Virtual Reality Systems

EPFL Immersive Interaction Group

Mathias DELAHAYE – Nana TIAN

2020

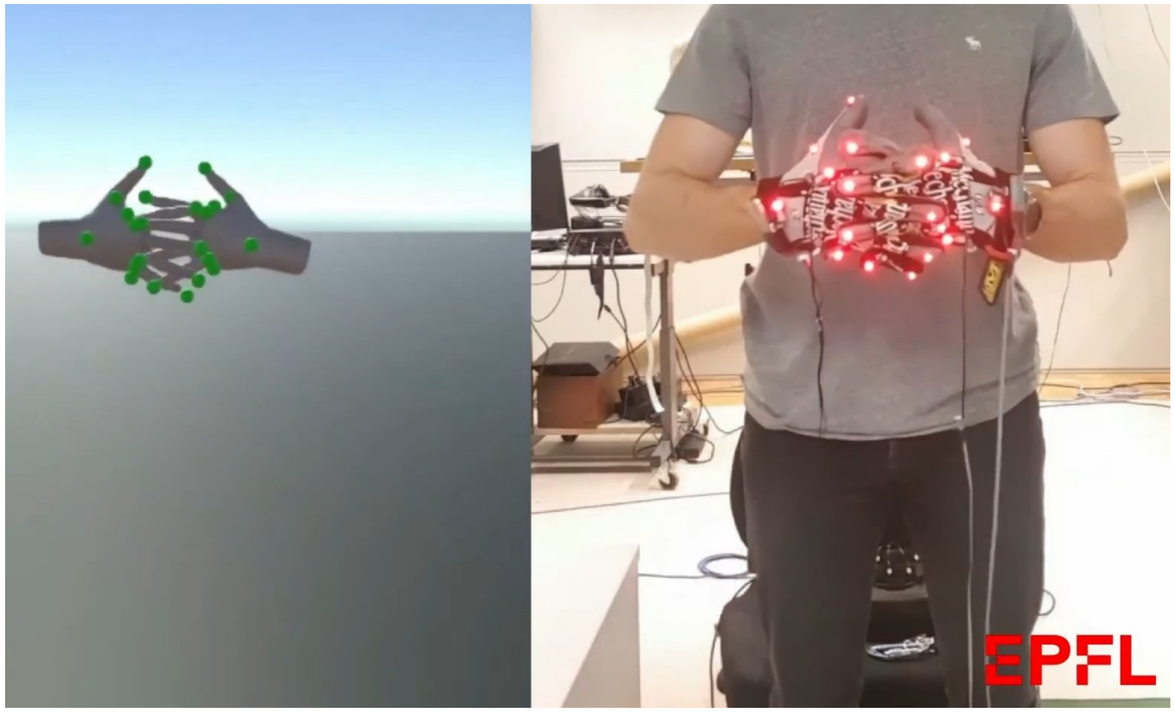
EPFL

IIG

My research interest_Nana

- Interplay between **Cybersickness** and **Embodiment**
- Inducing **Emotion** via VR games

Research field



Finger level control

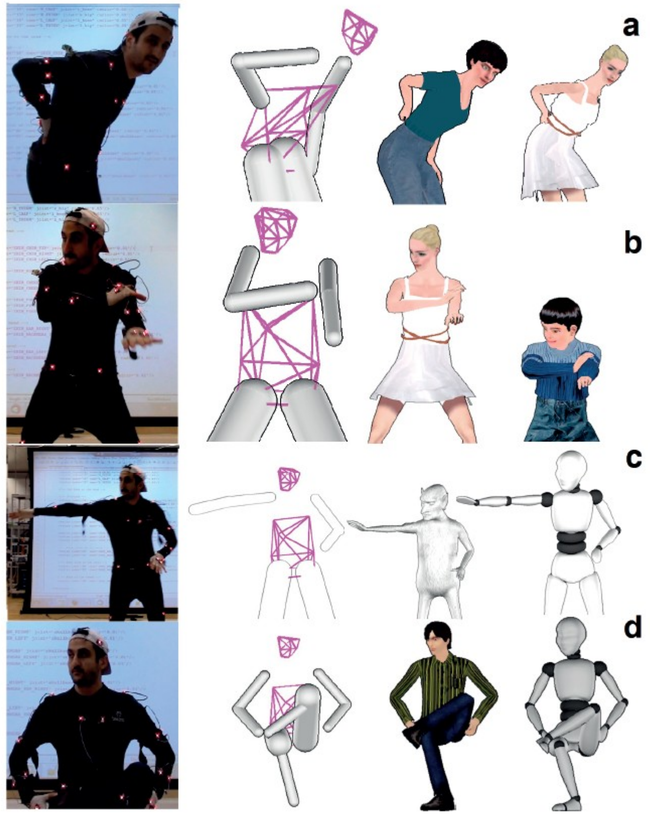
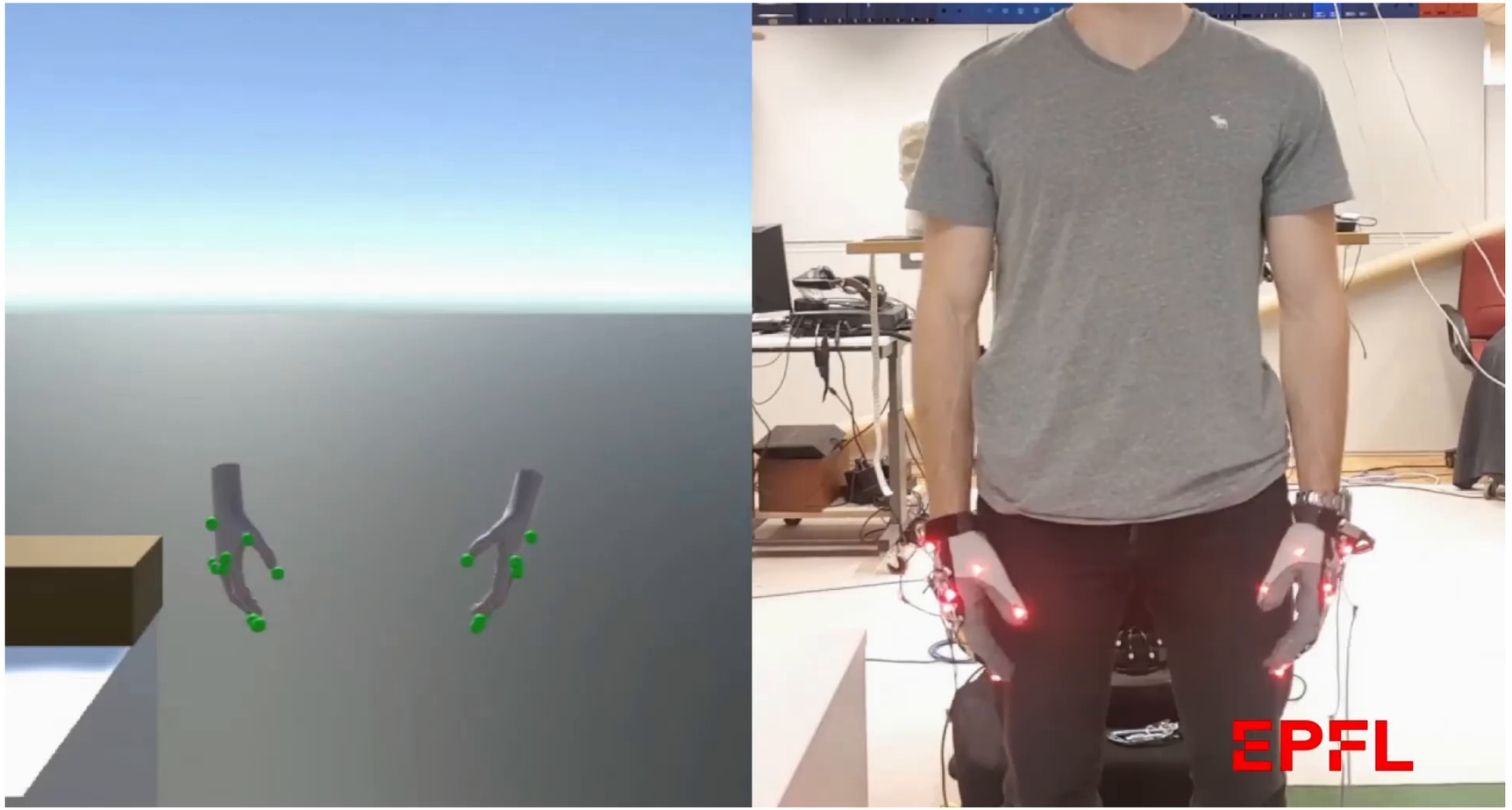


Figure 6.20: Performance Animation. Left: Performed posture. Second column: Captured motion. Last two columns: Our results. a) Back pain. b) Haka dance. c) Contact free dance. d) Leg crossing. E. Molla

Polymorphic embodiment

Research field



Outline

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


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

HTC Vive Pro Eye

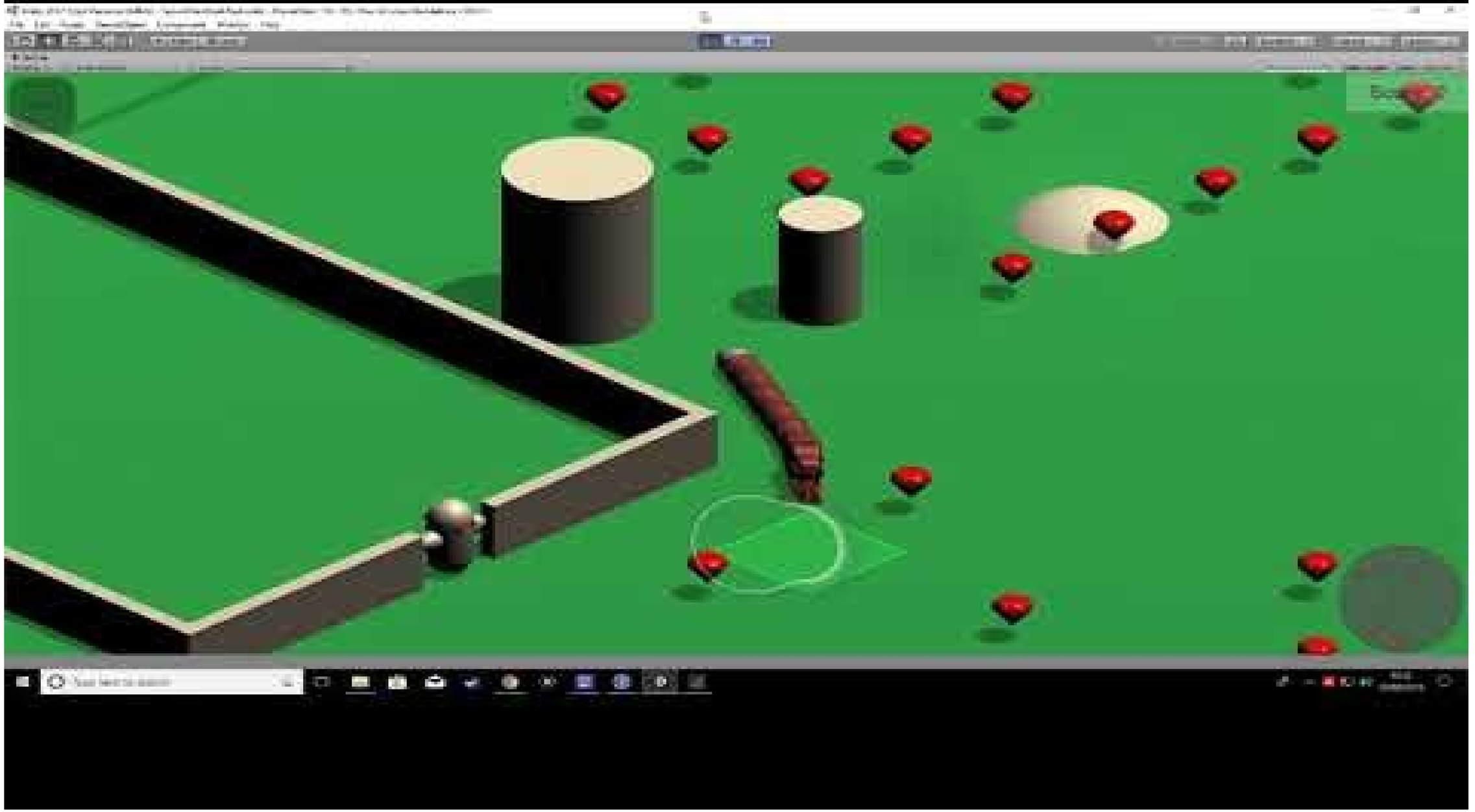
- PC powered
- 360 motion tracking with base stations
- OLED Display, 1440x1600 pixel per eye resolution and a refresh rate of 90 Hz.
- Field of View = 110 degree

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

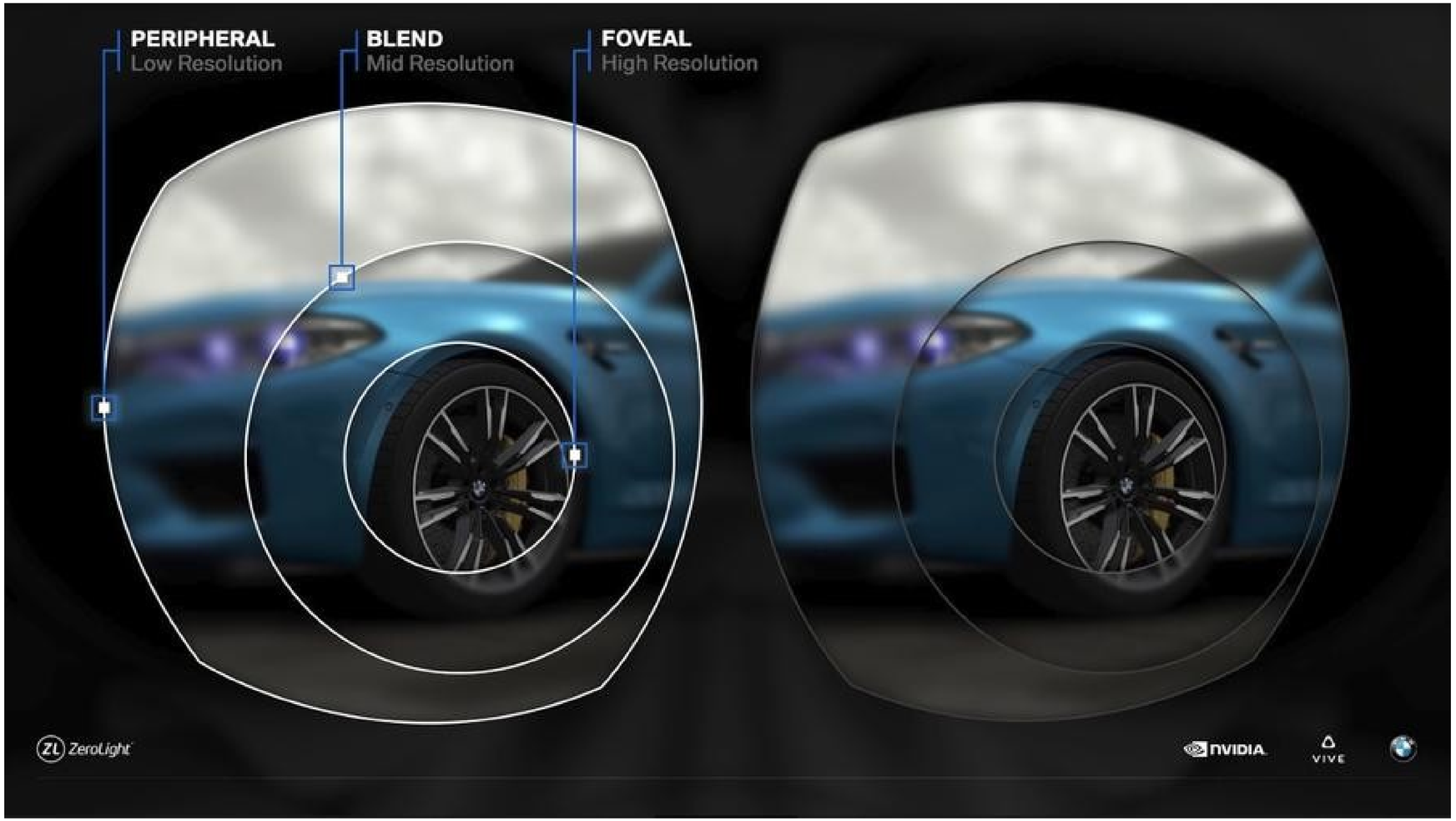

Mirror
Switch Avatar

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



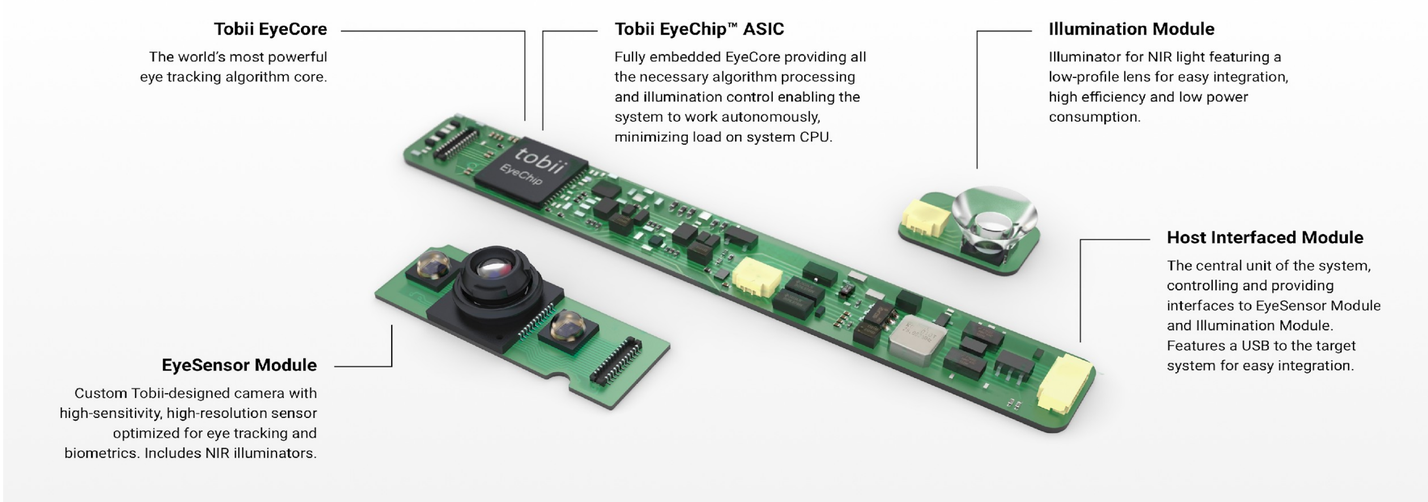
Foveated Rendering




STANDARD
No Foveated Rendering

Eye Tracking Technology

- The eye tracker emits a near infrared (NIR) light beam.
- This light is reflected in the user’s eyes
- The reflections are captured by the eye tracker’s cameras
- Through filtering and triangulation, the eye tracker determines where the user is looking-the gaze point-and calculates eye movements data.



HTC Vive Pro Eye Technical Specifications

- Gaze data output frequency (binocular) 120 Hz
- Trackable Field of view = 110
- Data output (eye information) : Gaze origin / Gaze direction / Pupil position /Pupil size / Eye openness
- Accuracy: 0.5°–1.1°
- Calibration: 5 points.

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.

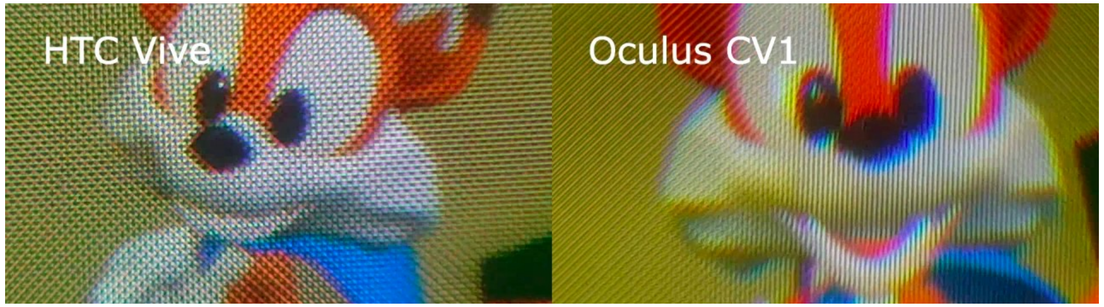
PiMax 8k X

- 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.

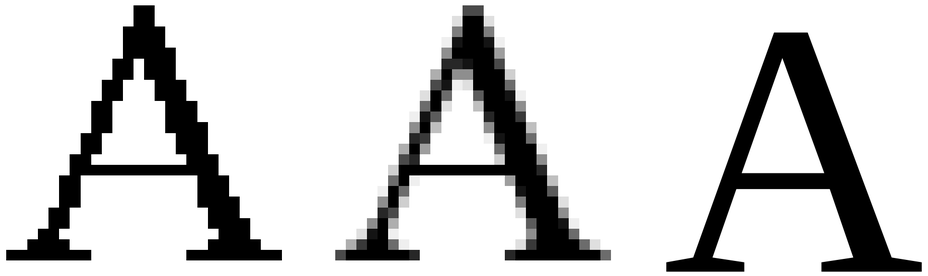
Field of View Comparison

Device display limitations



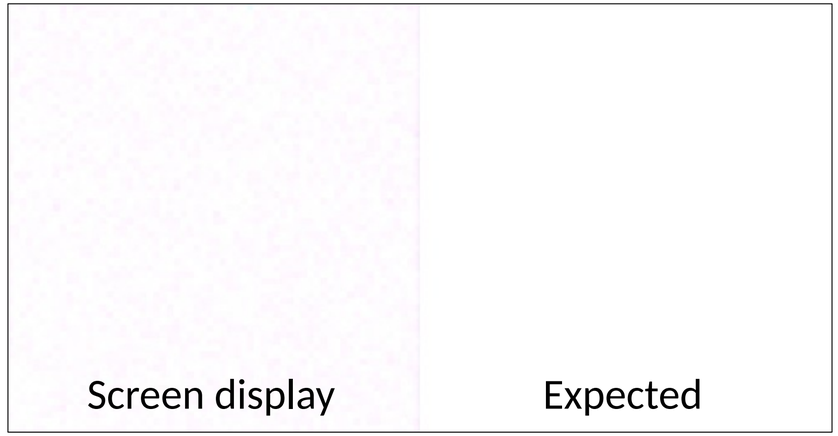
Screen Door

Lens Flare



Raw display Anti-aliasing Expected

Aliasing



Mura Effect

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 º x 115 º
- 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

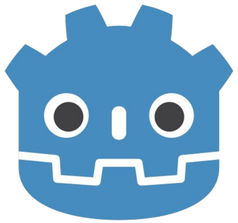
PlayStation Controllers

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

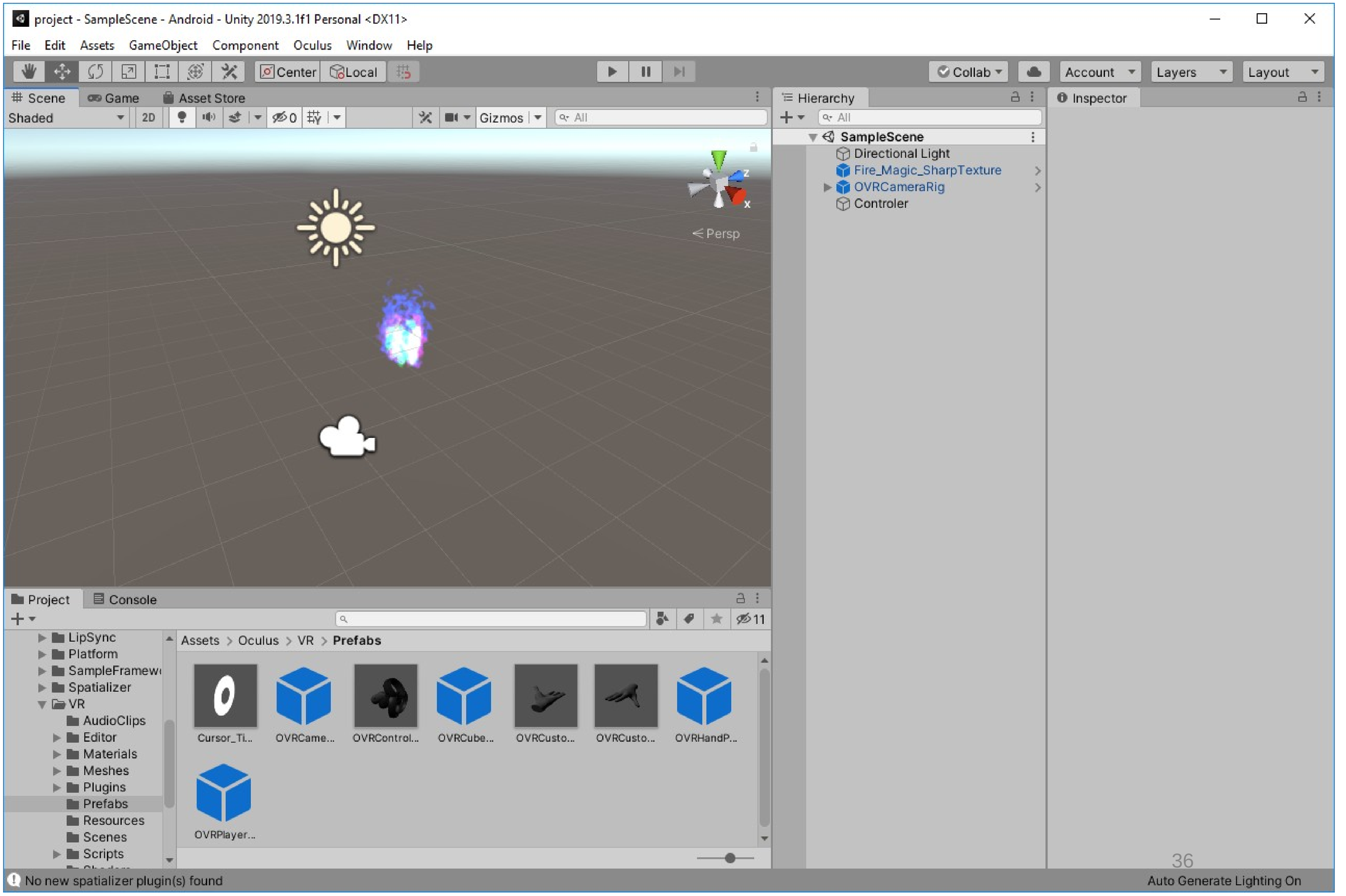


Proprietary

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


project - SampleScene - Android - Unity 2019.3.1f1 Personal <DX11>
File Edit Assets GameObject Component Oculus Window Help
Center Local
Collab Account Layers Layout
Scene Game Asset Store
Shaded 2D Gizmos All
Persp
Hierarchy
SampleScene
Directional Light
Fire_Magic_SharpTexture
OVRCameraRig
Controler
Inspector
Project Console
LipSync Platform SampleFramew Spatializer VR
AudioClips Editor Materials Meshes Plugins Prefabs Resources Scenes Scripts
Assets > Oculus > VR > Prefabs
Cursor_Ti... OVRCame... OVRControl... OVRCube... OVRCusto... OVRCusto... OVRHandP...
OVRPlayer...
No new spatializer plugin(s) found
Auto Generate Lighting On

Questions ?