

3D User Interfaces – Tutorial 6

Speaker: Linda Rudolph, M.Sc. (Teaching Assistant)

Responsible Professor: Prof. Gudrun Klinker, Ph.D.

Summer Semester 2023

09:00 – 10:00 time for individual questions

10:00 - ~11:00 lecture part

Topics Today

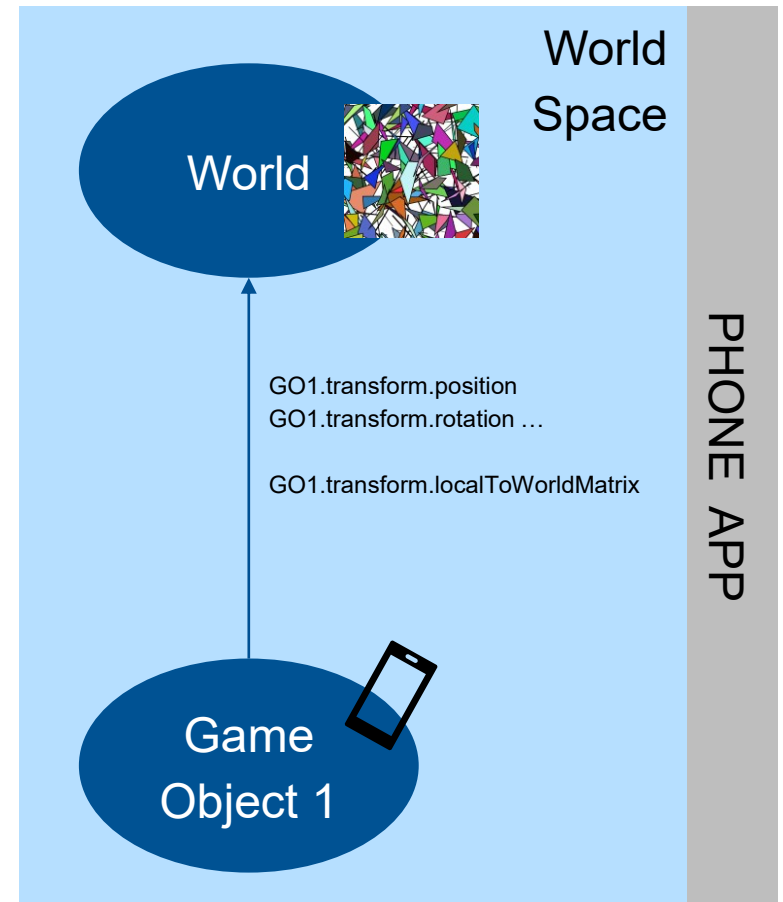
SceneGraphs

Travel

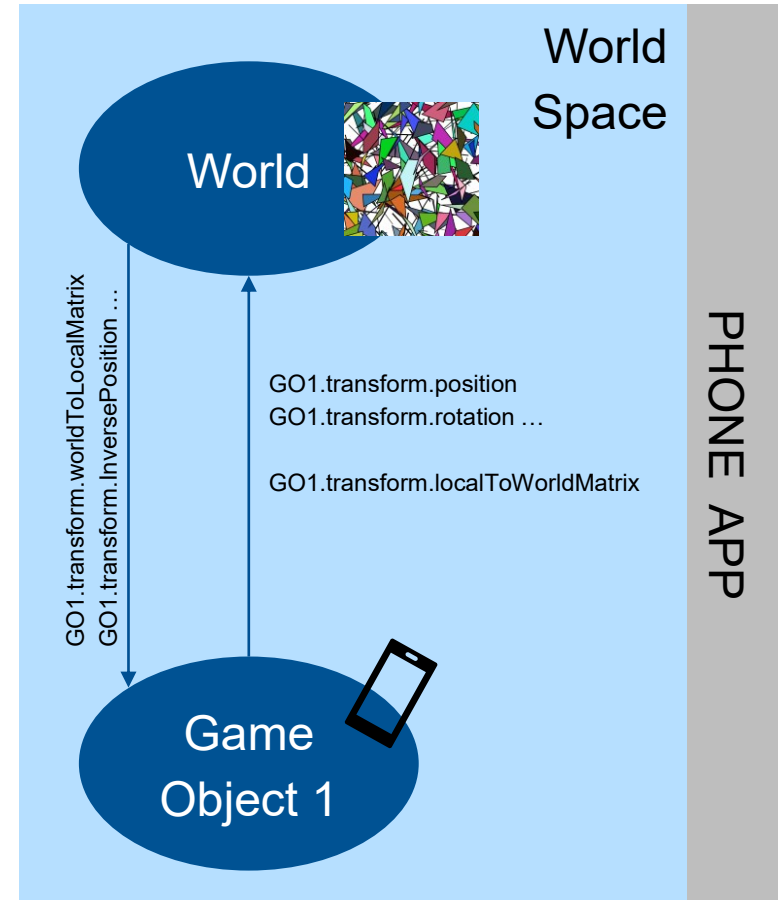
NavMesh

Virtualized Environments (V*E)

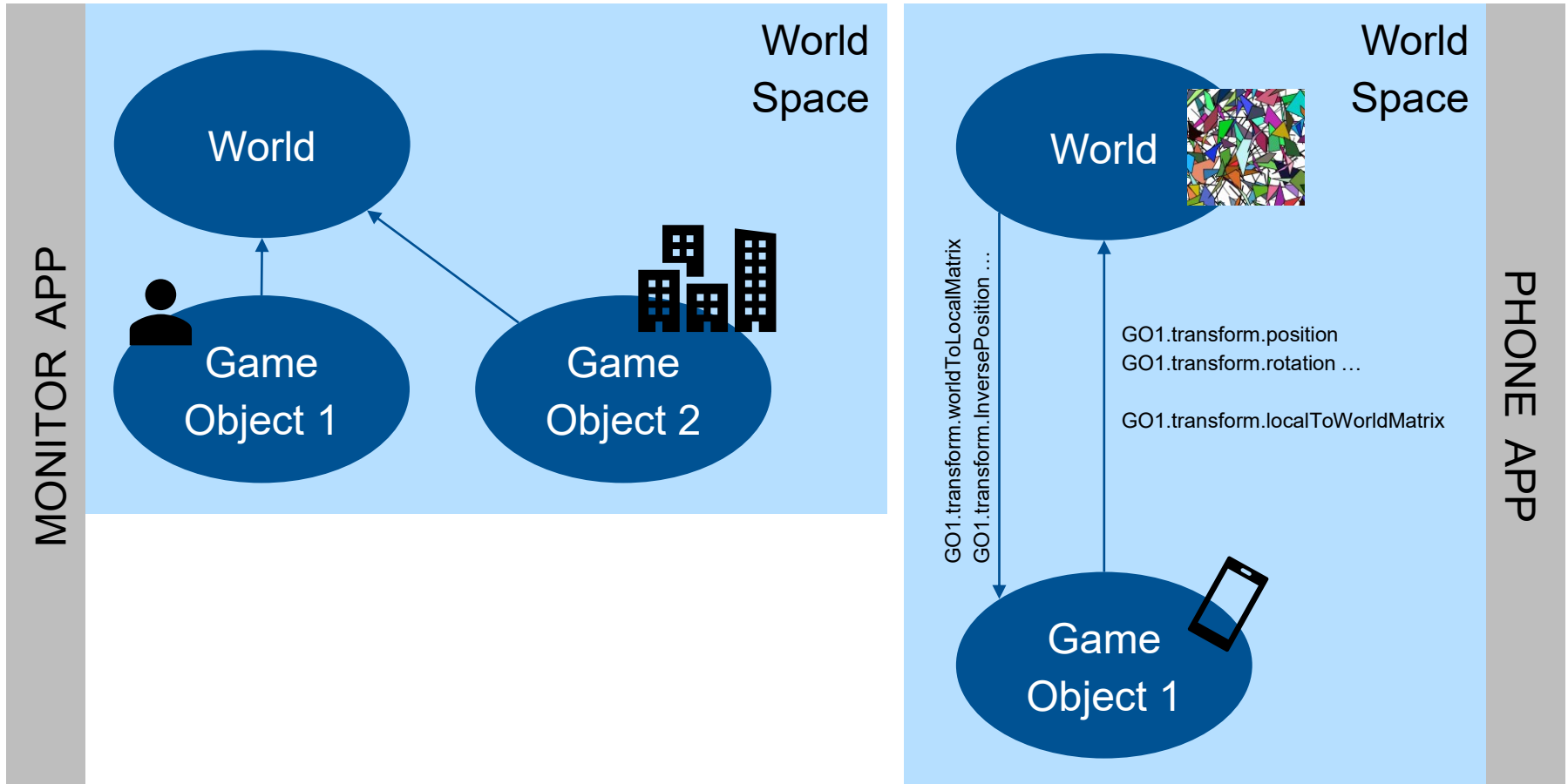
Scene Graphs



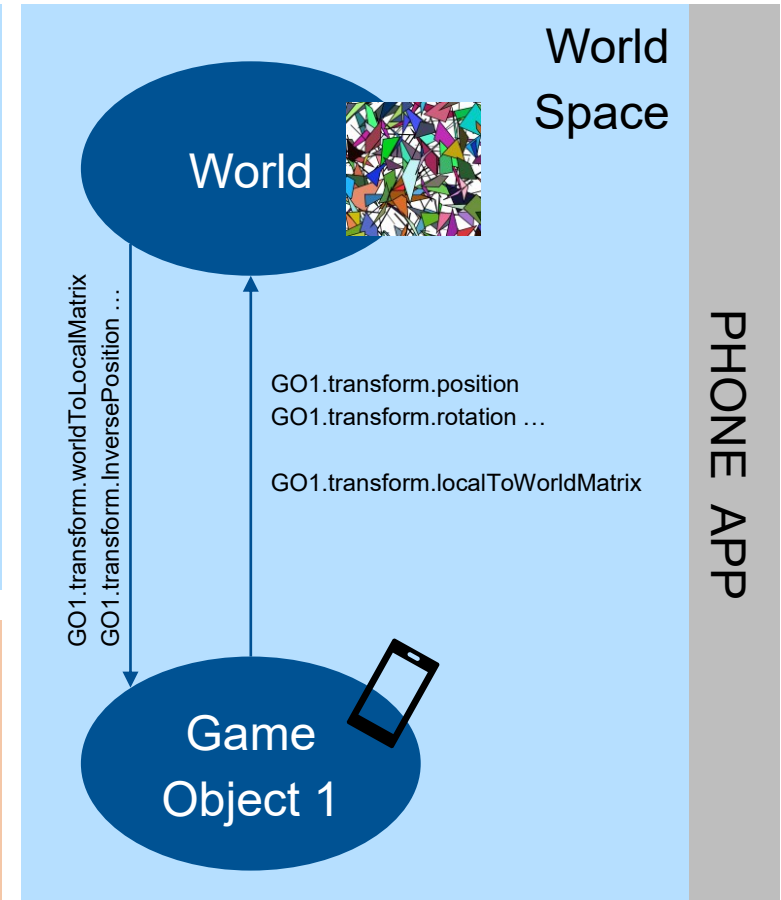
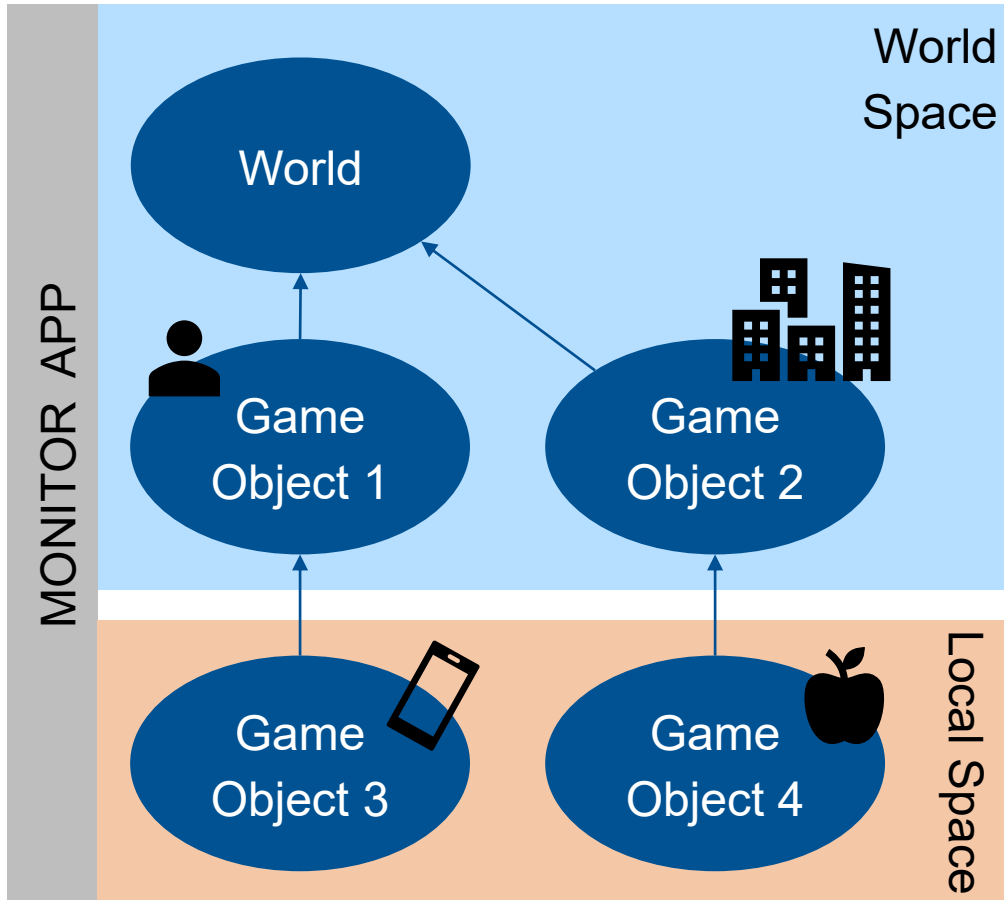
Scene Graphs



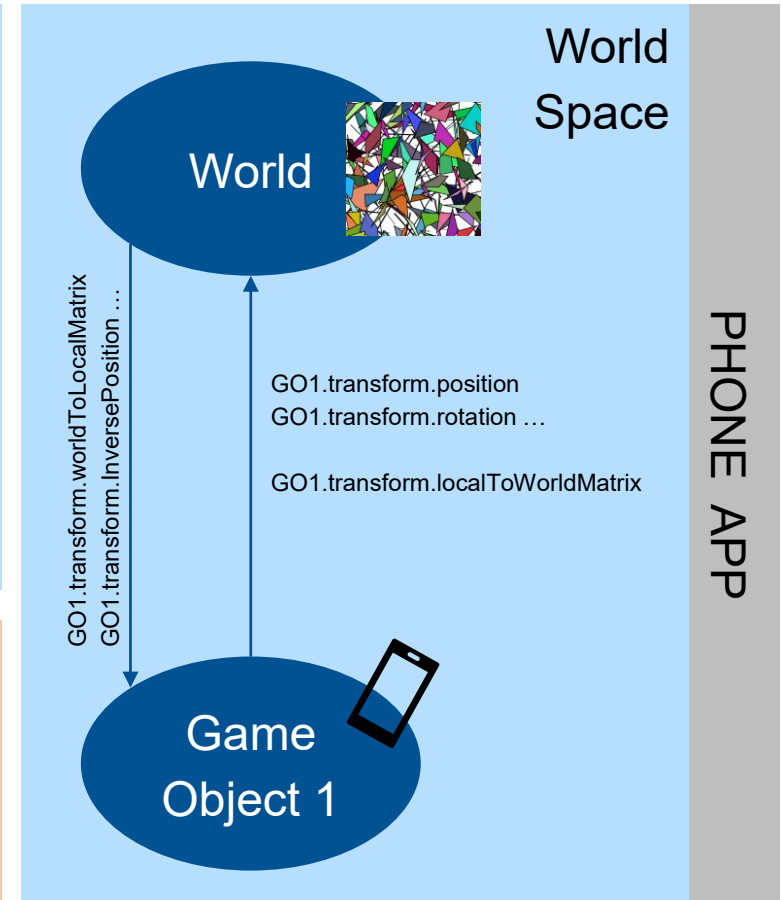
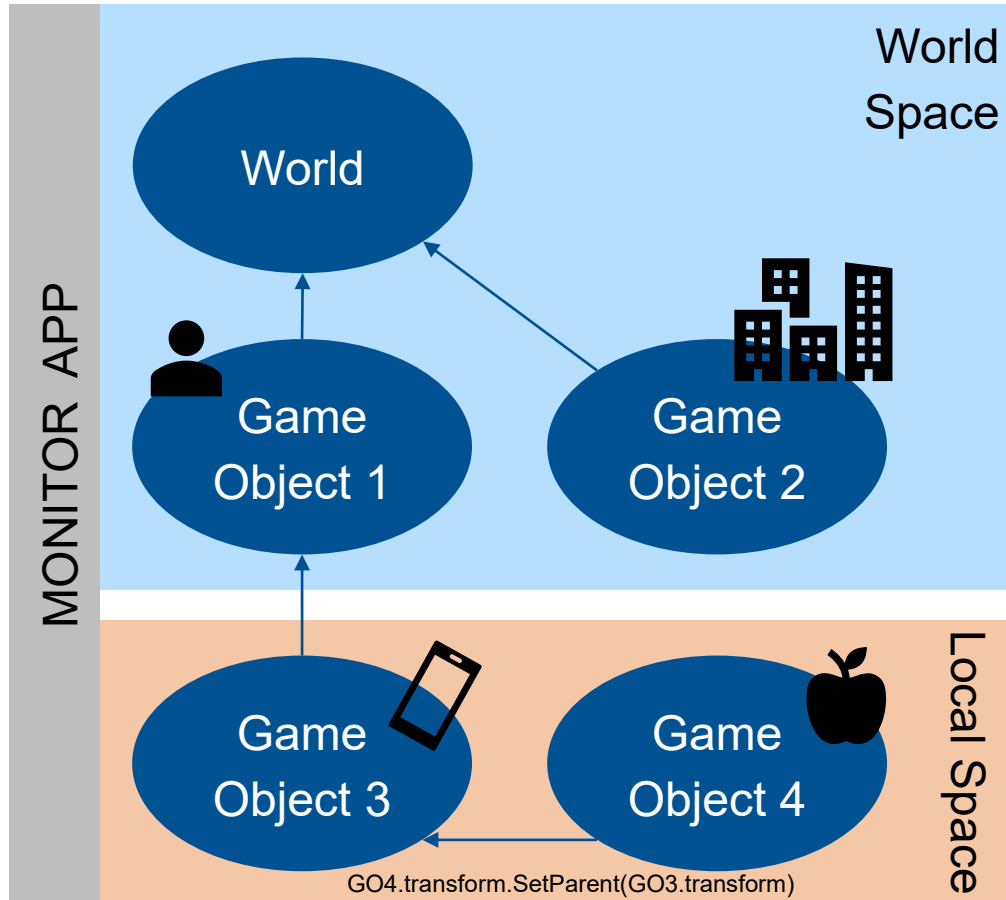
Scene Graphs



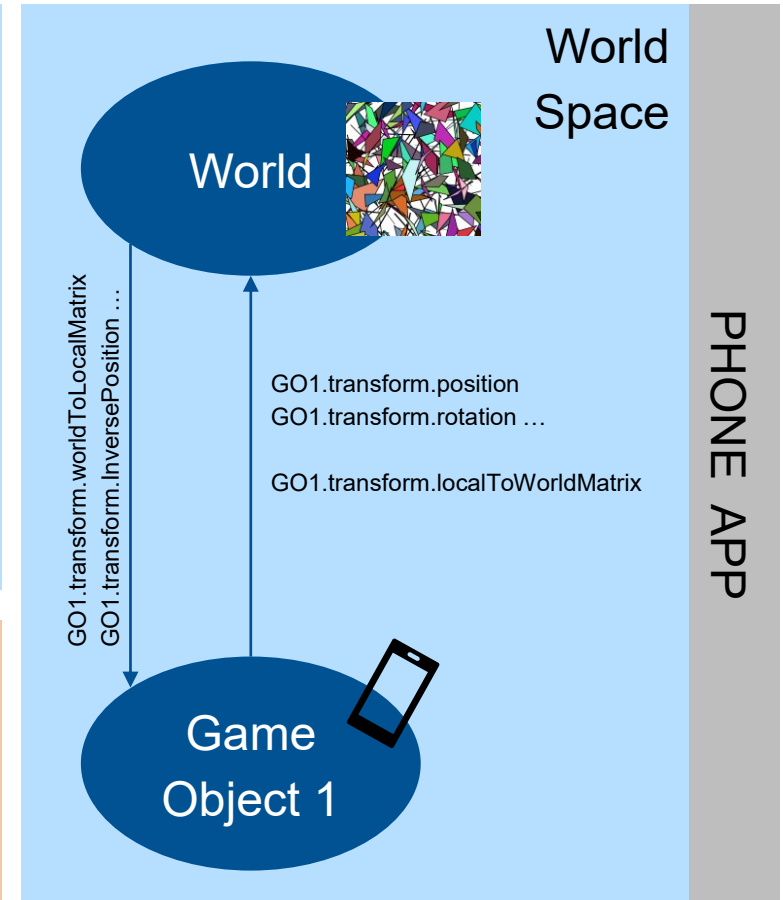
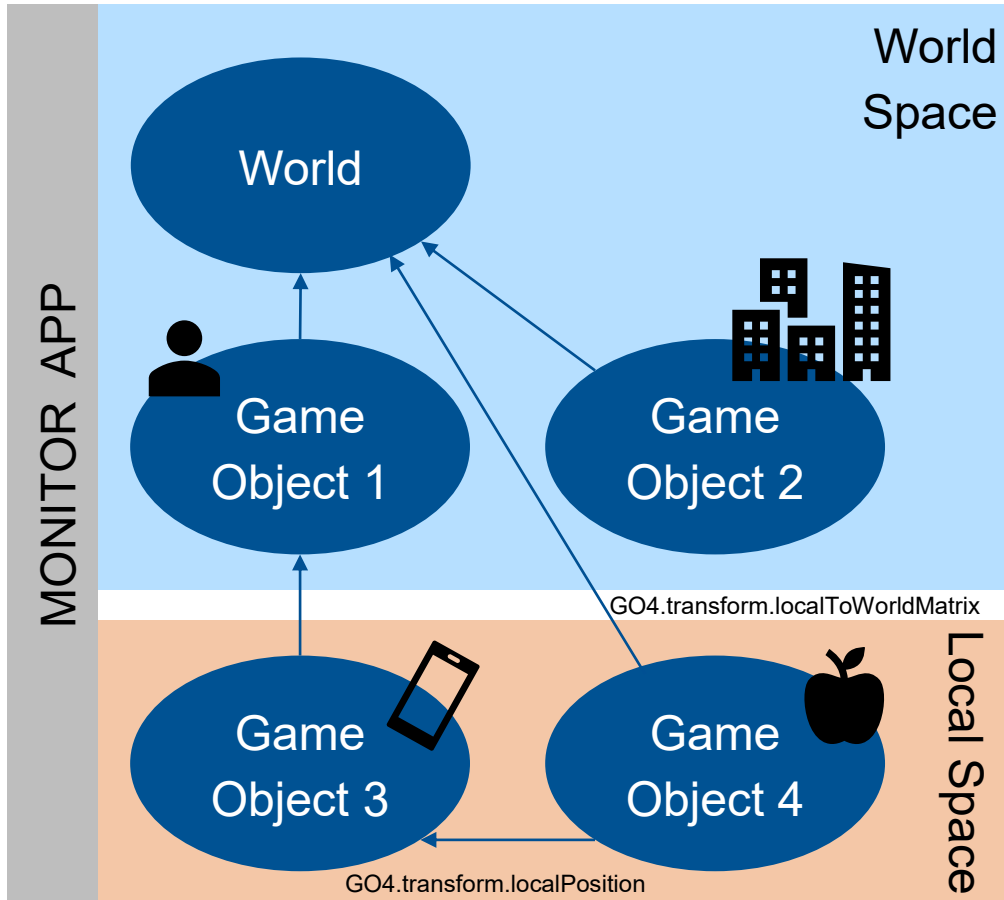
Scene Graphs



Scene Graphs



Scene Graphs



Travel in Unity3D

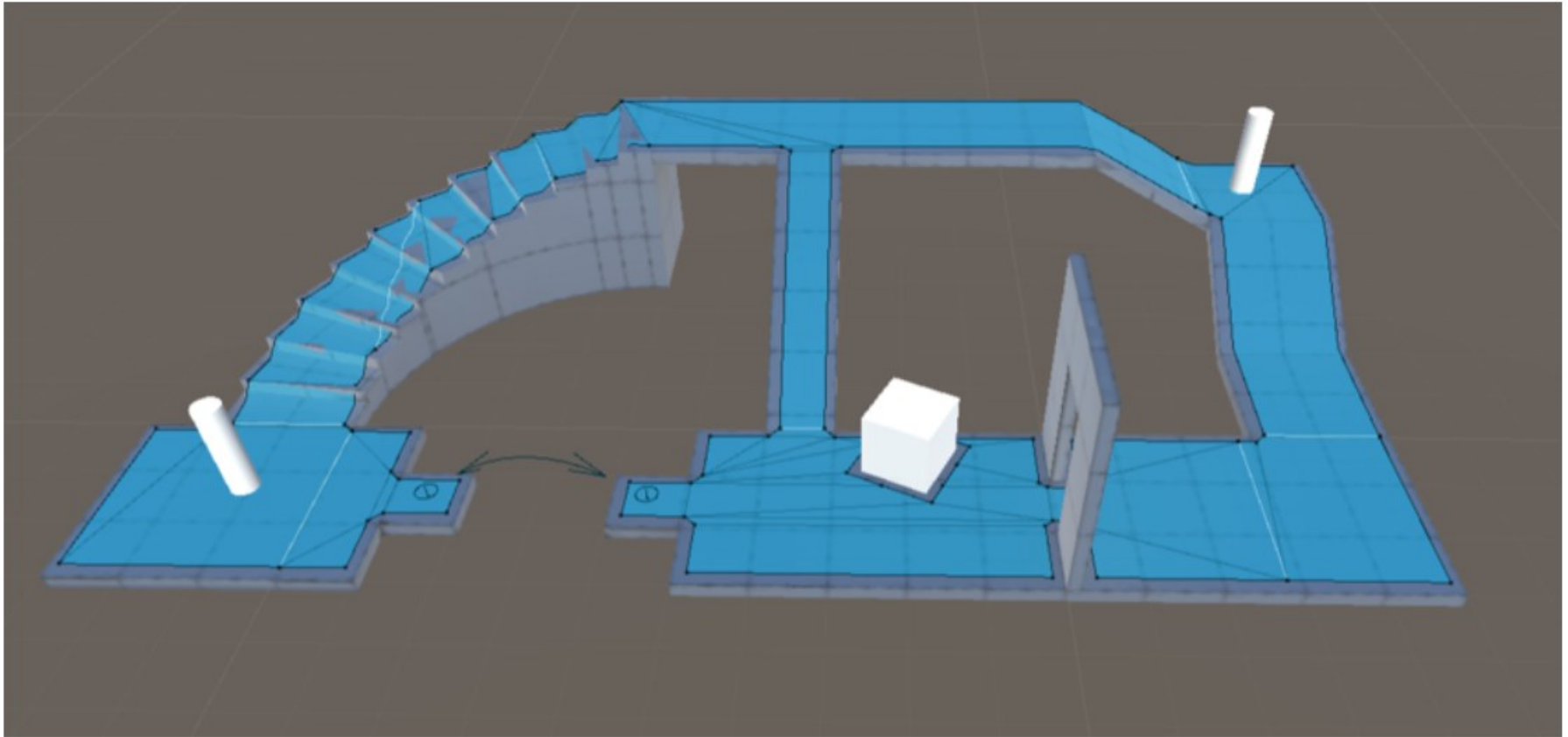
Standard: Keyboard & Mouse binding

Two Methods: Rigid Body Based / Character Controller Based

Rigid Body: Character reacts to the physics of the Unity world (Not so good if we deal with “physical world” mappings)

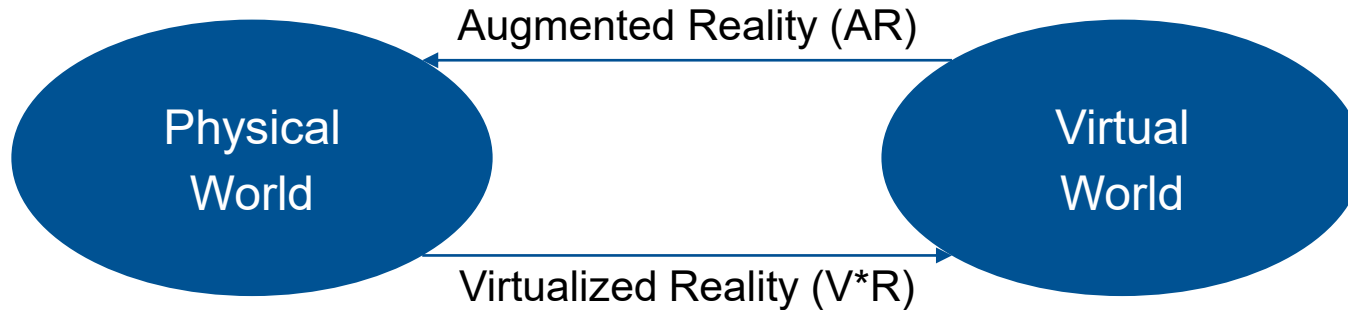
Character Controller: Less (Unity scene based) realism, more freedom

NavMeshes



<https://docs.unity3d.com/Manual/Navigation.html>

Virtualized Reality

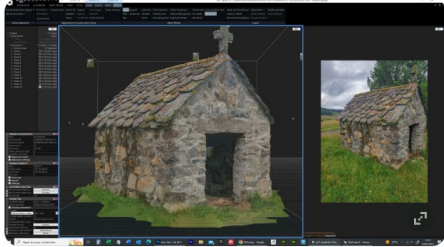


Kanade, T., Rander, P., & Narayanan, P. J. (1997). Virtualized reality: Constructing virtual worlds from real scenes. *IEEE multimedia*, 4(1), 34-47.

Use Cases

- Asset Creation for Virtual Environments
- Remote Inspection
- Training Scenarios
- AR Authoring

Asset Creation



It is often convenient to scan an existing object as a first step of a asset-creation pipeline



If you scan & use art pieces or people, be aware of legal issues!

1. Personal rights

Public Interests versus Privacy Rights?

2. Copyright laws

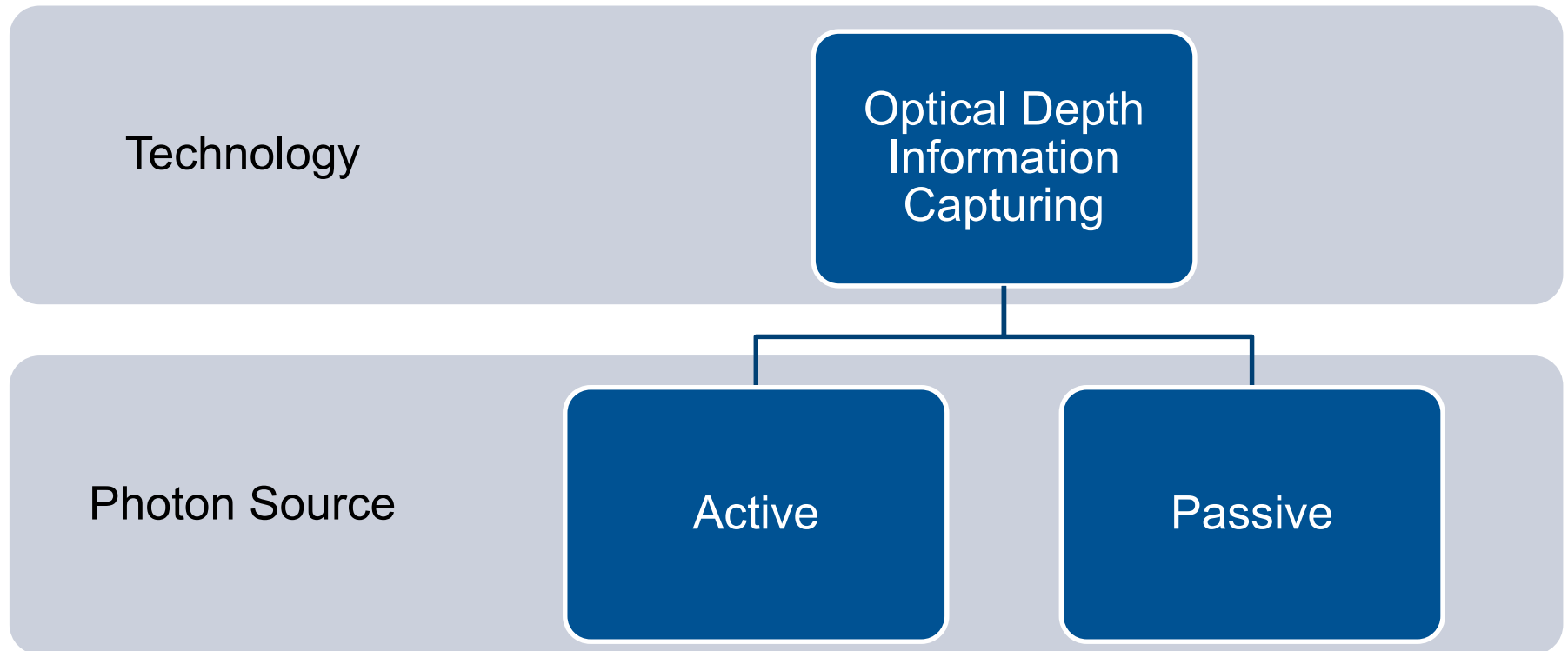
Are you scanning an art piece younger then 70 years
for another reason then science or education?

Further Examples: <https://www.pix-pro.com/blog/post/3d-asset>
https://sketchfab.com/3d-models/goat-skull-test-xiaomi-mi-11-auto-1fb5a2b2404546d99d3f0bfc23c378a4?utm_medium=embed&utm_campaign=share-popup&utm_content=1fb5a2b2404546d99d3f0bfc23c378a4

Remote Inspection



Optical Scanning Techniques



Optical Scanning Techniques - Active

Photon Source

Active

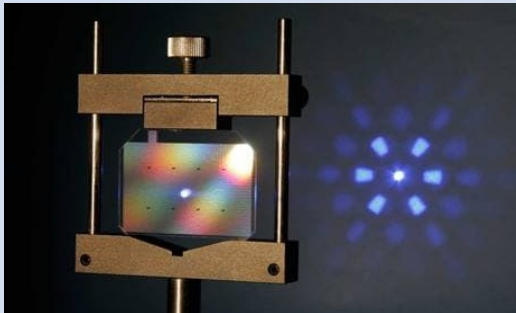
Photon Distribution

DOE

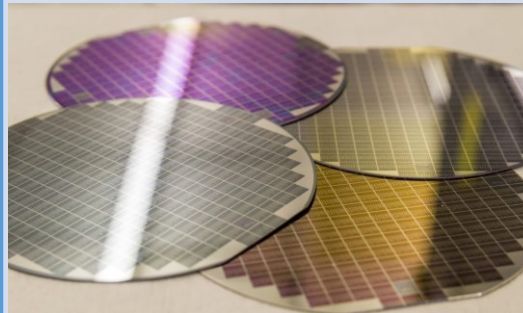
Micro mirror

Mechanical

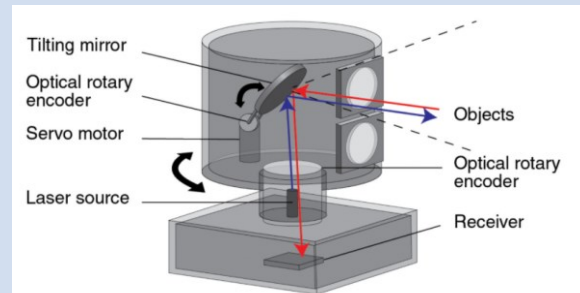
Diffractive Optical Elements
Small FoV, no active components



Micro-Electro-Mechanical Systems
Mirrors, Medium angle



Rotating Mirror, single Laser beam 360°,
bulky, active components



Depth Calculation

Photon Source

Active

Photon Distribution

DOE

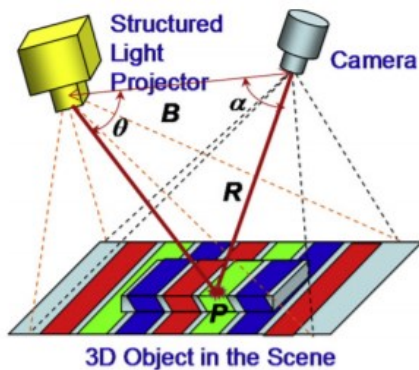
Depth Calculation

SL

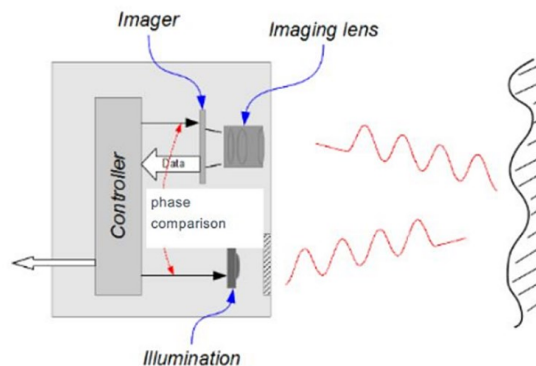
iTOF

dTOF

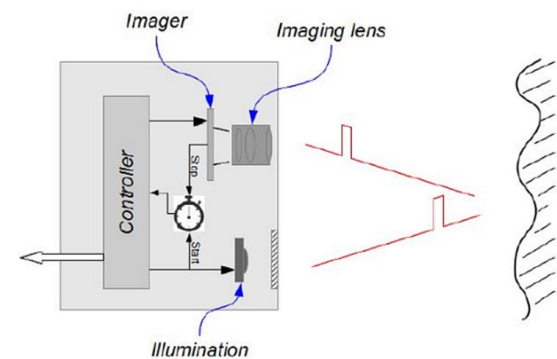
Structured Light



Indirect (Modulated) Time of Flight



Direct Time of Flight



<https://www.rfwireless-world.com/Terminology/Difference-between-Direct-ToF-Sensor-and-Indirect-ToF-Sensor.html>
Image source

Devices

Photon Source	Active		
Photon Distribution	DOE		
Depth Calculation	SL	iTOF	dTOF
	Microsoft Kinect (1 st Generation) Occipital Structure Sensor Apple FaceID Sensor	Microsoft Kinect (newer generations) Microsoft Hololens	Apple iPad Pro 2020 / 2021 "LIDAR" Sensor



Scanning results – Apple LIDAR sensor



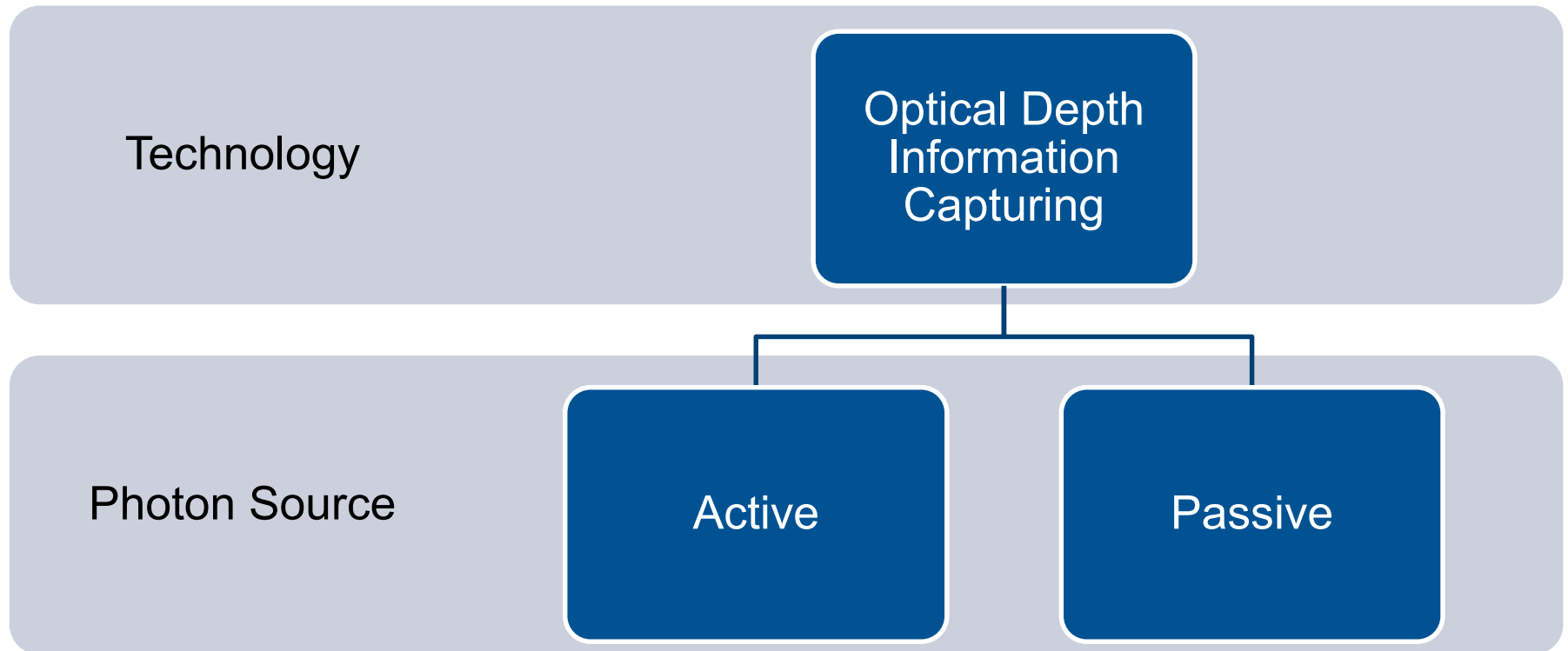
Scanning results – Apple “FaceID”-Sensor



Sensor Accuracy



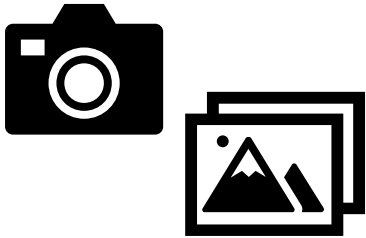
Optical Scanning Techniques



Optical Scanning Techniques - Passive

Photon Source

Passive
(Image based)



Input

Image Set
(+ Camera Poses)
(+ Camera Intrinsics)

} Can be calculated via
Structure From Motion
Techniques

Reconstruction
Technique

Photogrammetry
(Multi View Geometry)

Light-Field-Based
(NeRF, Plenoxels)

...

Optical Scanning Techniques - Passive

Photon Source

Passive
(Image based)

Reconstruction
Technique

Photogrammetry
(Multi View Geometry)

Light-Field-Based
(NERF, Plenoxels)

Depth from Focus,
Silhouette...

Photogrammetry

- Calculates surfaces
- Uses salient features for sparse reconstruction
- Intents to find one depth value for each pixel in each image (Dense Reconstruction)
- Projects color value to geometry (View-Independent Texturing)

Good for diffuse, natural objects with many features



<https://bitfab.io/blog/photogrammetry/>

Scanning Result – Meshroom Photogrammetry



Optical Scanning Techniques - Passive

Photon Source

Passive
(Image based)

Reconstruction
Technique

Photogrammetry
(Multi View Geometry)

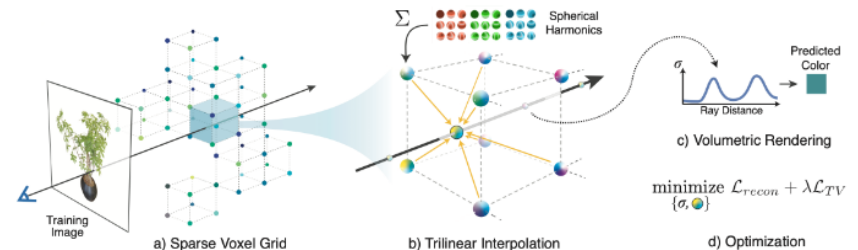
Light-Field-Based
(NeRF, Plenoxels)

Depth from Focus,
Silhouette...

Light-Field-Based

- Calculates volumetric distribution of light in a scene
- Uses the 5-dimensional plenoptic function
- Explicit (Voxel based -> Plenoxels) and implicit (Neural Network based -> NeRF) Approaches

Highly realistic results, even in challenging environments ... Integration in 3D Engines not trivial



Yu, A., Fridovich-Keil, S., Tancik, M., Chen, Q., Recht, B., & Kanazawa, A. (2021). Plenoxels: Radiance fields without neural networks. *arXiv preprint arXiv:2112.05131*.

Reminder: Homework 6

Homework 6 (until June, ~~5th~~12th)

Build a travel system and add it to your „homework 4“-application

1. Add a scene to travel in (e.g. the demo scene of <https://assetstore.unity.com/packages/3d/environments/urban/city-package-107224>)
2. Reuse your raycast – selection to build a teleport technique
3. Design and add an interaction method to look around in the scene (at least by rotation in the horizontal axis) with your smartphone controller as well

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- ✓ Reference Code for Homework 3 (as first step in Step-by-Step solution Homework 6)
 - ✓ Step-by-step solution for Homework 6 are published

Next week

Q&A Homework 6

Guest talk by Chloe Egtebas

Second chance to pitch your project ideas