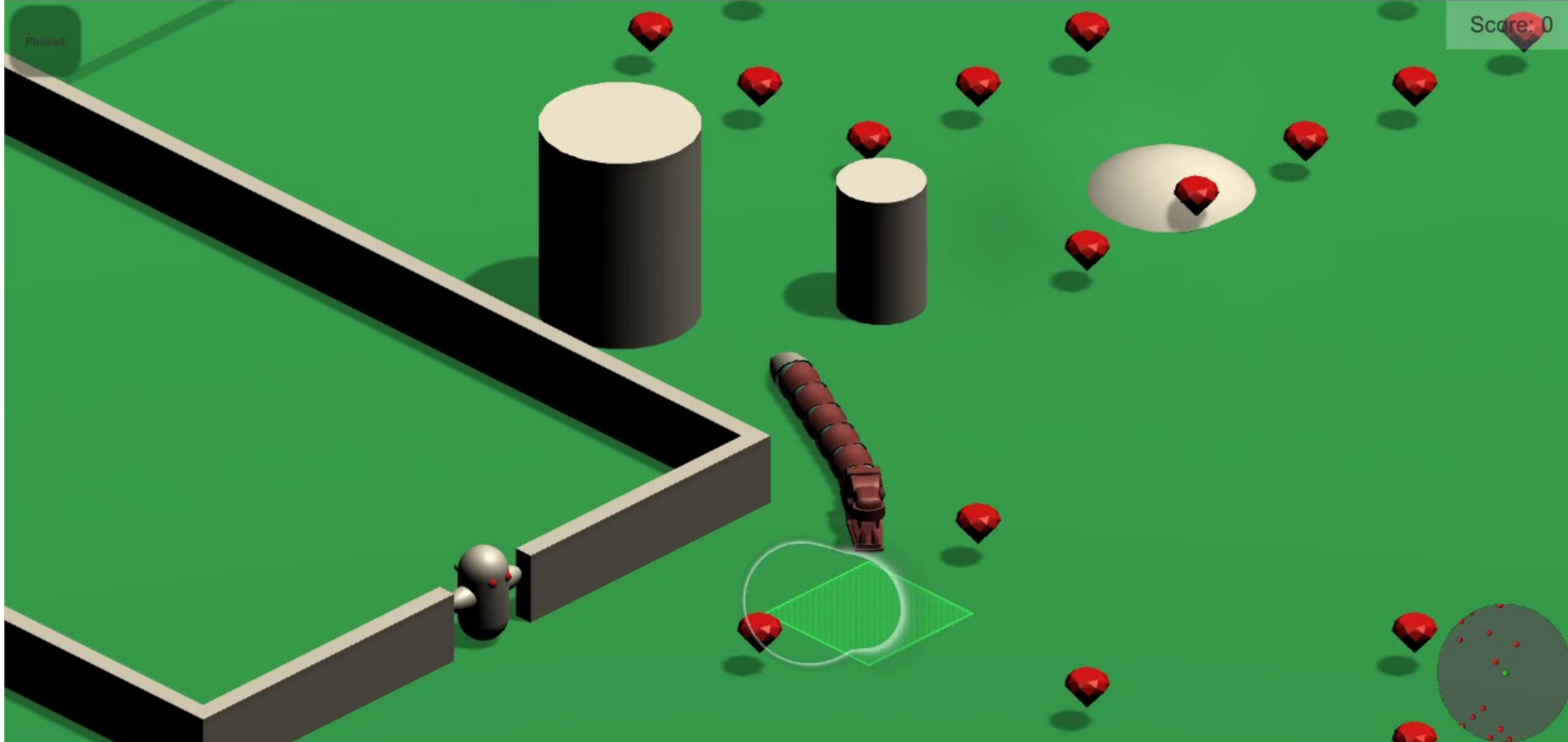
Hand Mirror  
Lip Camera  
Saloch Avatar



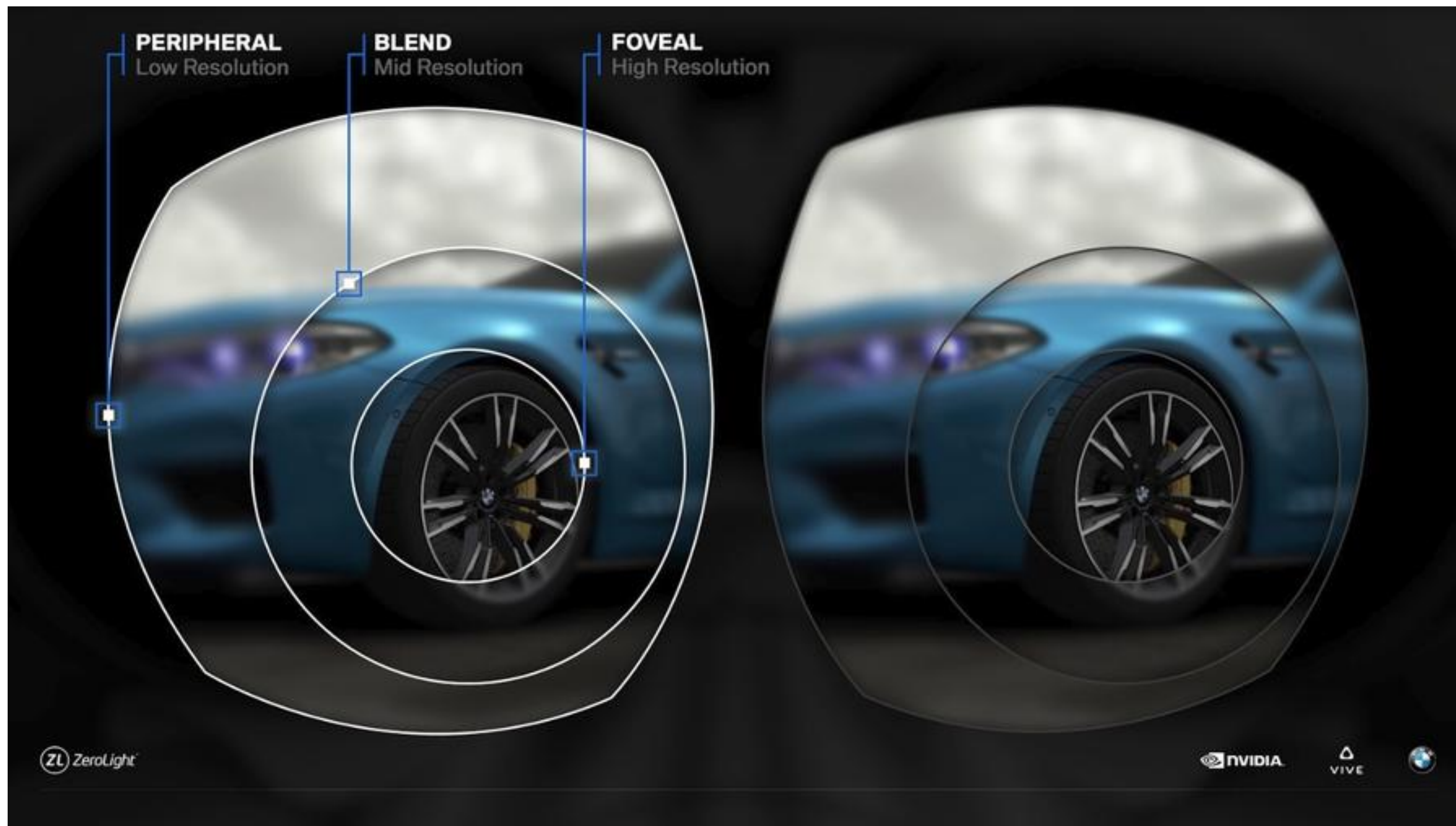
# Tobbi Eye Tracking



- Enable Foveated Rendering
- Inter-Pupillary Distance (IPD) adjustment
- Richer social interactions.
- Natural and intuitive **interactions** that simplify aiming, pointing, and selection with or without handheld controllers



# Foveated Rendering



STANDARD



No Foveated Rendering

# Valve Index

- PC powered
- 360 motion tracking with base stations or lighthouses.
- LCD Display, 1600x1440 pixels per eye resolution and a higher refresh rate of 90/**120/144 Hz**.
- **Field of View of 130 degrees**

Selling point: Wide field of view/Controllers with 87 sensors / Advanced Sound system



# PiMax 5k Plus

- PC powered
- 360 motion tracking with base stations
- CLPL Display, **2560x1440 pixels** per eye resolution and a refresh rate of **120 Hz**.
- **Wide Field of View of 200 degrees**

Selling point: Ultra-wide field of view with high resolution.



# PiMax 8k X

- PC powered
- 360 motion tracking with base stations
- CLPL Display, 3840x2160 pixel per eye resolution and a refresh rate of 75/90 Hz.
- Field of View = 200 degree

Selling point: Ultra-wide field of view with sharpest resolution.

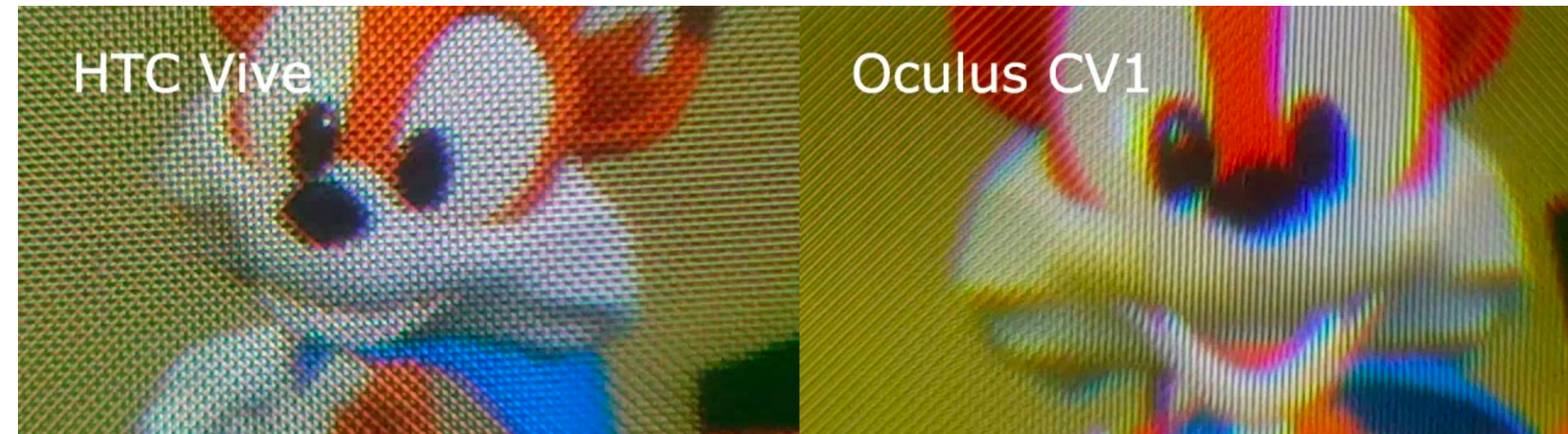


# Field of View Comparison





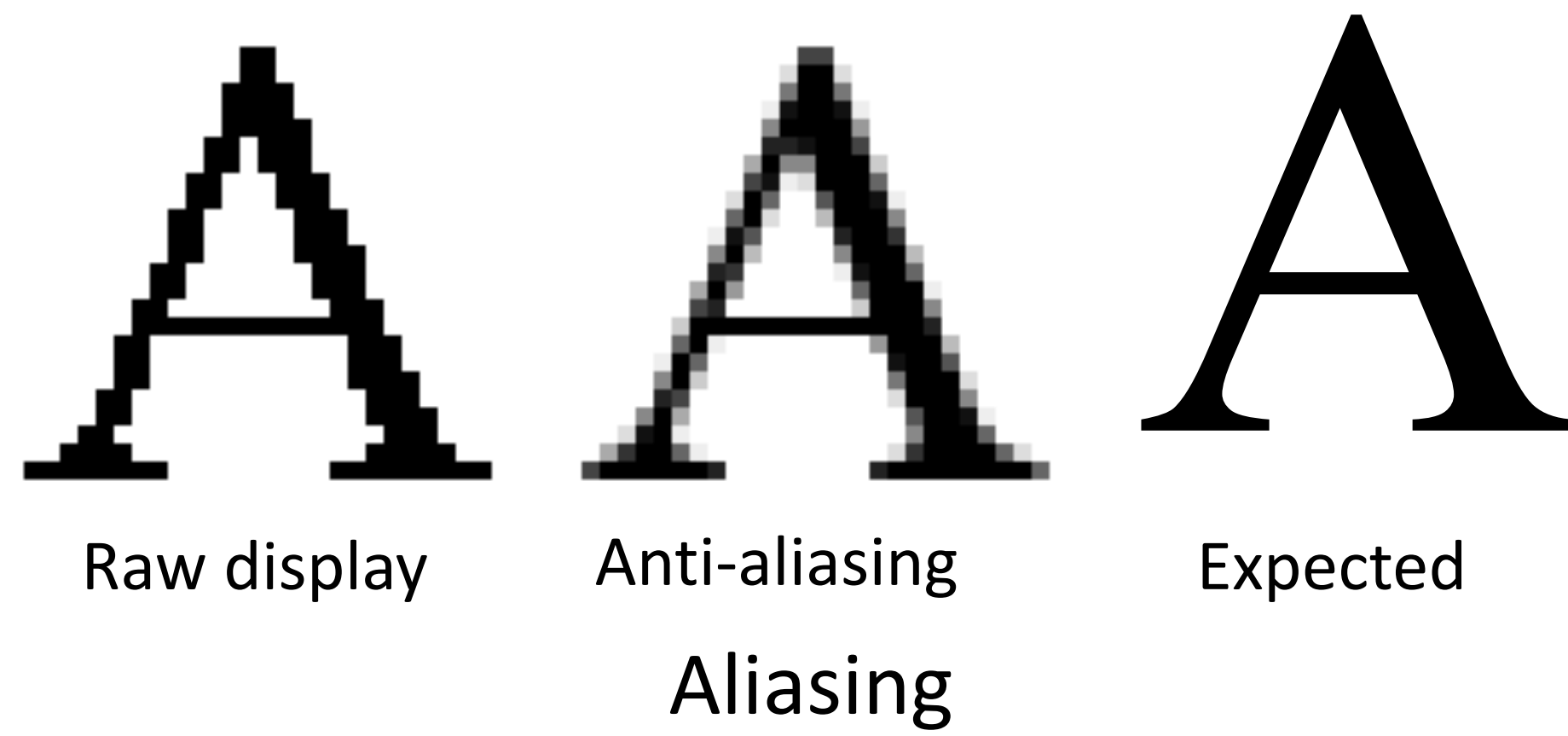
# Device display limitations



Screen Door



Lens Flare



Raw display

Anti-aliasing

Expected

Aliasing

Mura

Pixels unable to output identical color



ROAD TO VR

# Device comparison

Features	Oculus Quest	HTC Vive Pro (Eye)	Valve Index	PiMax 5k Plus
Minimal requirements	A smartphone for the setup only	GTX 1070 Quadro P5000	GTX 970 AMD RX480	GTX 1070
Display technology	OLED	OLED	LCD	CLPL
Remote connection	Limited	DisplayPort 1.2+ USB 3.0	DisplayPort 1.2+ USB 3.0	USB 2.0/3.0 + DP1.4
HMD sensors	IMU, Gyroscope, Cameras	IMU, Gyroscope, (eye tracking -> IPD)	IMU, Gyroscope	IMU, Gyroscope
Controllers inputs	Buttons   Hand tracking	buttons   eye tracking	Capacitive touch / Force sensors	
Field of View	~ 90 degrees	~ 110 degrees	~ 130 degrees	~ 200 degrees
Resolution (per eye)	1440 x 1600 px	1440 x 1600 px	1440 x 1600 px	2560 x 1440 px
Refresh Rate	72 Hz	90 Hz	90 / 120 / 144 Hz	120 Hz
Price (AVG)	CHF 530	CHF 1700	CHF 1100	CHF 810

# Tracking system

## Camera based

- Marker based active tracking
- Marker based passive tracking
- Markerless tracking

## Pros

- No drift over time
- Accurate devices

## Cons

- Occlusions

## Camera free :

- Mechanical capture
- IMU
- Deformable gauges

## Pros

- No occlusions

## Cons

- Low accuracy
- Drifts

# Lighthouse / Base station

- Active tracking marker based
- Rotating laser @6000rpm
- Range of 7m per base station
- FoV :  $160^{\circ} \times 115^{\circ}$
- 4 Base stations can cover up to 10 x 10 m surface
- The device scan the environment to identify without error the ID of each device



# Vicon Shogun

- Passive marker based solution
- High refresh rate
- High accuracy
- Unable to identify markers without context
- Expensive system
- Targets a professional market



Performer equipped with passive suits for motion capture using Vicon Shogun

# Oculus Quest Tracking

- Passive tracking
- Use computer vision with wide angle camera based sensors to locate the headset in space
- Doesn't requires external devices
- These cameras also provides a markerless finger tracking



# Input Devices

- Oculus Touch
- Vive controller
- Knuckles
- Etc.

# Oculus Touch

Each controller contains

- One joystick
- Two press buttons
- Two trigger buttons
- One meta button
- Infrared tracking
- IMU and Gyroscope
- Vibrators





# Vive Controller

Each controller contains

- A trigger
- Two meta buttons
- A tactile button pad
- Two lateral buttons
- IMU and Gyroscope
- Infrared tracking
- Vibrators



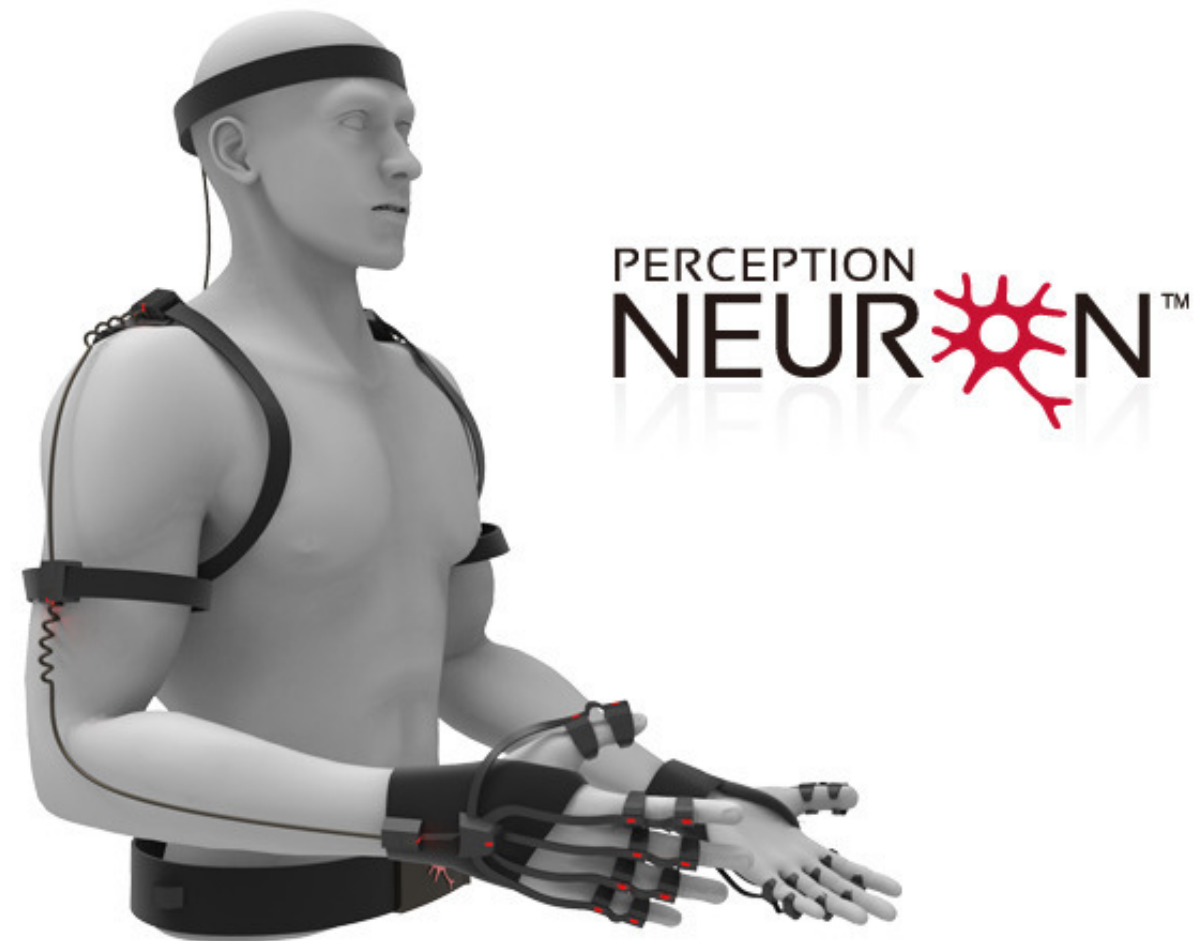
# Knuckles

Each controller contains

- One joystick
- Two press buttons
- One trigger
- One meta button
- Finger tracking through proximity sensors



# Miscellaneous Inputs



Manus VR



PlayStation Controllers



Windows Mixed Reality

# Software Environment : Game Engine / Editor

- Handles the core of the Game such as
  - Frames
  - Rendering
  - Sound
  - Collisions
  - Physics
  - Etc.
- Provides a framework for developers

# Common Games Engines



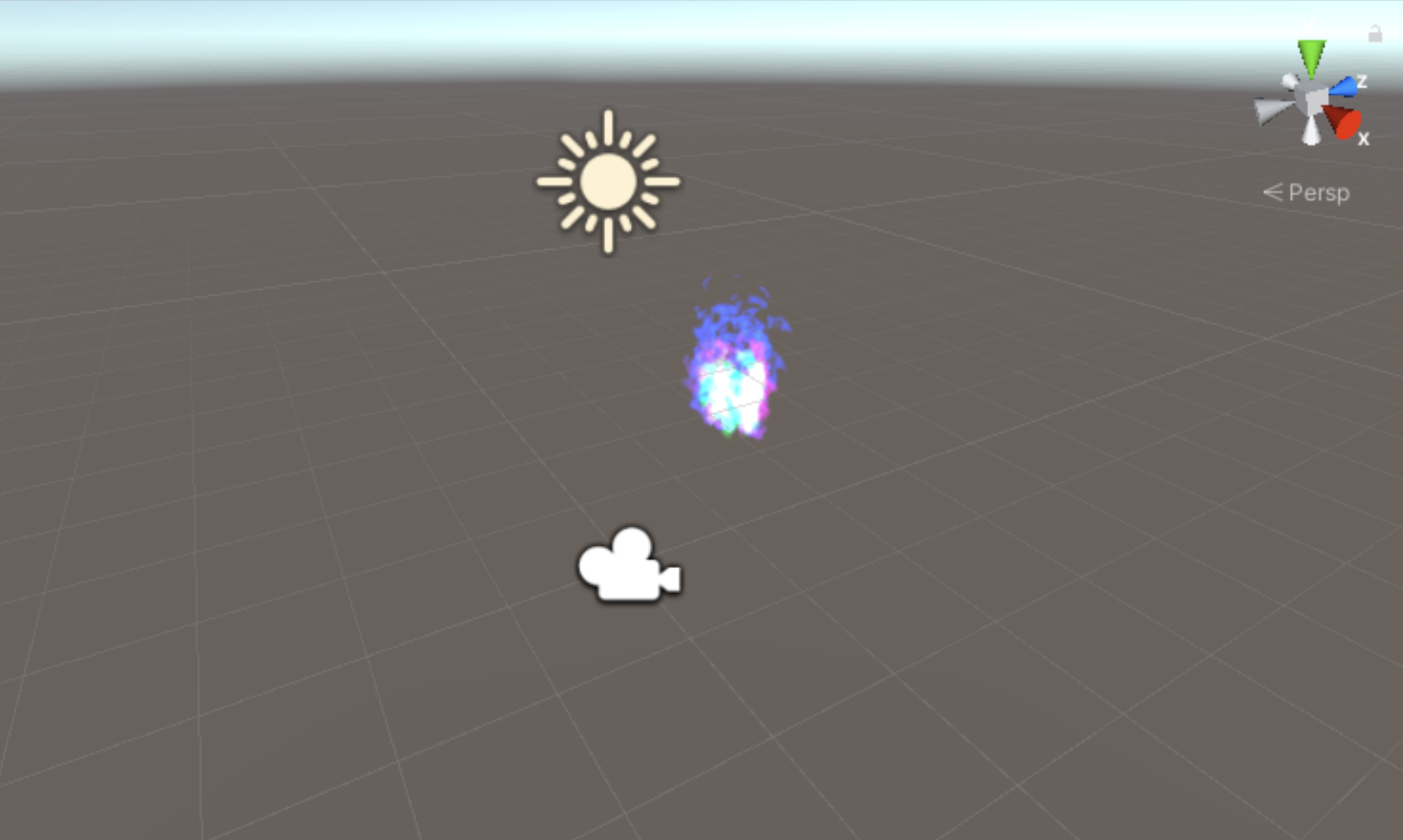
Proprietary



Open Source

# Unity 3D

- Widely used (many forums available with tips)
- Licensed software (free for education / personal use)
- Multi-target support (Linux, Android, Windows, Mac, PS4, Switch, Etc.)
- Scripting in C# (or JS)
- Perfect integration with Visual Studio
- Many resources through the asset store
- Technology we use within the IIG



- SampleScene
  - Directional Light
  - Fire\_Magic\_SharpTexture
  - OVRCameraRig
  - Controler

Assets > Oculus > VR > Prefabs

Cursor_Tl...	OVRCame...	OVRControl...	OVRCube...	OVRCusto...	OVRCusto...	OVRHandP...

OVRPlayer...

# Questions ?