

Virtual Reality and Physically-Based Rendering Tutorial

05.11.26

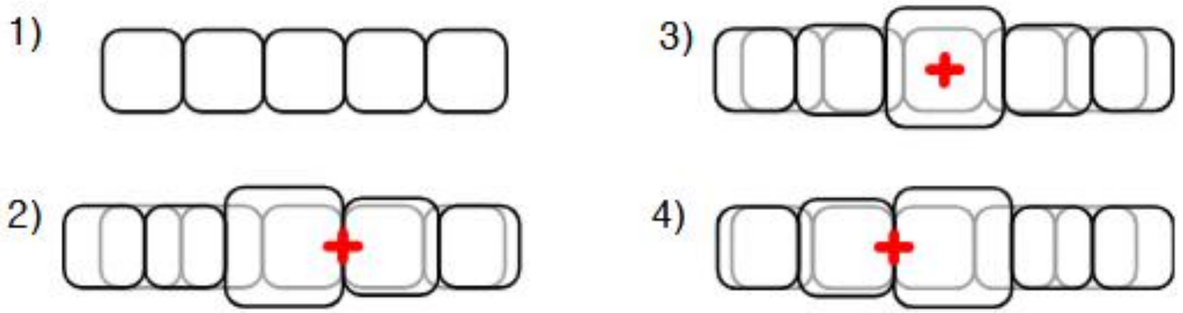
Assignment 2

Assignment 2 – Exercise 1

Exercise 1 (Fitts's Law and Apple's Dock, *3 Credits*)

Explain why the dynamic magnification effect of icons in Apple's dock (as discussed in the lecture) does *not* increase the effective target size. Hint: you might want to review the concepts of "display space", "motor space", and "C-D ratio".





Assignment 2 – Exercise 2

Exercise 2 (Interaction Taxonomies, *3 Credits*)

The lecture introduced the concept of taxonomies to classify interaction techniques and systematically explore the design space of possible interactions in VR. The goal of this exercise is to develop your own taxonomy for a chosen interaction task and use it to design two different interaction techniques.

1. Choose an interaction task (either in VR or the real world) and briefly describe it. Develop a graphical taxonomy containing at least three independent design dimensions, each with at least two possible alternatives.

   You may use the taxonomies presented in the lecture as inspiration, but do not simply reproduce them.

2. Use your taxonomy to construct two different interaction techniques by combining alternatives from the identified design dimensions. Briefly explain how each technique works.

Assignment 2 – Exercise 3

Exercise 3 (Coral Reef & Fast Motion Sickness Scale, *4 Credits*)

As discussed[1], you will find the PCs set up for VR (using Meta Quest 3 HMDs) in our big lab and small lab. Before launching the Coral Reef demo, make sure that the Meta Horizon App is running and then start SteamVR. When you are done, close SteamVR. For other Unreal projects, you should not need to interact with SteamVR.

Launch the Coral Reef demo by clicking on the shortcut on the desktop. In this demo, you can experience a virtual coral reef environment in VR. Try out the following two movement modalities separately (take a short break between each of them):

- **Swimming**: use physical movements to swim around (act as if you were swimming with both of your arms). You can do this regardless of what item(s) you currently hold in your hands.
- **Aqua scooter**: a small motorized device that pulls you in the direction in which you point it. In the demo, it is the yellow object shown in Figure 1. You need to grip both handles; otherwise, the aqua scooter will not work. When both hands are holding the handles, hold the left trigger to pull yourself forward. Steer by moving your arms in the direction you want to go.

Assignment 2 – Exercise 3

FMS-Instruction (English)

Dear participant,

The following scale was designed to measure your general discomfort, in particular nausea. The experimenter will ask you to verbally report how you feel once every minute. We kindly ask that you respond to this question by choosing a single score on the following 20-point rating scale:

0 ----1----2----3----4----5----6----7----8----9----**10**---11---12---13---14---15---16---17---18---19---**20**

NO SICKNESS AT ALL FRANK SICKNESS

Thus, a score of 0 indicates that you feel perfectly fine, whereas a score of 20 indicates severe nausea to the brink of vomiting.

Please focus in your ratings on currently felt nausea, general discomfort, and stomach problems. It is very important that you respond honestly. You should also note that any additional feelings, such as fatigue, boredom, excitement, nervousness etc., should not influence your rating.

If you have any questions, please ask the experimenter now.

Assignment 2 – Exercise 4

Exercise 4 (Unreal Materials, *3 Credits*)

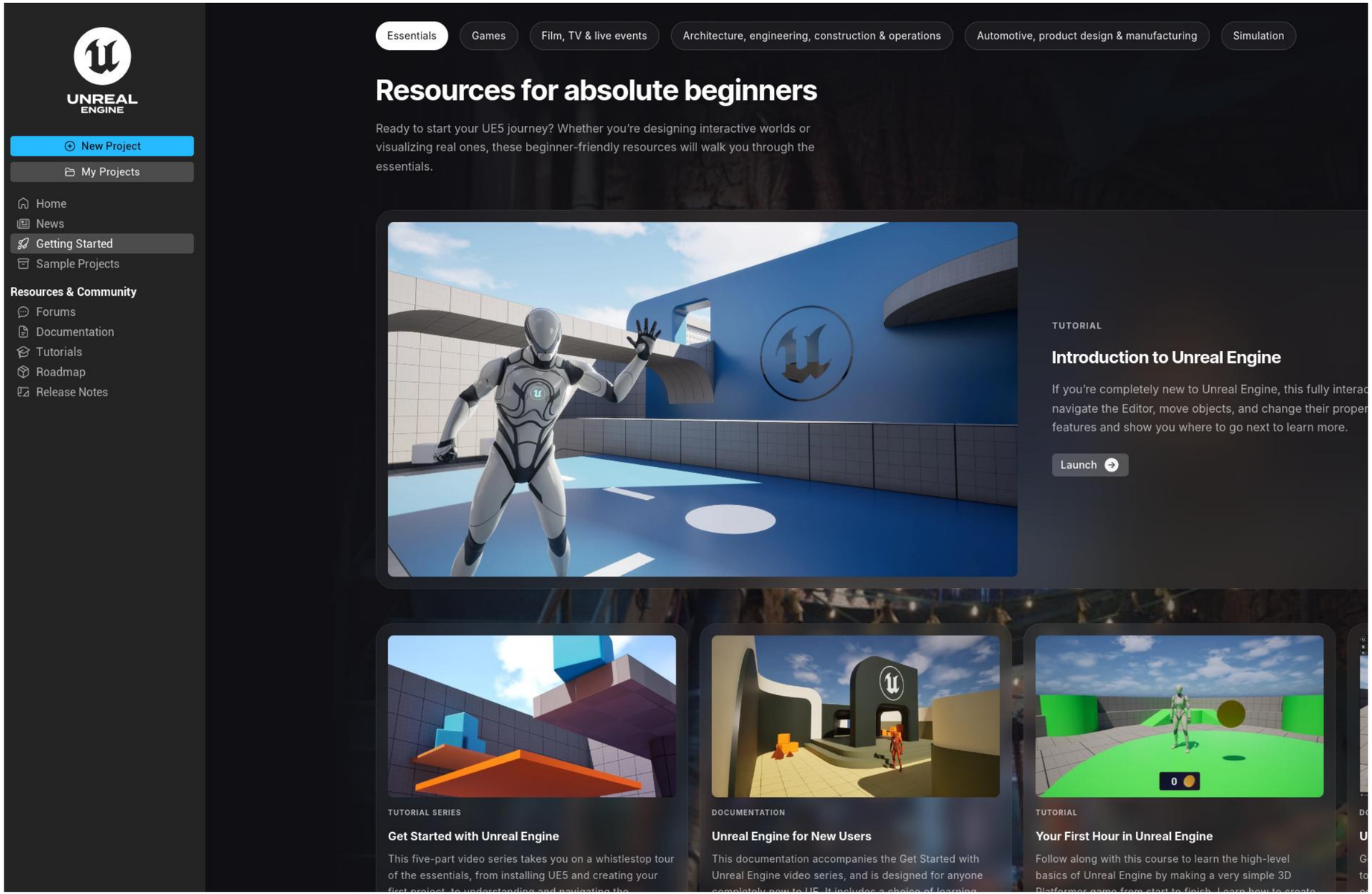
Materials are an essential component of Unreal Engine 5, defining the visual appearance of objects in a scene. Now, you'll get practical experience with materials by reconstructing the scene shown in Figure 2. You can download the scene (*Framework ex. 3*, built against Unreal Engine 5.8), which currently has no materials, from the course website. Once you've got the scene, here's what you'll need to do:

a) Create two different materials for the two spheres in the scene: One material should make a sphere look rough. The other material should make a sphere look metallic.

b) Create another material that applies the texture *banner/banner_tex* to the flat display surface in the scene.

c) Make the *Hello!* text appear to glow by giving it a material that emits light.

d) Animate the *Hello!* text so that it moves horizontally across the display surface.


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Assignment 2 – Exercise 5

Exercise 5 (Hello VR, *0 Credits*)

In future assignments, we will be working with VR. To prepare for this, make sure you have access to a Head-Mounted Display (HMD) and can run an Unreal Engine project in VR.

Several workstations in our labs are already equipped with Meta Quest 3 HMDs and have all the necessary software installed and configured. You can use these workstations to complete this exercise without having to set up the hardware yourself. Alternatively, Meta Quest 1 HMDs are available to borrow (first come, first served). Please contact us if you would like to borrow one.

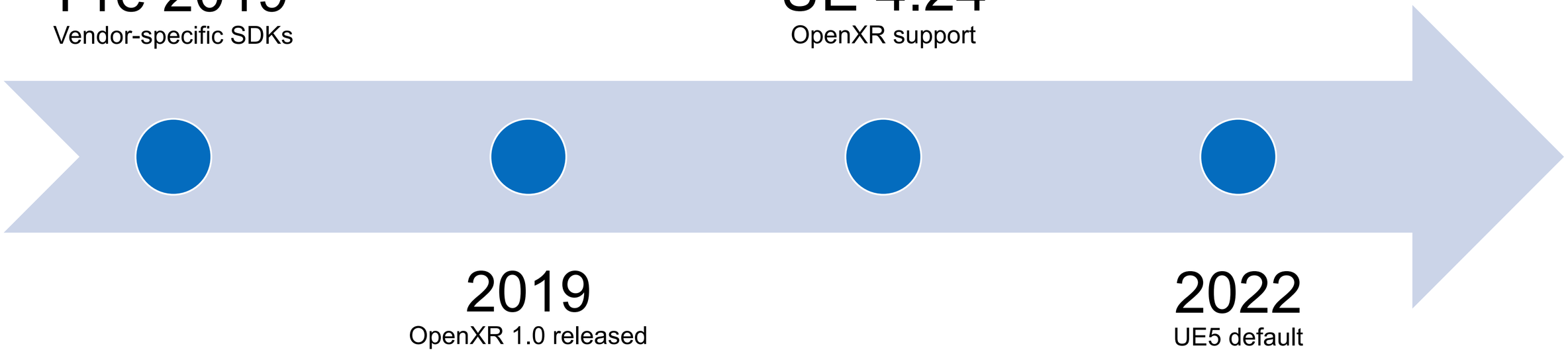
Create a new Unreal Engine project using the **VR Template** and launch it in VR. Make sure that the environment is displayed correctly in the headset and that the controllers and basic interactions work as expected.

Additional resources for using Unreal Engine 5 with Meta Quest headsets:

1. Meta Quest Unreal Engine documentation: `https://developers.meta.com/vr/documentation/unreal/unreal-engine-basics/`
2. Meta Quest 3 setup guide: `https://www.meta.com/en-gb/help/quest/1000469391293478 3/`

VR Development

VR SDKs


Pre 2019
Vendor-specific SDKs
2019
OpenXR 1.0 released
UE 4.24
OpenXR support
2022
UE5 default

Standalone vs. PC-VR

- Standalone:
  - Runs on HMD hardware
  - No external PC required
  - Android build
- PC-VR:
  - Runs and renders on an external PC
  - Video streaming via USB or WiFi
  - Usually higher graphic possible
  - Typical setup for development

Meta Quest 3



Meta Quest 3 - Setup

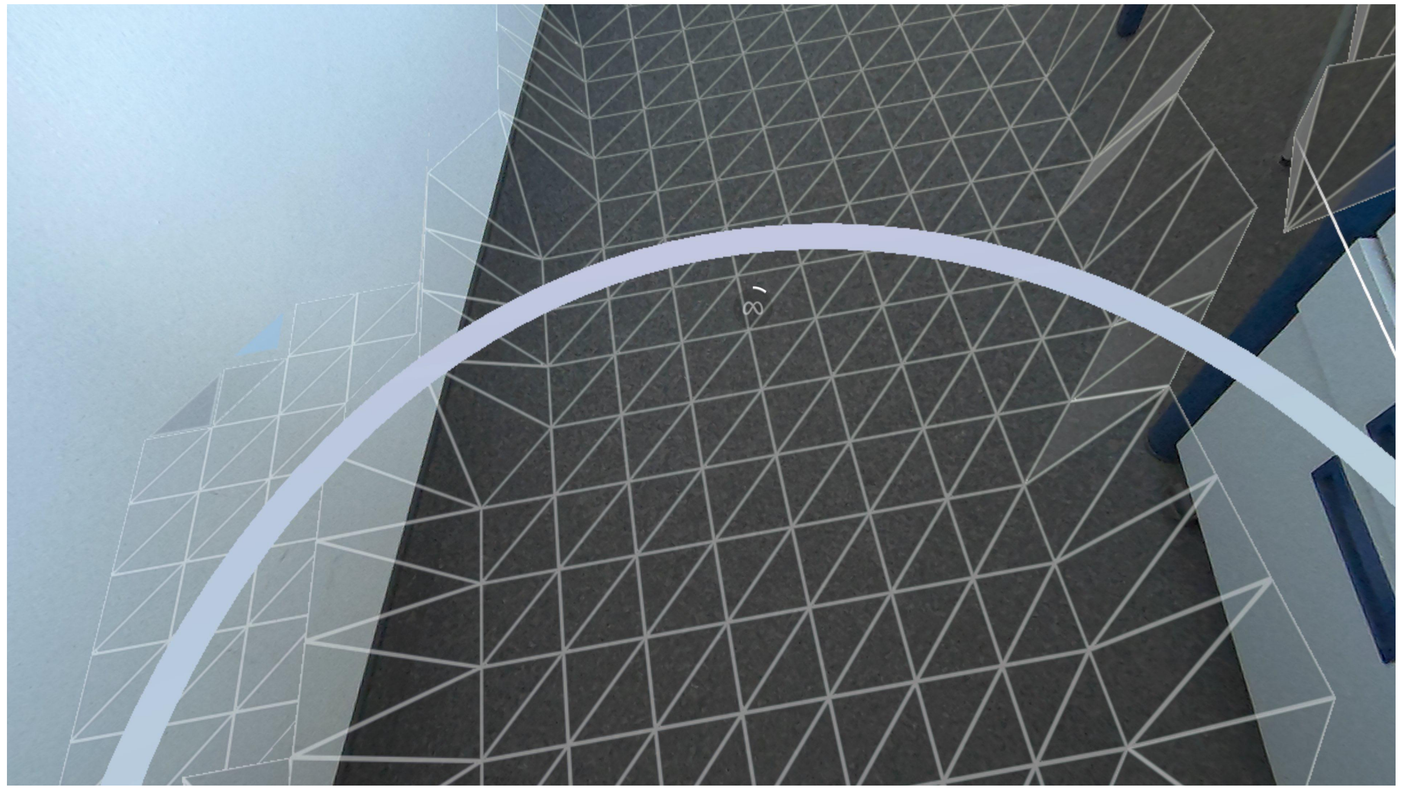
1. Connect the HMD to your PC

   (USB or WiFi)



Meta Quest 3 – Tracking & Boundary

- No external base stations, internal sensors
- Controller & hand tracking
- Boundary
- Floor calibration



Meta Quest 3 – Controls

- Trigger button
- Primary input key
- For example to click a button in the UI



Meta Quest 3 – Controls

- „Home“-Button
- Reset view, orientation, floor height
- Open menues in fullscreen applications



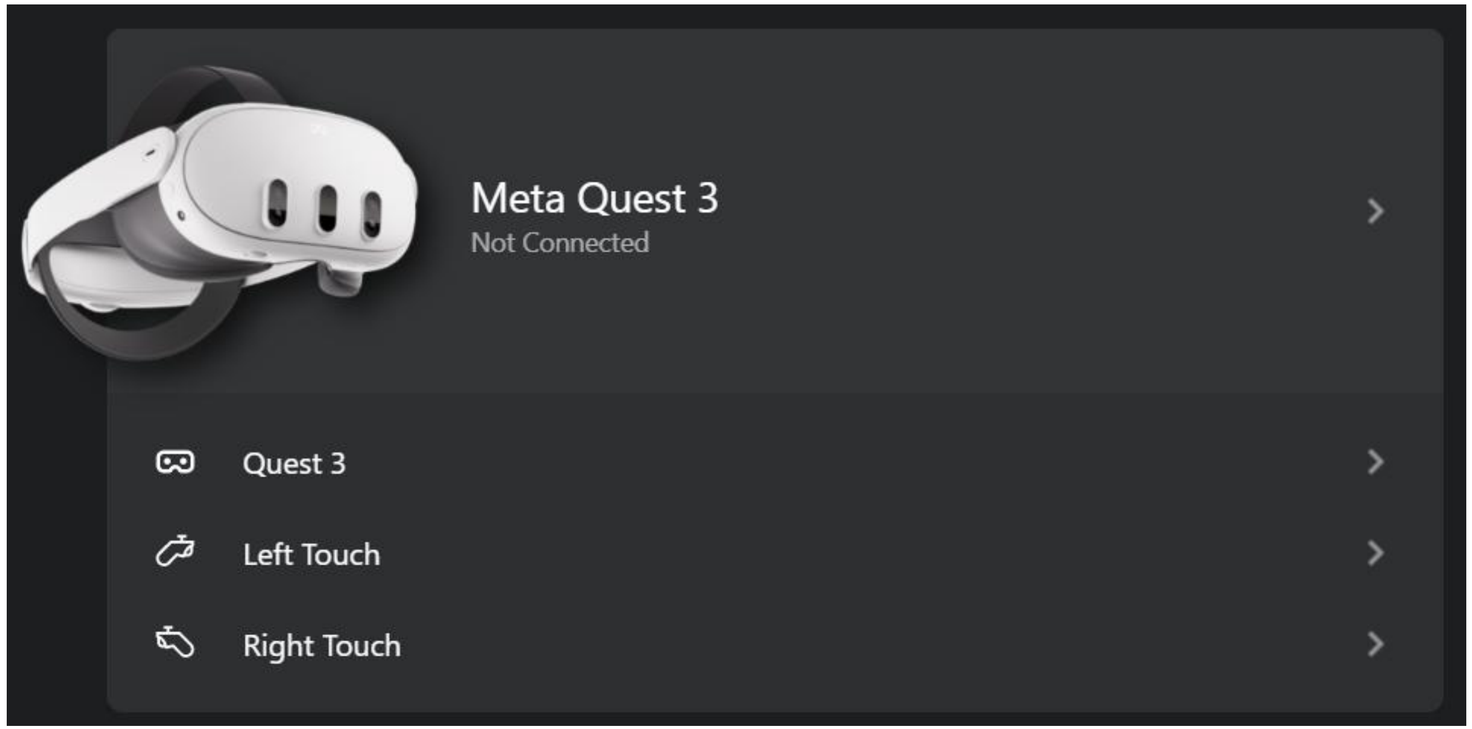
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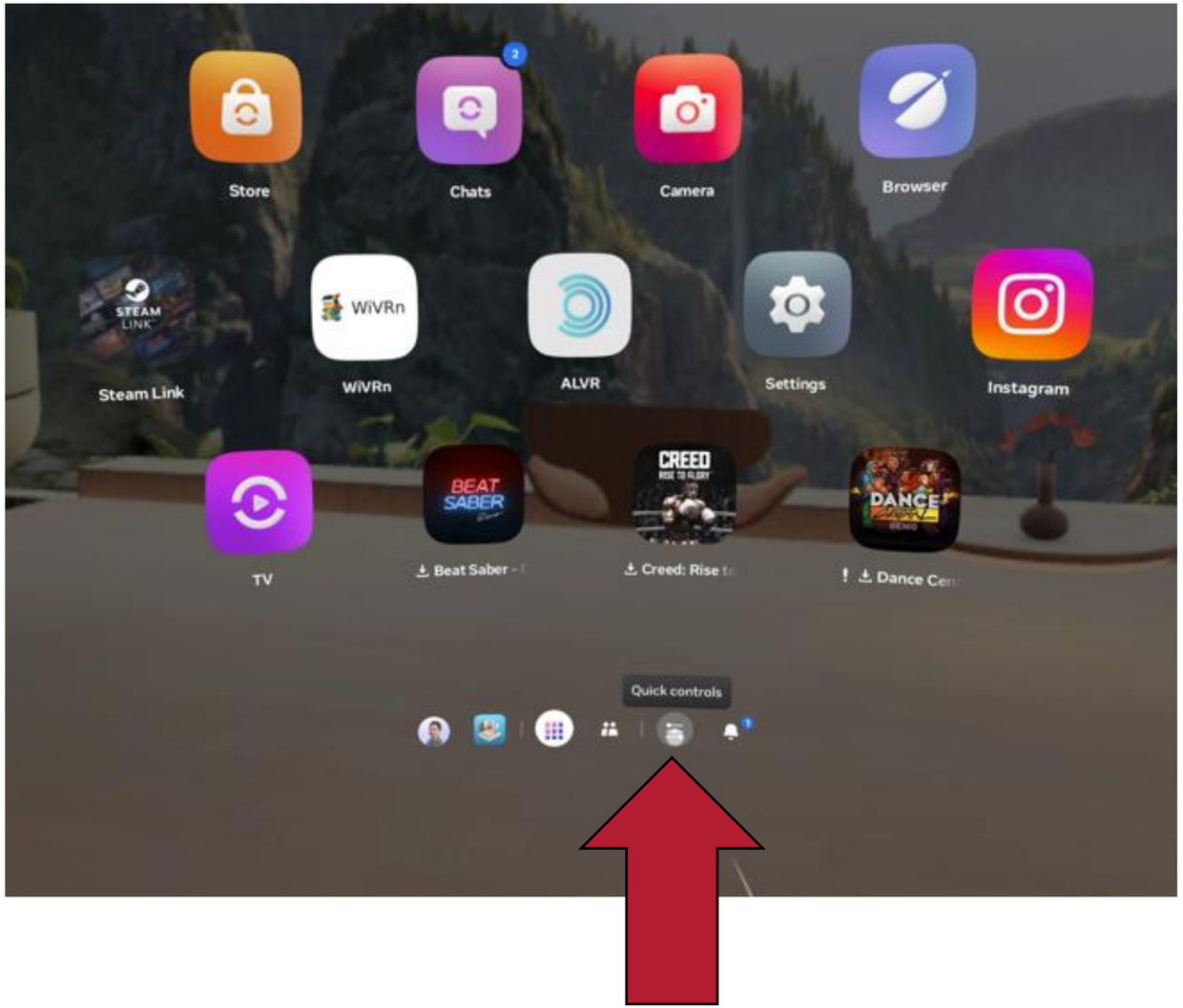
2. Start Meta Horizon Link on the

   PC



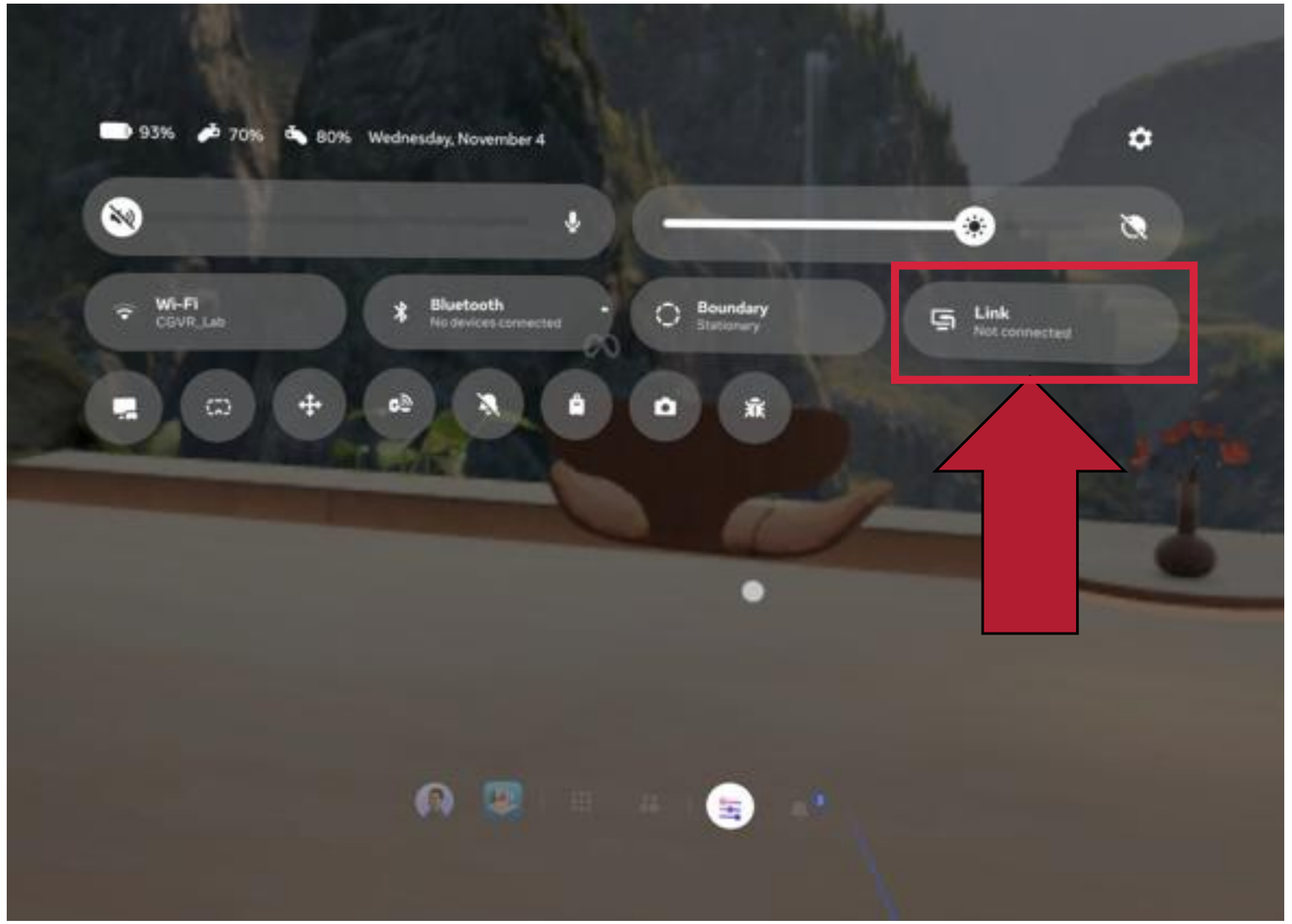
Meta Quest 3 - Setup

1. Connect the HMD to your PC (USB or WiFi)
2. Start Meta Horizon Link on the PC
3. Connect to Link in the HMD (either via popup or quick controls)



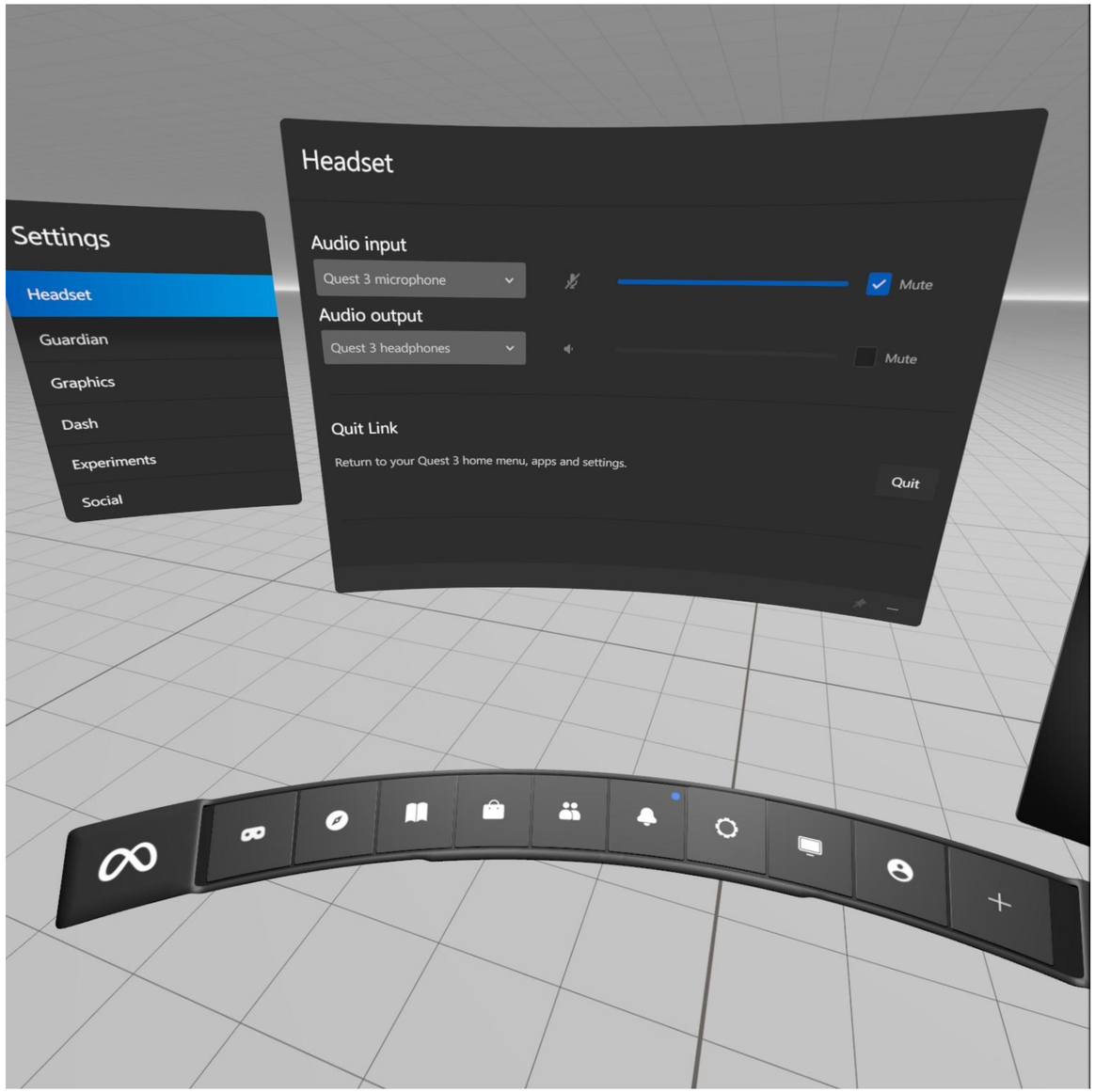
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Meta Quest 3 - Setup

1. Connect the HMD to your PC (USB or WiFi)
2. Start Meta Horizon Link on the PC
3. Connect to Link in the HMD
4. Link waiting for application

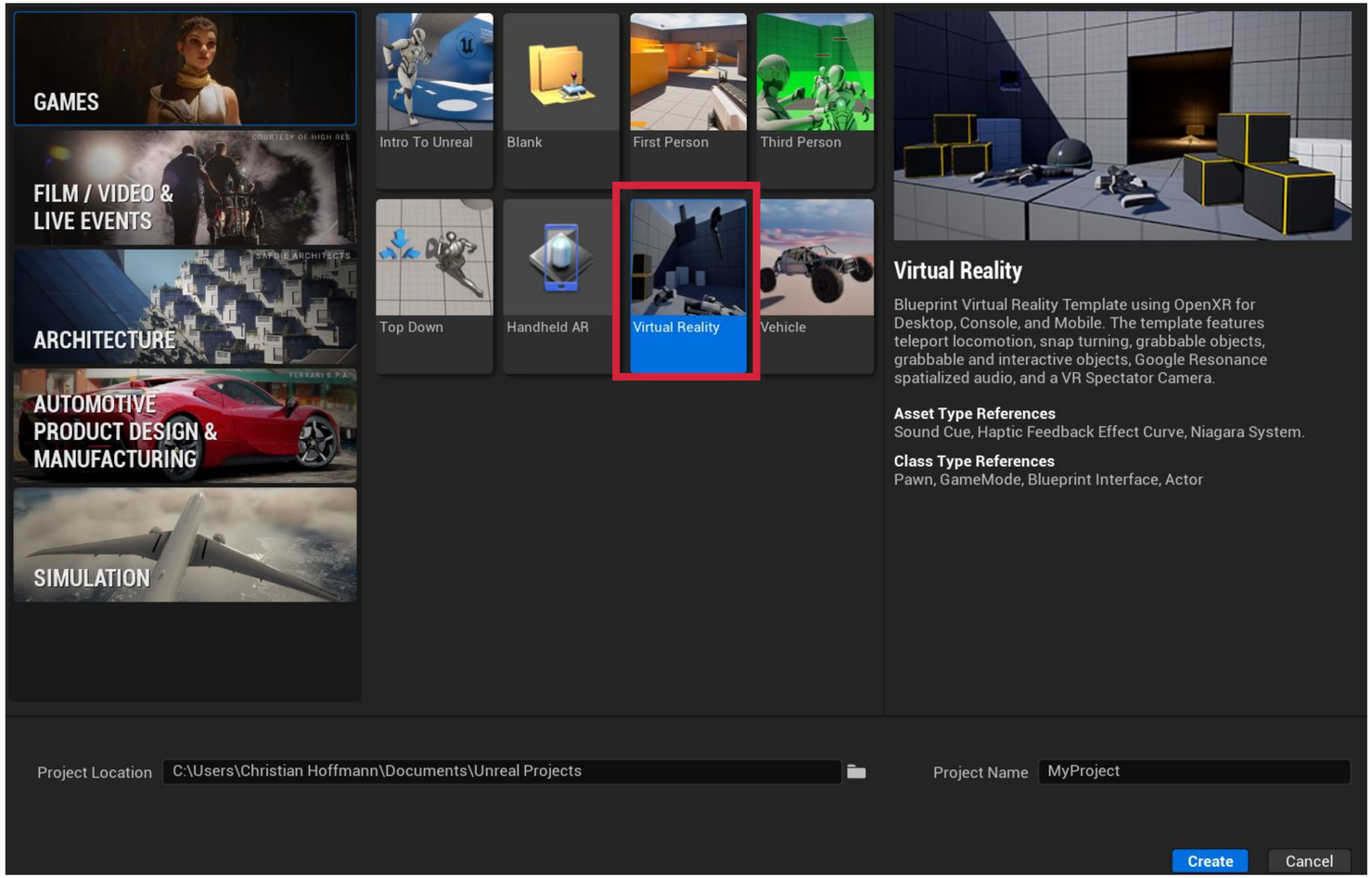


SteamVR

- Valve's VR platform, widely used before OpenXR
- Still popular for PCVR gaming (Steam)
- Supports legacy VR applications using OpenVR
- Also provides an OpenXR runtime for modern applications
- For our exercises:
  - Coral Reef (UE4): Start SteamVR after Quest Link
  - UE5 VR Template: SteamVR not required with Meta's OpenXR runtime

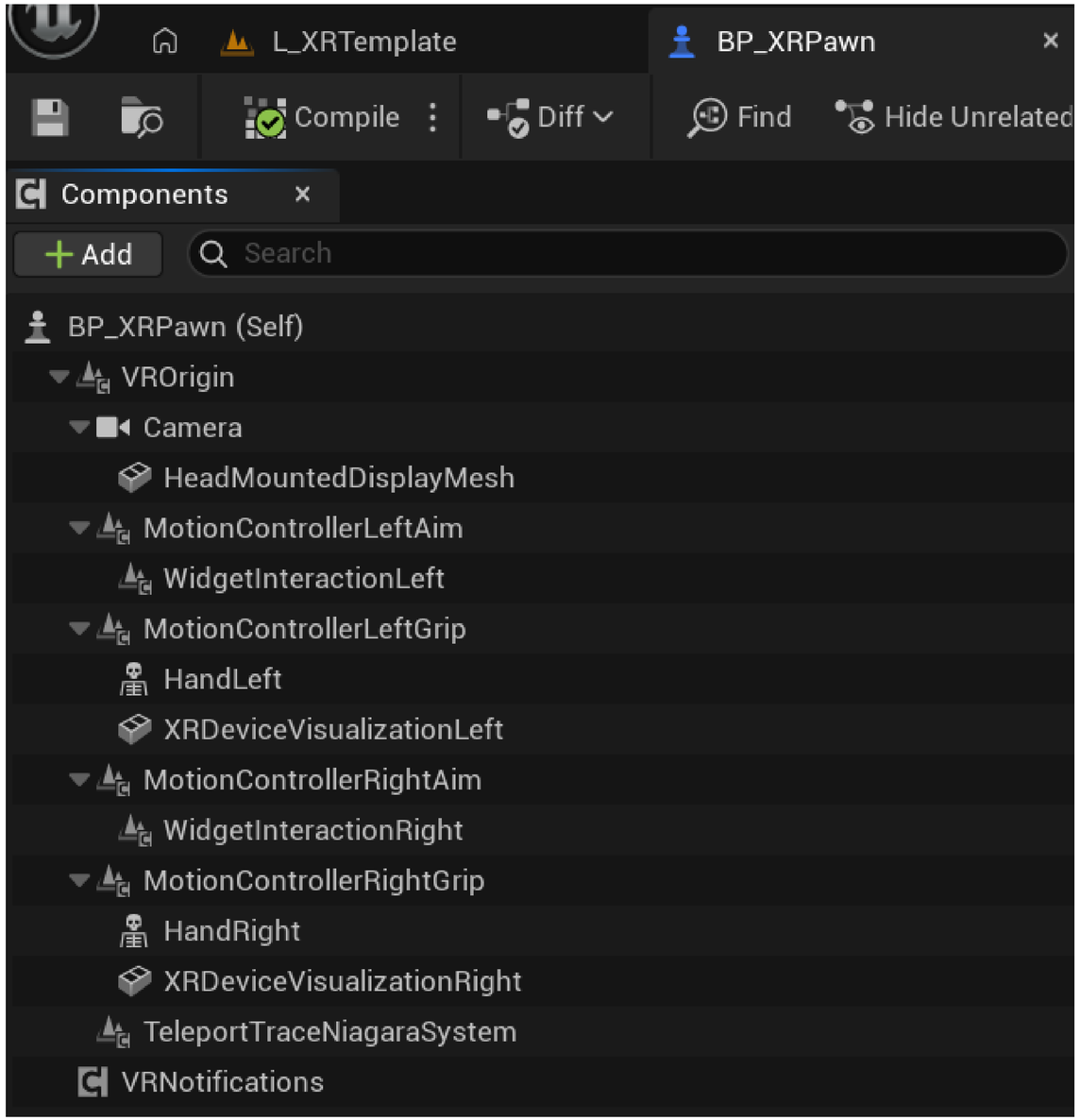
Unreal Engine VR Template

- Starting point for VR development



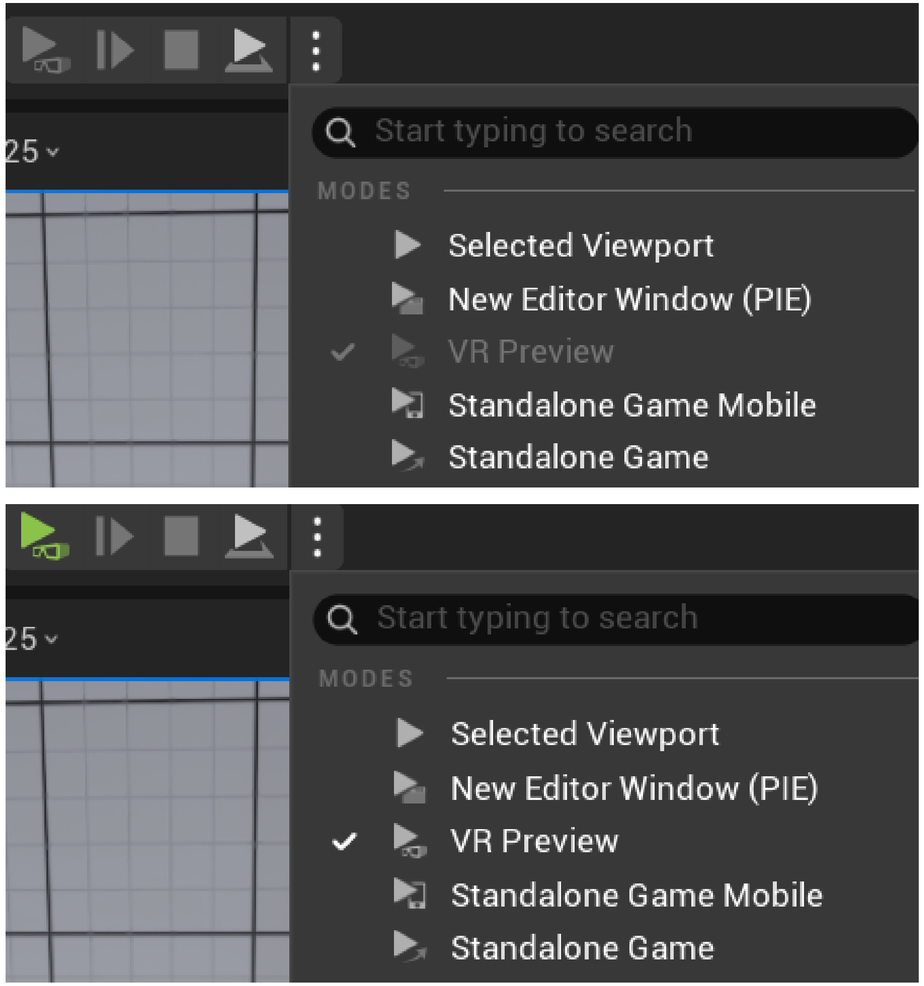
Unreal Engine VR Template

- Starting point for VR development
- Preconfigured VR Pawn and inputs
- Teleportation, snap turning, grabbing



Unreal Engine VR Template

- Starting point for VR development
- Preconfigured VR Pawn and inputs
- Teleportation, snap turning, grabbing
- Launch using VR Preview



UE5 VR Project Settings – VR Rendering

FYI

- Meta Quest 3: 2064 x 2208 pixels per eye
  - 2 separate viewports rendered for stereoscopic vision
- Typically target frame rate around 72-120 Hz
- At 90 Hz: ~11.1 ms per frame

UE5 VR Project Settings – Performance

FYI

- Stable framerate very important
- Advanced UE5 rendering features:
  - Lumen
  - Reflections and shadows
  - …

UE5 VR Project Settings – Default

FYI

- Several VR optimized global configuration options
  - Forward shading
  - Instanced stereo
  - MSAA
  - Very reduced reflections/shadows