Virtual Reality and Google Cardboard

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What is Virtual Reality (VR)?

- Short survey:

  - https://docs.google.com/forms/d/e/1FAIpQLSfonEe0hUtztJIldmj7haHdHMatTEudil UCxegYpQ8P2Kp7rg/formResponse

- Download Unity 2019.x.

VR Introduction

- Despite popular belief, virtual reality is by no means a modern invention. The concept has been around for decades, with the first head-mounted display created in the late 1960s. The main difference between early VR and today's VR is accessibility.

- In the 1950s and early 1980s, VR devices were expensive and difficult to produce, available as one-offs or in limited runs. They were usually large machines that had to be set up and assembled and bore little resemblance to the devices we know today. The high cost of the machines and the large size were the main reasons VR failed to take off.

- But as VR technology has evolved, these problems have diminished.

VR Introduction

▶ Public interest in virtual reality peaked in the late 1980s and 1990s, when several companies tried to produce devices for a wider audience. These attempts eventually failed; some never made it to market, and those that did were poorly received - but they likely played an important role in raising the profile of VR.

▶ Virtual reality really started to take off after 2010, when the technology needed to make devices consumer-friendly became affordable. Adoption of VR technology has been slow but steady. Since it's been less than a decade since the industry really took off, it's easy to trace the key points in history that led to the release of the headsets themselves.

VR Environments

- Computer-generated representations of real or imaginary environments. Experienced as three-dimensional via a number of senses - visual, aural and/or tactile;

- Objects within these environments are independent of the user and can display real world behavior.

- The user or users have autonomous control - the freedom to navigate and interact with objects, using a number of different viewpoints.

- Interaction occurs in real-time; and the users experience feelings of presence and/or immersion.

What is Virtual Reality (VR)?

- Two definitions of VR:
    - Virtual Reality means feeling the imaginary (virtual) world, rather than the real one. The imaginary world is a simulation running in a computer.
    - Inducing targeted behaviour in an organism by using artificial sensory stimulation, while the organism has little or no awareness of the interference (LaValle).

What is Virtual Reality (VR)?

- Non-immersive VR
- Semi-immersive VR
- Full-immersive VR

Ivan Sutherland - Sketchpad Demo
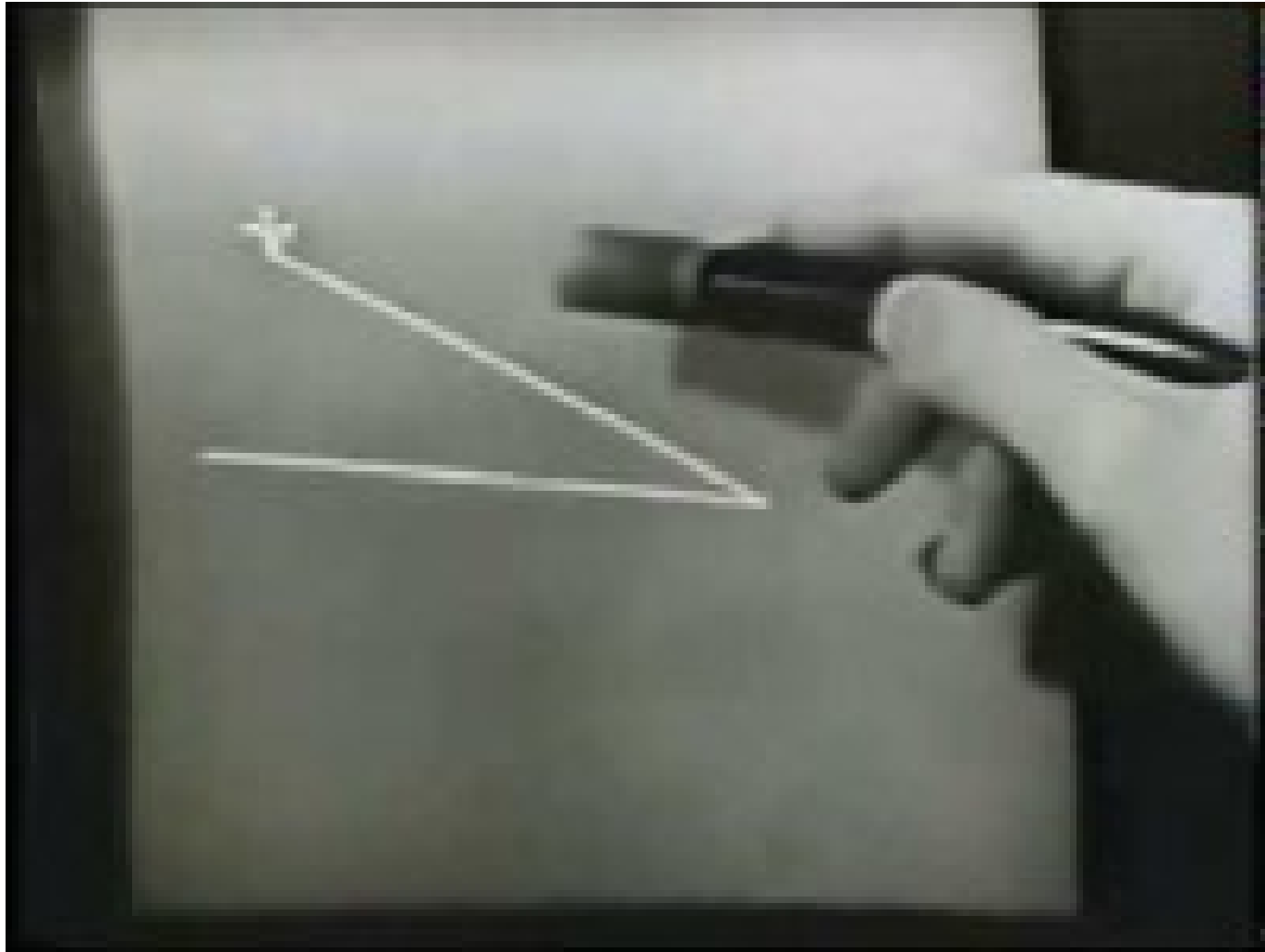
- Developed in 1963 by Ivan Sutherland for his PhD thesis.

- https://www.youtube.com/watch?v=YB3saviltTI

Sensorama

The Sensorama is a machine created by Morton Heilig in 1957, it was an object that had:

1) 3D stereo images
2) Vibrations
3) Wind
4) Feedback on a handlebar
5) Tactile sensation of movement
6) tereophonic audio;
7) System to reproduce scents to provide olfactory sensitivity.

https://www.youtube.com/watch?v=zf61nlyBC3M

VPL DataGlove

Developed in 1985.

The system was wired to a computer. It was interactive and contained fiber-optic bundles to track movements and orientation. That data would then be transmitted to the computer so that the information could be duplicated virtually. It allowed for people to manipulate and re-orient virtual objects. Applications for this wearable device centered on input computer control, gaming, and also the potential for remote surgery.

https://www.youtube.com/watch?v=AhNr5o6o

Computer size over time
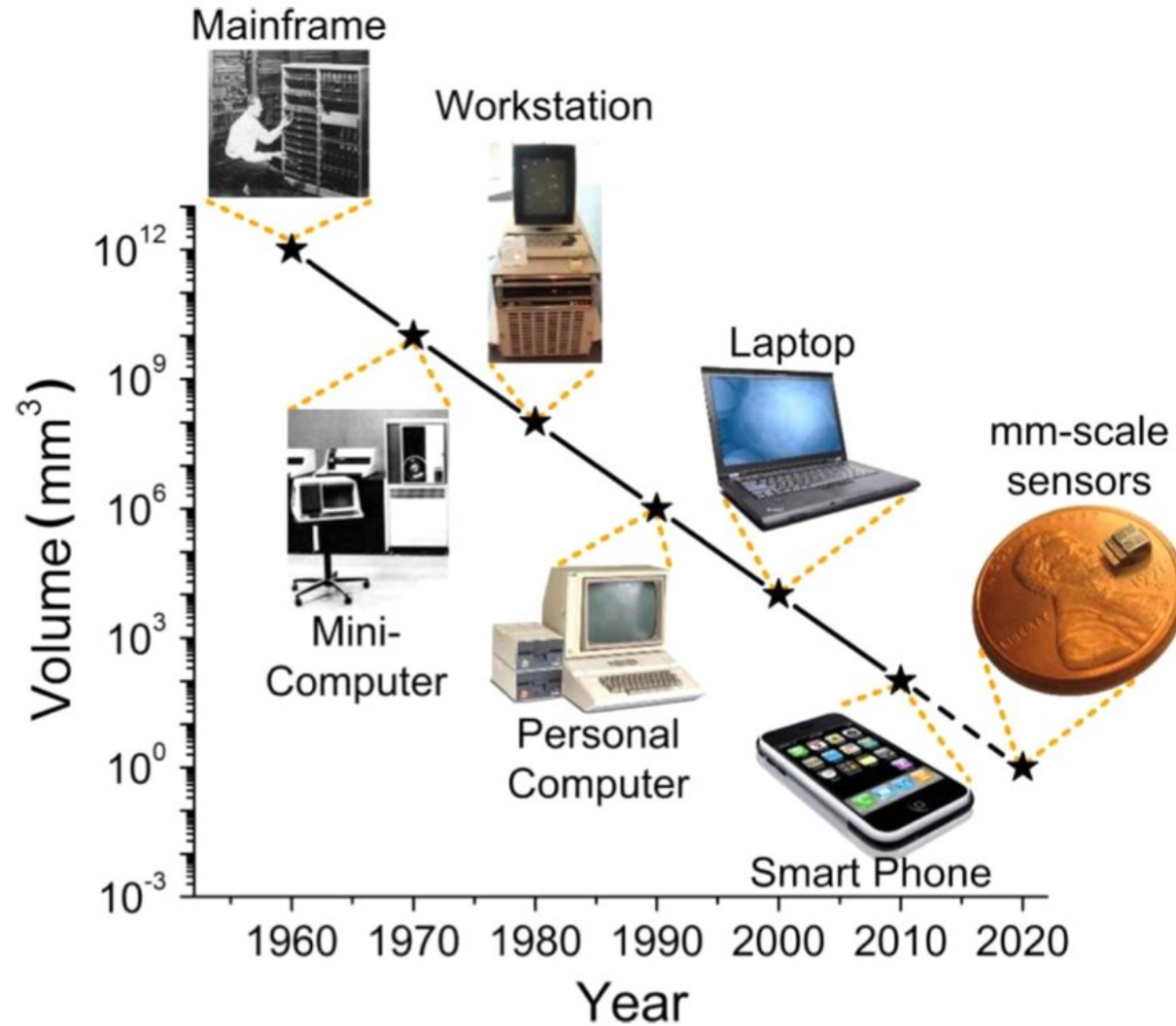
Virtual Reality

▶ Users can now be immersed in a Computer Generated environment

 ▶ Head-mounted display, gloves, body tracking, eye tracking..

Typical VR System

https://www.youtube.com/watch?v=eJCiyf8Kn9w

VR: Key Characteristics

▶ Three main characteristics:

1) 3D stereoscopic display

2) Wide field of view display

3) Low latency head tracking

These three points are necessary to try to provide an immersive experience.

https://benchmarks.ul.com/compare/best-vr-headsets

https://www.youtube.com/watch?v=FPcbBJbGhmk

VR: Presence

- One of the most important key factory in VR is «Presence».

- Presence is defined as «the sense of being in an environment».

- In our case, we can speak about «telepresence», i.e., the experience of presence in an environment by means of communication medium.

- To provide a high-quality VR experience, it is fundamental that the player perceives telepresence.

David Zeltzer's cube

- **Autonomy**: user can react to stimuli and events.

- **Interaction**: user can interact with the world and its objects.

- **Presence**: the sensation of immersion

- Our goal is to maximize all of them.
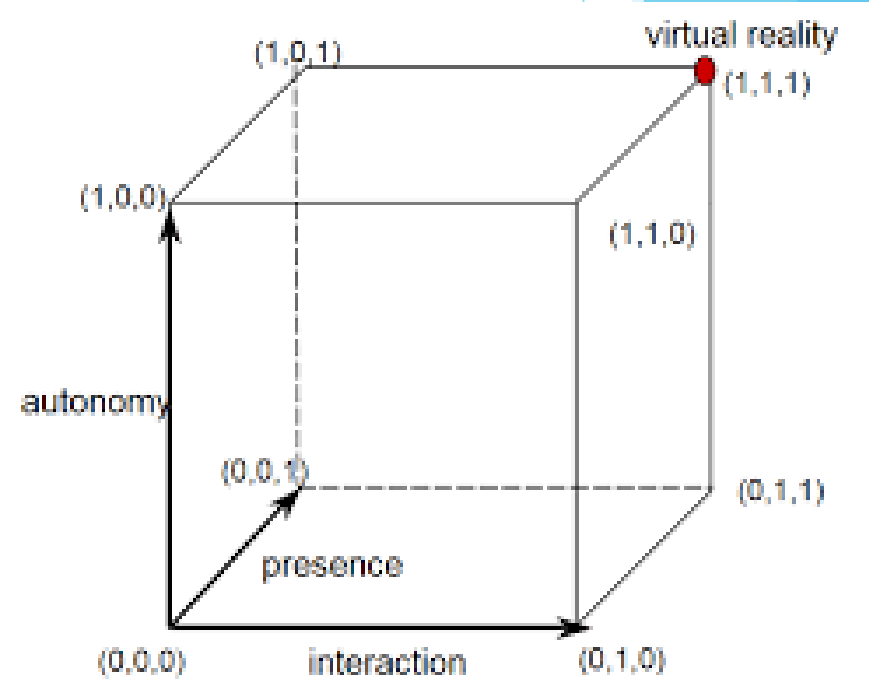
Oculus Rift

- A major contributor to the rise of virtual reality was a consumer-level headset prototype developed by entrepreneur Palmer Luckey in 2010, which became the first iteration of the Oculus Rift.

- In 2012, Luckey started a Kickstarter campaign to fund a do-it-yourself version of the headset, which attracted global attention and sparked interest from developers and tech enthusiasts.

- The campaign raised $ 2.4 million and prompted other major companies to take notice of the potential of virtual reality in the consumer space. In 2014, Oculus was bought by Facebook for $ 2 billion. The first consumer version of the Rift was released in 2016.

Oculus DK1

- ▶ Released on March 29, 2013 for 300 dollars.

- ▶ DK1 was intended to be used by developers and hardcore VR enthusiasts to create VR content.

- ▶ The display of DK1 is a RGB LCD screen with a resolution of 1280 x 800 or 640 x 800 per eye. It has a diagonal FOV of 110° and horizontal FOV of 90°.

- ▶ Oculus Rift DK1 tracks the rotational movement of your head with Gyroscope, Accelerometer and Magnetometer.

Oculus DK2

▶ Released on July 24, 2014 for 350 dollars. Released a year after DK1, DK2 is the second version of Oculus Rift intended for developers of VR content.

▶ DK2's display is an OLED Pentile panel with a resolution of 1920 x 1080 (1080p). It has higher resolution, lower persistence, more vibrant colors and less screen door effect than DK1's display.

▶ DK2 has an external camera that tracks your position. Within the camera's view, it tracks IR LED array in the front part of the headset to capture your head's position and movement within the 3D space. The CMOS camera is able to capture your movements up to 60 times per second.

HTC Vive

- ▶ Developed through a partnership between Valve and HTC, the Vive is a room-scale VR device first released in 2015.

- ▶ Valve had researched VR for several years and shared many findings for visual improvements with Oculus in 2013.
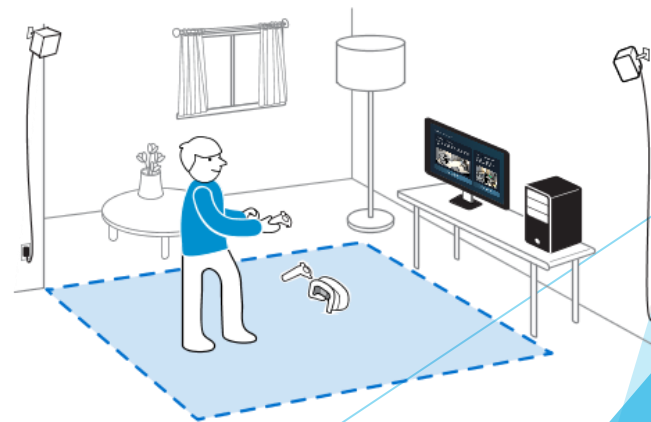
PSVR

- ▶ First announced in 2014 and released in 2016, Playstation VR (PSVR) was the first entry into the VR space from a major platform.

- ▶ The PSVR was designed as a peripheral for the Playstation 4 to work with some PS4 games.

- ▶ Despite speculation, neither Microsoft nor Nintendo have released competing VR devices for their consoles.

Gear VR

- Developed by Samsung in partnership with Oculus and first announced in late 2014, the Gear VR was one of the first leading headsets developed for high-end mobile virtual reality.

- Unlike its predecessors, the Gear VR was powered by the user's Samsung phone, with the headset housing the phone.

- This limited the VR experience to the capabilities of the mobile device; however, it was significantly cheaper at launch ($ 99 versus Rift's original price of $ 599) and used a device the user already owned.

Google DayDream

▶ One of the latest additions to the VR space is Google Daydream, released in late 2016. Like the Gear VR, Daydream relies on the user's phone to run the experience, although it is compatible with some other devices.

▶ It is often described as one of the most comfortable mobile VR headsets.

Modern devices

- As modern VR devices have evolved with increasing popularity, a division in high-performance devices has emerged.

- Newer devices are either PC-dependent (or tethered) or PC-independent (or untethered / standalone).

- While they still exist, mobile-based VR experiences have decreased in recent years in favor of untethered devices, especially as the price of untethered devices comes down and their qual.

Oculus Quest 2

- Oculus Quest was released in 2018 as a tetherless VR device and has been very well received.

- Released in 2020 as a successor to the original Quest, Oculus Quest 2 is designed more like a dedicated VR console.

- It features a nearly 4K custom LCD screen and enhanced processing capabilities with the ability to cast the user's view to smart TVs, Google Chromecast devices, and PCs.

- Taking its cue from mobile device sales, the Oculus Quest 2 was released in two price ranges: 64GB for $ 299 and 256GB for $ 399.

Oculus Rift S

- Introduced in 2019 to replace Oculus Rift, Rift S offers improved performance and a lower initial purchase price ($ 399 vs $ 599).

- Being a tethered device that debuted at roughly the same time and at the same price as the untethered Oculus Quest, adoption hasn't been as quick as its untethered counterpart.

- Improvements over its predecessor include a sharper screen (thanks to a higher resolution LCD screen) and faster refresh rate, lighter controllers and easier setup procedures

HTC Vive Pro

- ▶ Vive Pro is the successor to the original Vive with improvements to display and tracking capabilities.

- ▶ Much of the form factor of the HTC Vive Pro is the same as the HTC Vive.

- ▶ Released in 2018, the headset alone costs $ 799 with upgrades available as a bundled package for $ 1,099.

HTC Vive Cosmos and HTC Vive Cosmos Elite

- The HTC Vive Cosmos was released in 2019 as a tethered device with inside-out tracking.

- While offering improvements to the display over the original HTC Vive, the device had issues with tracking in high- and low-light settings.

- The HTC Vive Cosmos Elite combines the external tracking of the original HTC Vive with the inside-out tracking of the Vive Cosmos via an additional faceplate.

- It was released in 2020 for $ 899.
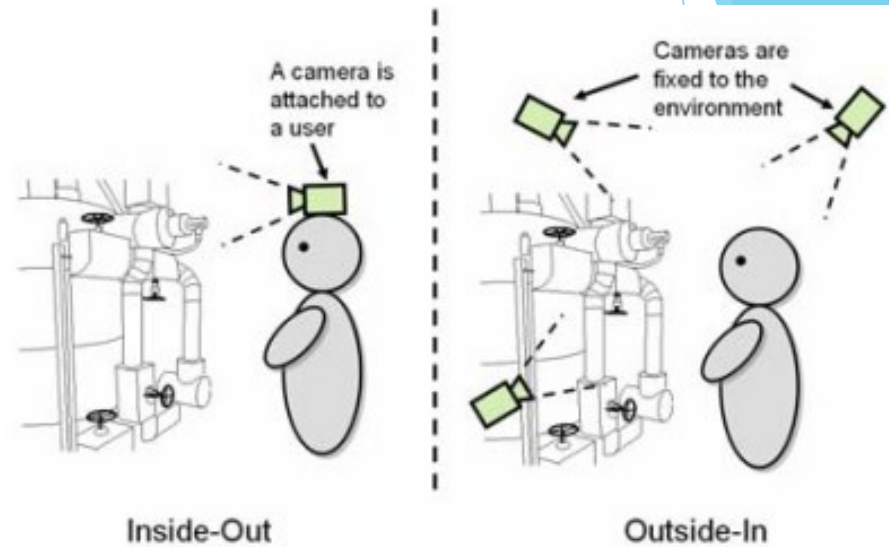
Valve Index

- Valve released the Index in 2019.
- Controllers, which provide full finger and grip tracking of the user, are the defining feature.
- While deceptively simple, the addition of finger tracking offers unique gameplay and greater immersion.
- The complete kit of (headset, controller and base stations) was priced at $ 999.

Valve Index

https://youtube.com/watch?v=cjXSXmHZP3Q

VR devices: categories (1/2)

- **Computer-based**
  - Headset and controllers are peripherals that require a high-end computer to function. These can be used for sitting / standing experiences or for the room scale.
  - Devices include Oculus Rift and HTC Vive.

- **Console-based**
  - Designed to work with a game console. Currently, the only existing headset in this category is Sony's PSVR.

VR devices: categories (2/2)

- **Mobile-based**
  - It relies on a mobile device to run the VR experience.
  - This is often considered the most accessible way to experience virtual reality, as most people own a smartphone that can function as a VR device.
  - There are a number of mobile virtual reality devices on the market; two of the most notable are Gear VR and Google Daydream.

- **Standalone**
  - Standalone VR devices are fully self-contained headsets and don't require a computer or cellphone to power the experience.
  - Oculus Quest and Oculus Go.

VR applications

VR allows to:

- Visualize and manipulate things that you cannot see in the real world

- Take on different perspectives

- Visualize 3D concepts

- Interact in real time

- Explore dangerous situations

- Present realistic or abstract scenarios

- Promote different learning styles and teaching methods

VR applications

- **Medical**
  - Treat panic and anxiety disorders
  - Virtual reality used to create a virtual environment in which the users receives various stimuli related to their phobia.
  - Both visual and auditory cues

VR applications - Rehabilitation

VR applications

- **Training and Education**
  - **Medical ->** Allows the medical staff to visualize complex medical data, e.g., during surgery.
  - **Military ->** Soldiers training, flight simultation, vehicles simulation.

VR applications

- **Education**
  - Children can get bored studying using books or looking at a chalk board.
  - The use of VR applications can entertain students more compared to "traditional" methods.

Google Cardboard

Google Cardboard

- Developed by Google

- Fold-out cardboard mount for smartphone

- Paired with app to create 3D vision

- Low-cost system designed to encourage interest and development of VR applications

- Simple assembly instructions are available, allowing people to assemble car dboard themselves

Google Cardboard: How to use

- Download the Google Cardboard app from the Google Play Store
  - https://play.google.com/store/apps/details?id=com.google.samples.apps.cardboarddemo&hl=it&gl=US

Google Cardboard: How does it work?

- Google Cardboard works by placing your phone at the optimal distance away from the lenses.

- A Google Cardboard-compatible app splits the smartphone dislay image in two, one for each eye and the result is a stereoscopic image with a wide field of view.

- Track and react to head movements

Google Cardboard: How does it work?
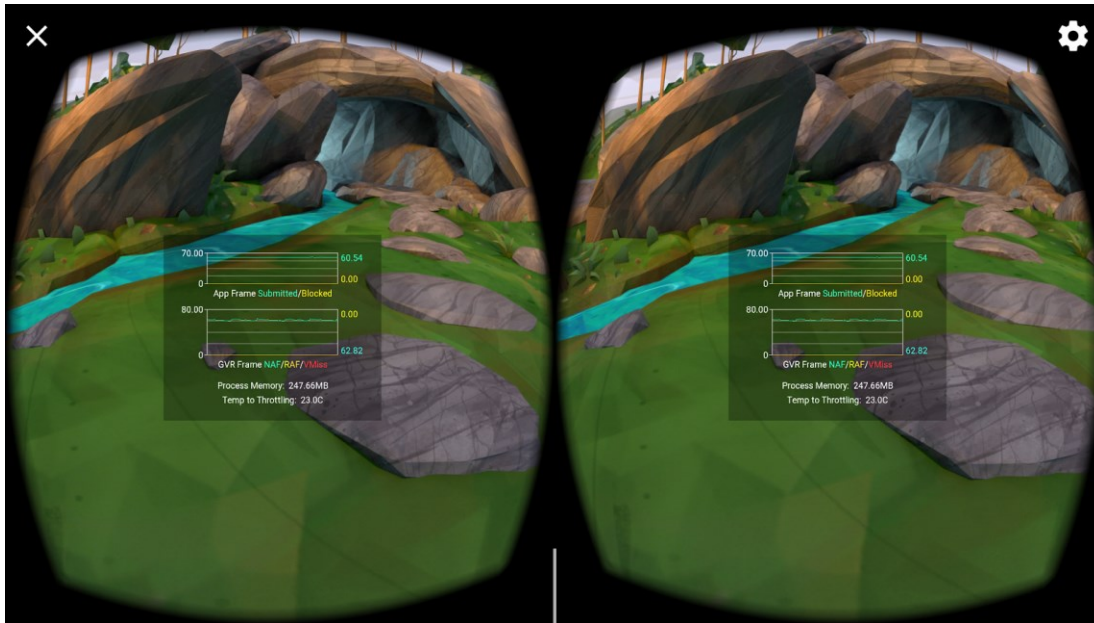
▶ By using compatible apps, the lenses create a 3D effect when held up to your eye.

▶ It is also possible to move the head, and the images will respond according to the rotation of your head, similar with what happens with Oculus and similar VR devices

Google Cardboard 1° Version: Magnet

- Little magnet on the side, used as a button.
- When moved, acts as you've pressed your screen.
- It used the magnetometer to sense the magnet movement.

Google Cardboard versions

First version

- Released at Google I/O 2014
- Can be used with phones up to 5.7 inches
- Used magnets as input
- Requires compass sensor

Second version

- Released at Google I/O 2015
- Can be used with phones up to 6 inches
- Magnet replaced with a conductive layer

Google Cardboard & Unity

- Open Unity Hub
- Create a new **3D Project** with **Unity 2019.x**
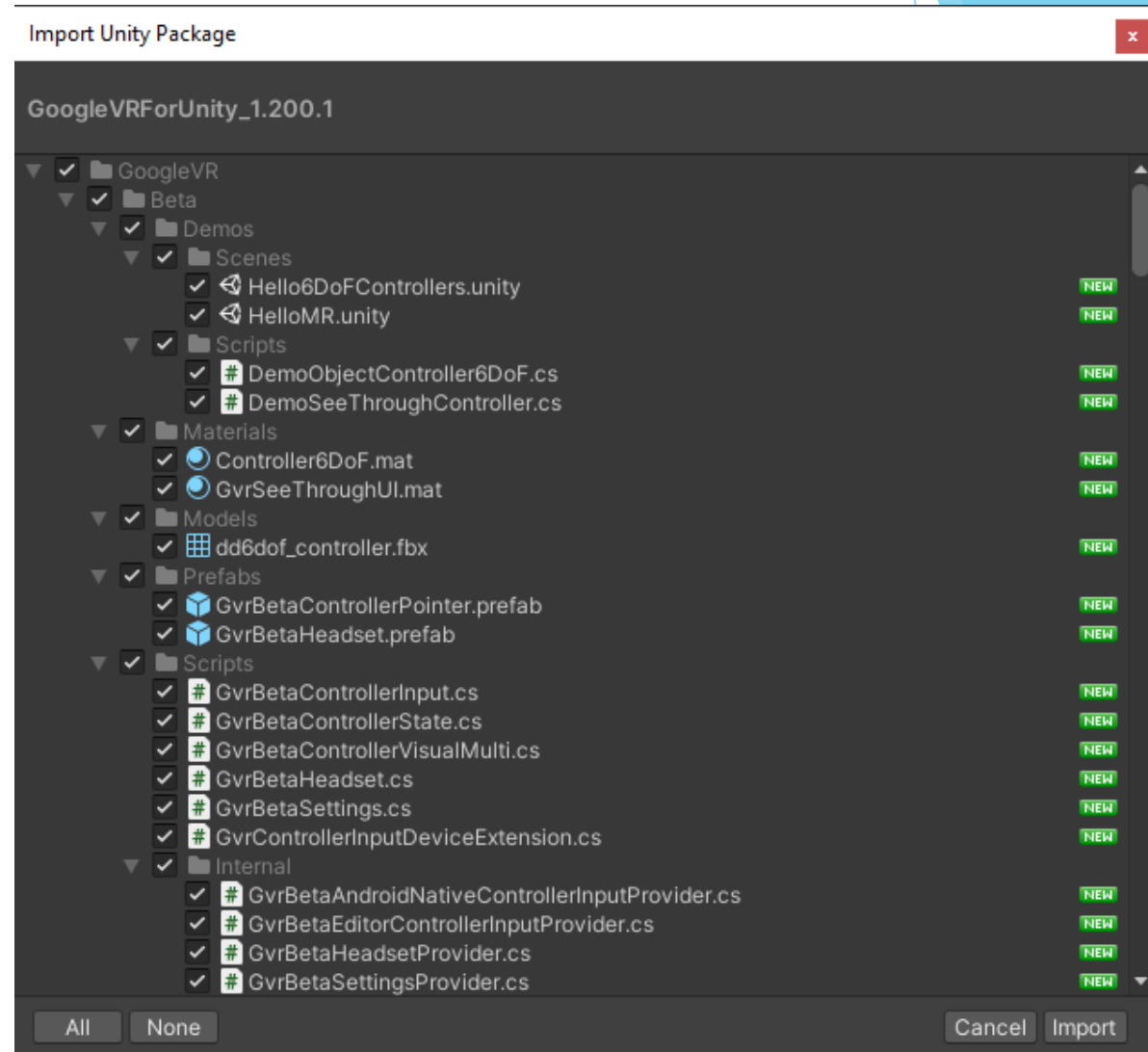 - Not tested with newest versions

Google Cardboard & Unity

▶ Build Settings -> Switch to Android

▶ Ensure that Android Build Support is installed

    ▶ Unity Hub -> Installs -> Select your unity version -> Add modules
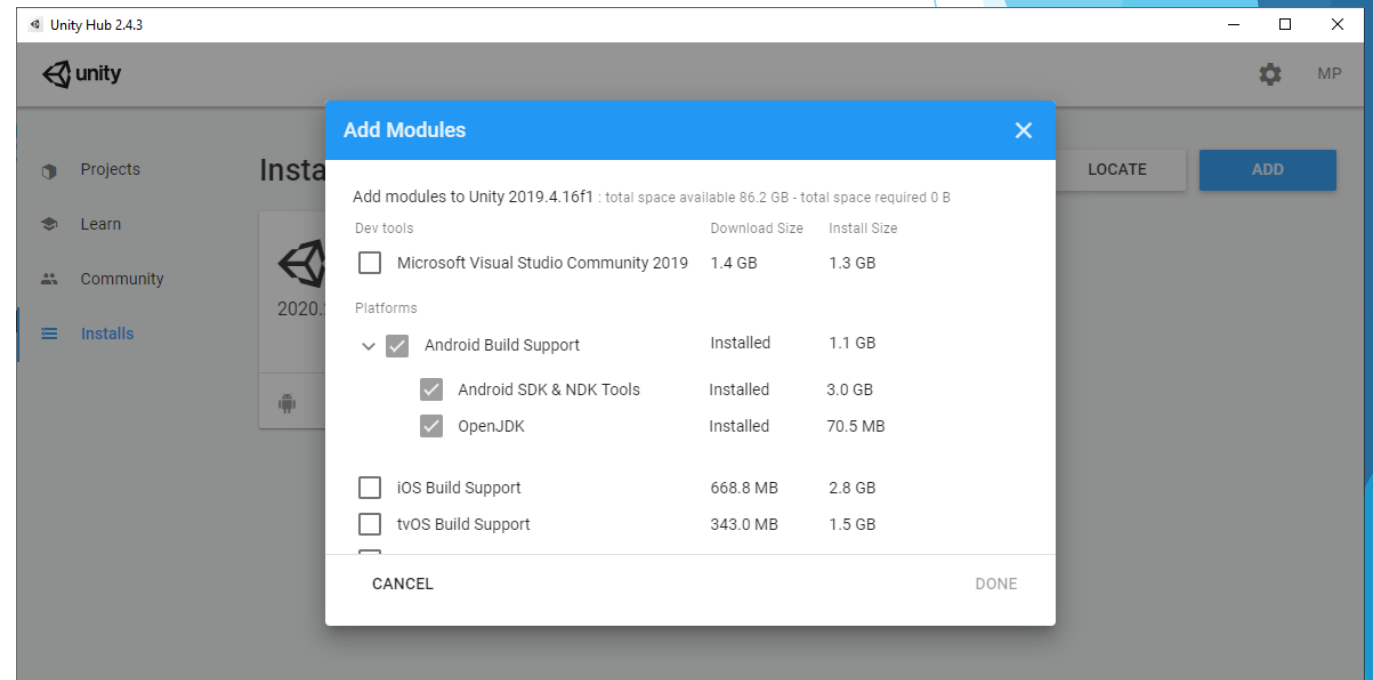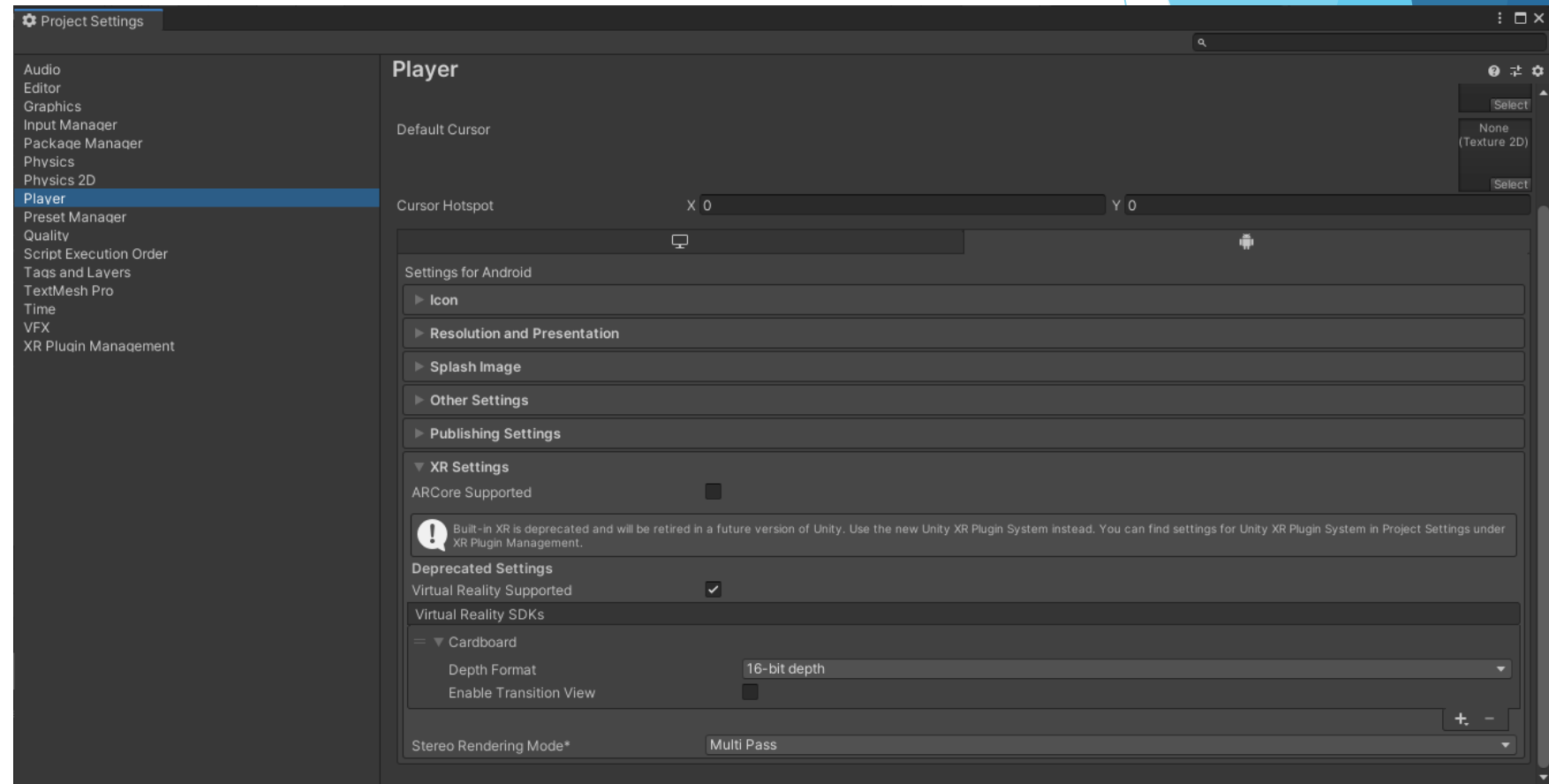
Google Cardboard & Unity

- ▶ Download the GVR SDK from:

  - ▶ https://github.com/googlevr/gvr-unity-sdk/releases

  - ▶ Click on «GoogleVRForUnity_1.200.1.unitypackage»

- ▶ Newest version:

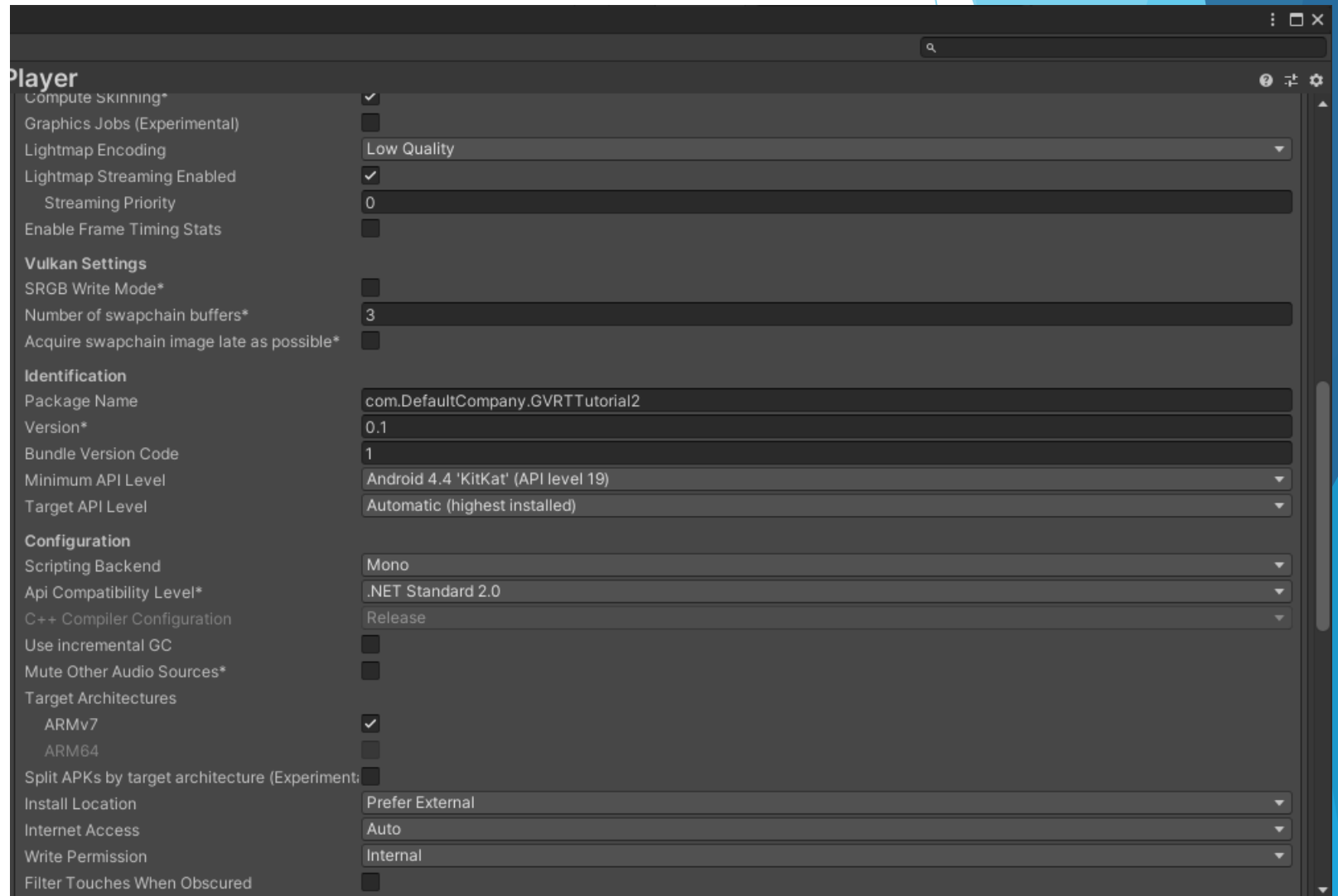 - ▶ https://developers.google.com/cardboard/develop/unity/quickstart

Google Cardboard & Unity

▶ Go to Project Settings -> Player

  ▶ XR Settings

    ▶ Enable Virtual Reality Supported

    ▶ Add «Cardboard» in Virtual Reality SDKs
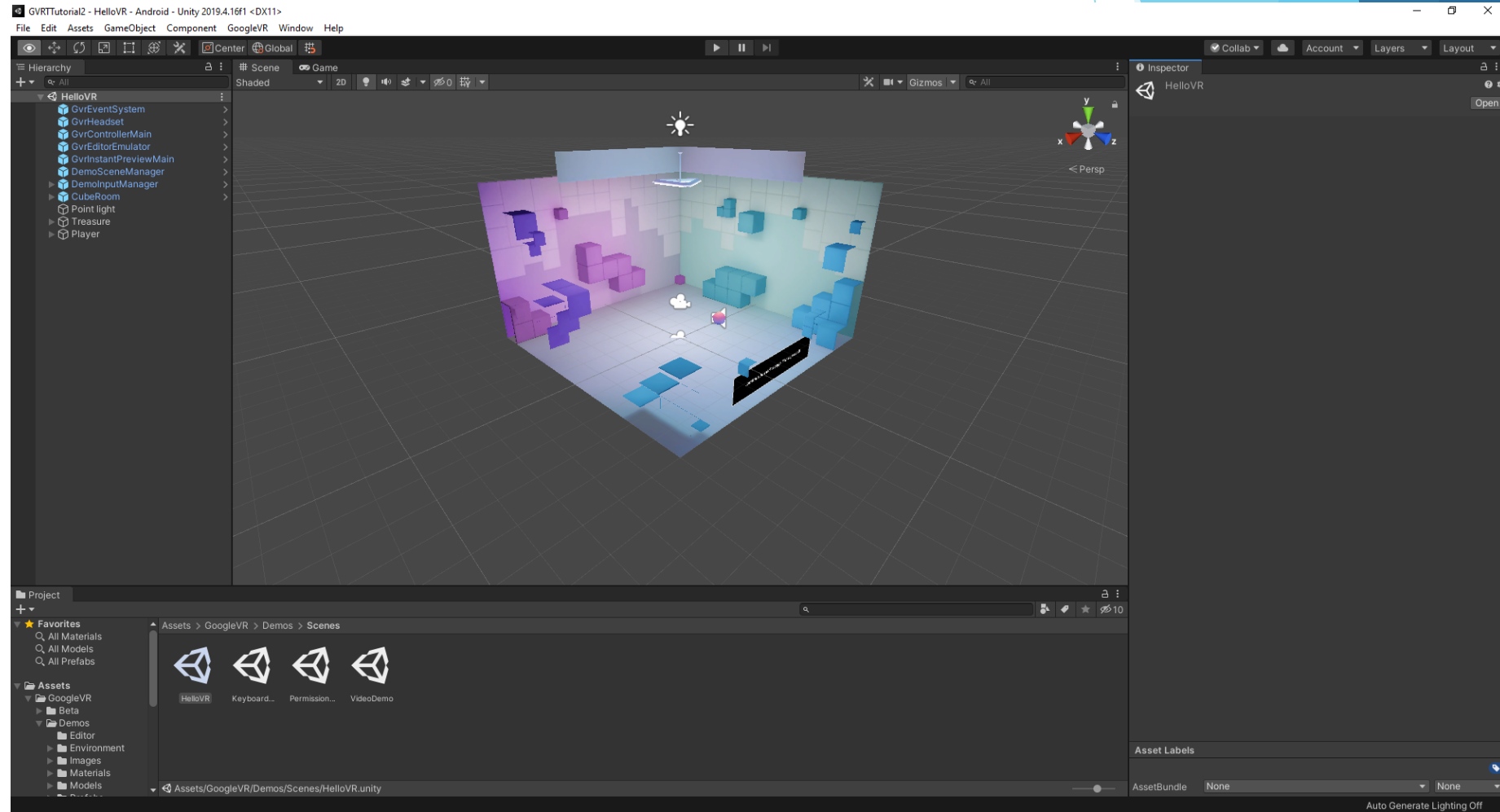
  ▶ Other settings

    ▶ Remove Vulkan from Graphics APIs

Google Cardboard & Unity

► Ensure that Minimum Level API is at least 19

Google Cardboard & Unity

▶ Open the scene:

▶ Assets/GoogleVR /Demos/Scenes/ HelloVR

Oculus - Unity

▶ VRTK is a collection of useful scripts and concepts to aid building VR solutions rapidly and easily in Unity.

   ▶ It covers several common solutions such as:

      ▶ Locomotion within virtual space.

      ▶ Interactions like touching, grabbing and using objects

      ▶ Interacting with Unity3d UI elements through pointers or touch.

      ▶ Body physics within virtual space.

      ▶ 2D and 3D controls like buttons, levers, doors, drawers, etc.

▶ https://vrtoolkit.readme.io/docs/summary

Oculus - Unity

- Unity Learn currently represents one of the best sources for learning Unity.

- Try following the following tutorial:
    - https://learn.unity.com/project/vr-in-unity-a-beginner-s-guide