

AUGMENTED AND MIXED REALITY

Corso Realtà Virtuale 2022/2023

eleonora.chitti@unimi.it



AR, MR or VR ?

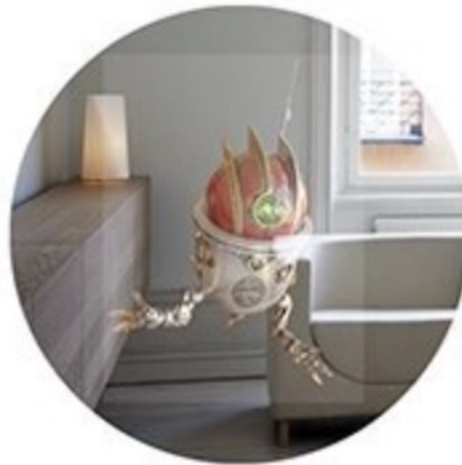
AR, MR AND VR

VR



Digital environments
that shut out the real world.

AR



Digital content on top
of your real world.



Digital content interacts
with your real world.

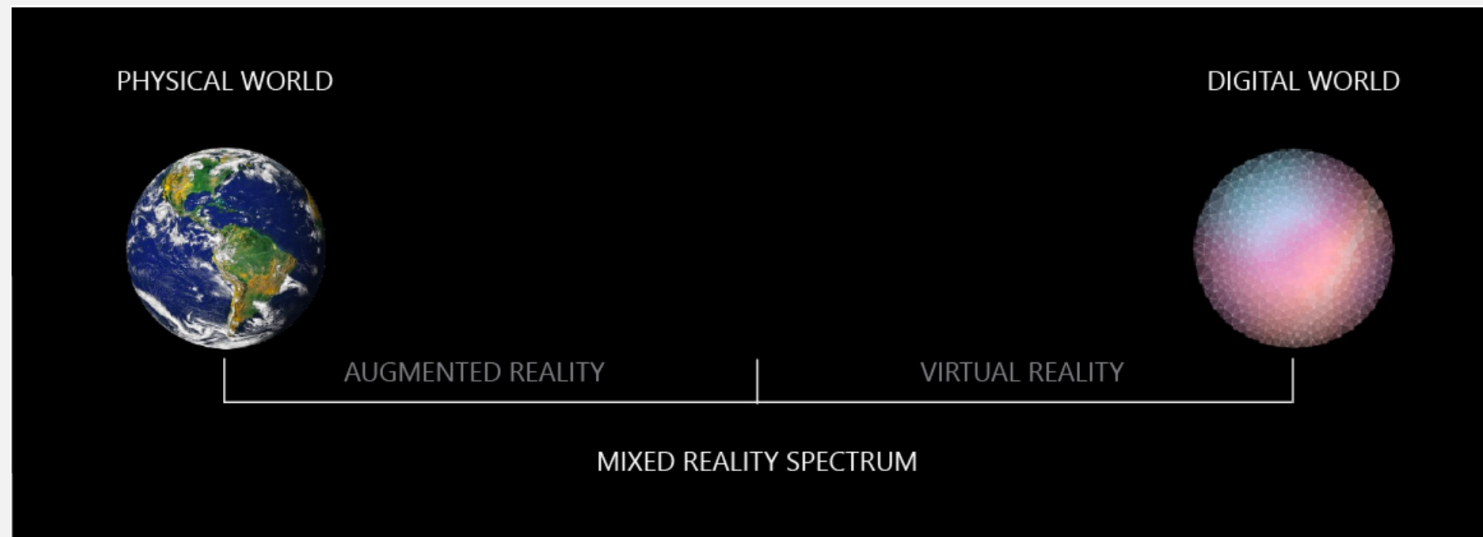


AR, MR AND VR

MR blends elements of the real and digital world. In mixed reality, you can interact and move elements and environments, both physical and virtual.

It offers the possibility of having one foot in the real world and the other in an imaginary place, breaking down the basic concepts of reality and imagination.

<https://www.intel.it/content/www/it/it/tech-tips-and-tricks/virtual-reality-vs-augmented-reality.html>



MR AND HOLOGRAMS

Holograms

The hologram is a virtual object made entirely of light that partially acts as the physical (real) object in the world:

Holographic objects can be viewed from different angles and distances, just like physical objects. They can also interact with the environment (e.g., bouncing ball on a table)

However, holograms do not offer any physical resistance when touched or pushed because they don't have a mass.



Holograms

In AR the digital content is displayed on top of visible real environment.

In MR the virtual objects are integrated into and responsive to the real world. For instance, a virtual ball under the desk would be blocked from a user's view.

MR takes the best qualities of AR and VR to create an immersive interface that overlays upon the user's reality. Rather than displaying simple images like AR, MR strives to put fully digital objects that are trackable and intractable in the user's environment.

Users can view and manipulate things from different angles which is as complex as an anatomy model. This type of rendering demands more processing power than AR, which is one main reason MR applications and devices are still in the proof-of-concept phase and far from consumer availability.

AR experiences aren't limited to visual additions to our world. You can create augmented experiences that are only audio additions to your physical world, or both audio and visual.



AUGMENTED REALITY

AUGMENTED REALITY

Augmented Reality applications are used to put additional virtual elements on the real world.

The virtual elements can include images, buttons and texts.

The ar app can be used for different purposes, from entertainment, as video-games, to business, as an ar app labeling objects or an ar app supporting marketing.



Image from <https://pokemongolive.com/it/>



AUGMENTED REALITY

Augmented Reality app can be developed for mobile phones or for xr headsets as Microsoft HoloLens ¹.

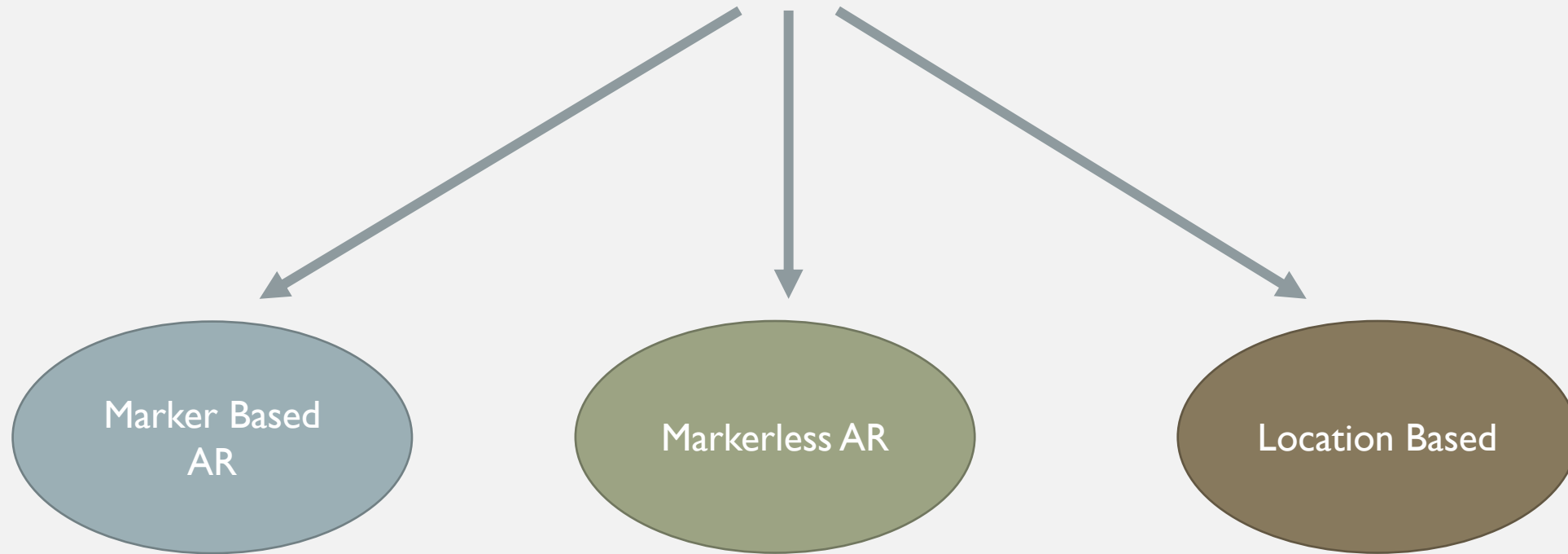
Frameworks:

- Android: ARCore ²
- iOS: ARKit ³
- Unity: ARFoundation ⁴ supporting ARCore and ARKit XR plugins, and Windows XR plugin for HoloLens
- Vuforia SDK ⁵, supports both native Android / iOS and Unity AR development

1. <https://www.microsoft.com/it-it/hololens>
2. <https://developers.google.com/ar>
3. <https://www.apple.com/it/augmented-reality/>
4. <https://docs.unity3d.com/Packages/com.unity.xr.arfoundation@4.1/manual/>
5. <https://developer.vuforia.com/downloads/sdk>

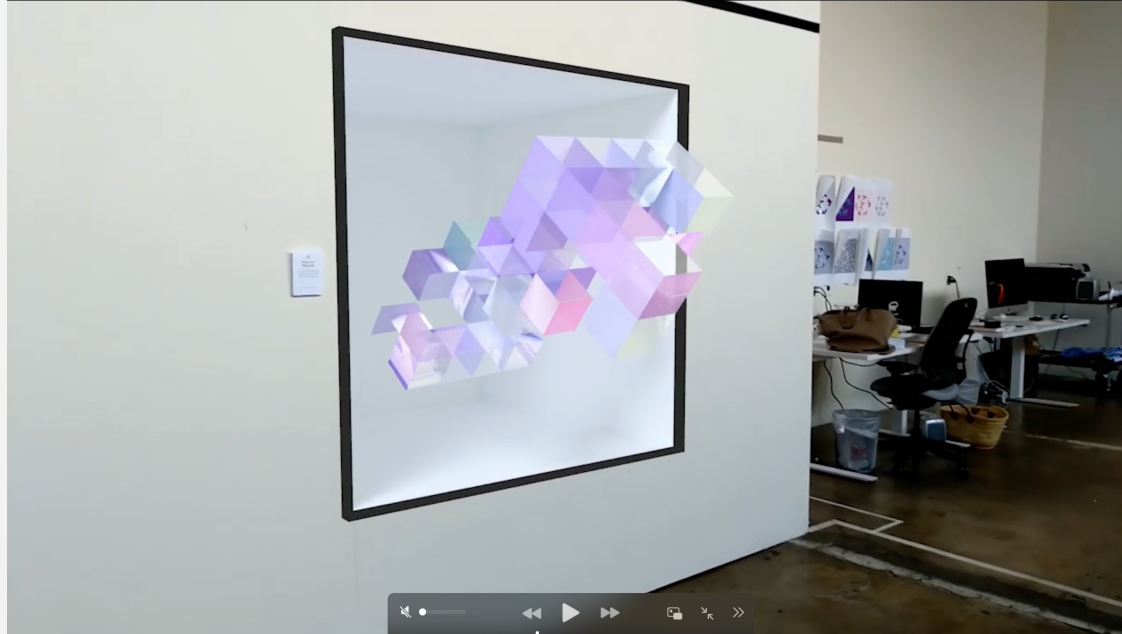


AUGMENTED REALITY TYPES



MARKER BASED

In **Marker based AR** (image tracking) a distinctive picture or page should be put in the real world. The picture is recognized through the device camera (pointing on the picture), and the additional virtual elements are shown on screen (on top of the image in the real world). The marker can be anything, as a QR code or a particular Picture, but it should have enough unique visual points. Mobile smartphones libraries (as ARCore and ARKit) support image tracking.



<https://developers.google.com/ar/develop/augmented-images>



MARKER BASED

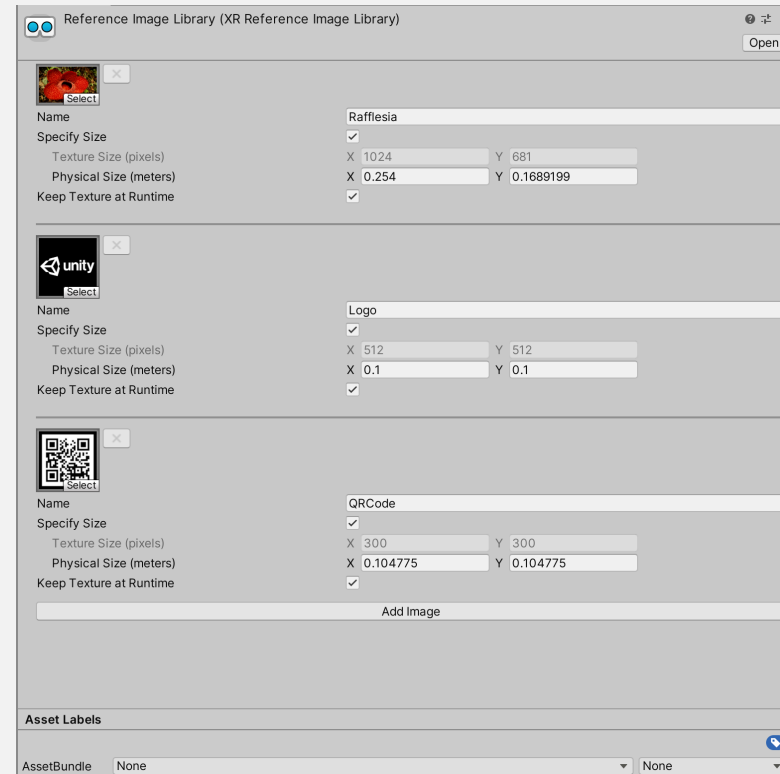
The images to be recognized are usually stored in a Reference Image Library structure.

Example from ARFoundation:

<https://github.com/Unity-Technologies/arfoundation-samples/tree/main/Assets/Scenes/ImageTracking>

Documentation on image tracking:

<https://docs.unity3d.com/Packages/com.unity.xr.arfoundation@4.2/manual/tracked-image-manager.html>



MARKER BASED

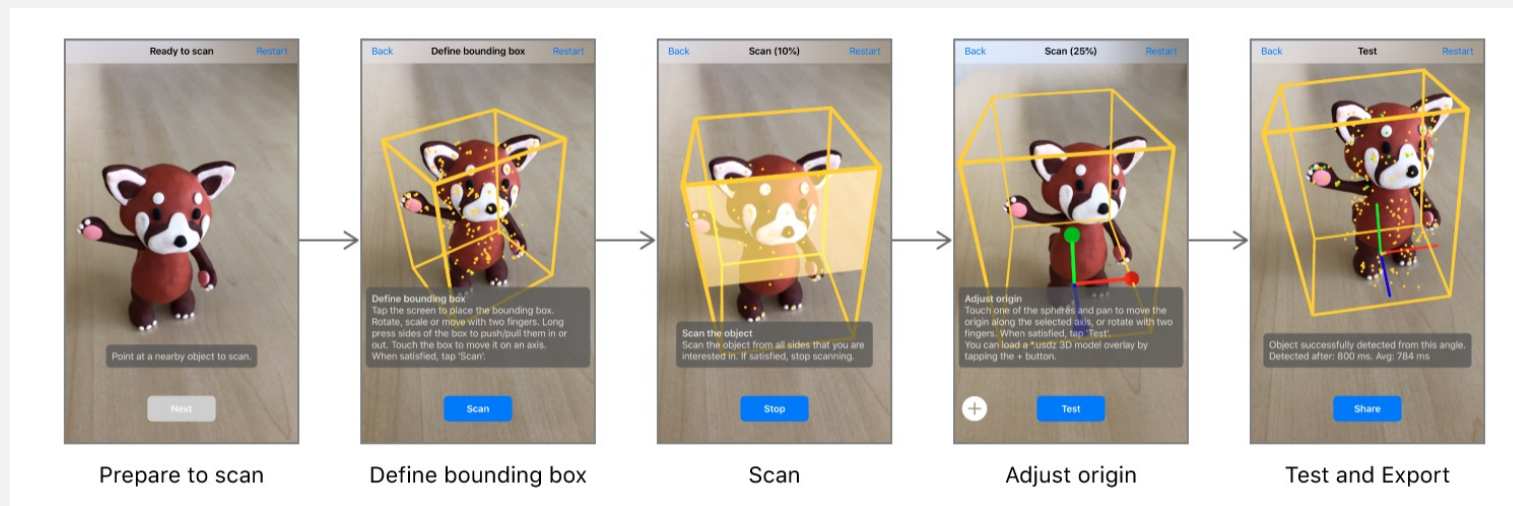
Recently also 3D **object tracking** is available with ARKit:

The structure is the same, a Object Reference Library contains the “object data” of each *reference object* to be recognized.

The “object data” is defined as “ARKit Object Reference”, you can scan objects in real world with a iOS mobile device and then send the resulting file to a PC.

The documentation and the code for the demo application for mobile devices to scan objects and create the ARKit Object Reference file is available here:

https://developer.apple.com/documentation/arkit/content_anchors/scanning_and_detecting_3d_objects



MARKERLESS BASED AR

Markerless based AR eliminates the need for capturing markers to trigger virtual interaction. Applications based on markerless AR exploit the device's sensors to gain data useful for AR, as tracking user's motion/ plane detection ...

Markerless AR merges digital data with real-time and real-world inputs. The technology combines software, audio, and video graphics with a smartphone's or headset's cameras, gyroscope, accelerometer, haptic sensors, and location services to show virtual object in 3D graphics upon the real world. ARCore and ARKit offers markerless AR, scanning the environment and creating maps of where to place virtual 3D objects.

Useful links:

- ARFoundation Plane Detection Setup
<https://docs.unity3d.com/Packages/com.unity.xr.arfoundation@5.1/manual/features/plane-detection.html>
- Unity Learn:
<https://learn.unity.com/tutorial/configuring-plane-detection-for-ar-foundation/?tab=overview>
- ARCore
<https://developers.google.com/ar/develop/fundamentals>
- ARKit
<https://developer.apple.com/videos/play/wwdc2018/610/>



LOCATION BASED

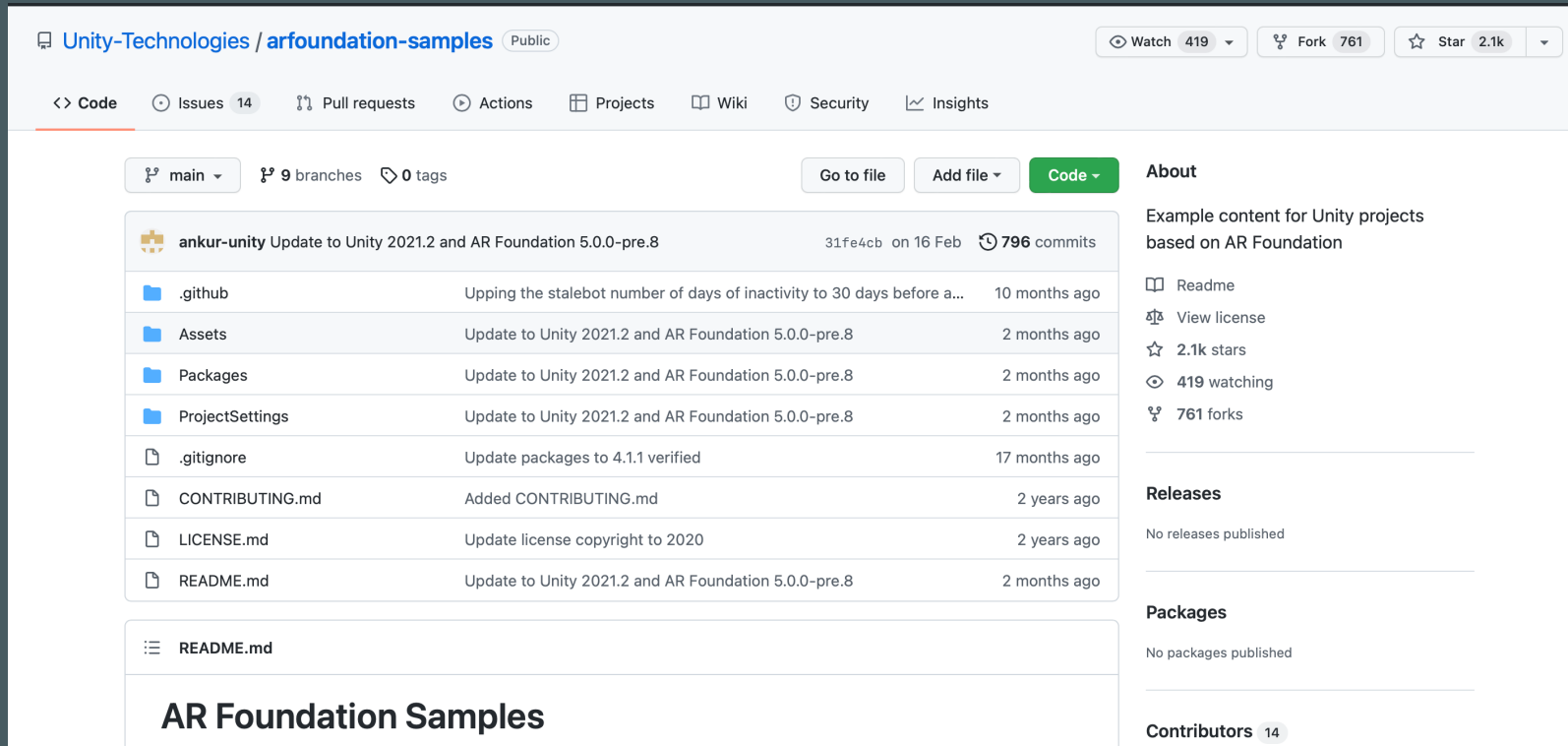
Location based AR exploit location technologies (GPS data, compass sensors of mobile phones,...) to place augmented reality content in a specific location.

This type of AR is usually exploited for commercial purposes, cultural heritage (as interactive maps that guide people through the city), and gaming (a famous example is Pokemon Go).



The ARFoundation GitHub repository collects all samples (with the corresponding documentation) of ARFoundation, and it includes Plane Detection, Image Tracking and Object tracking.

<https://github.com/Unity-Technologies/arfoundation-samples>



Unity-Technologies / arfoundation-samples Public

Watch 419 Fork 761 Star 2.1k

<> Code Issues 14 Pull requests Actions Projects Wiki Security Insights

main 9 branches 0 tags

ankur-unity Update to Unity 2021.2 and AR Foundation 5.0.0-pre.8 31.fe4cb on 16 Feb 796 commits

.github	Upping the stalebot number of days of inactivity to 30 days before a...	10 months ago
Assets	Update to Unity 2021.2 and AR Foundation 5.0.0-pre.8	2 months ago
Packages	Update to Unity 2021.2 and AR Foundation 5.0.0-pre.8	2 months ago
ProjectSettings	Update to Unity 2021.2 and AR Foundation 5.0.0-pre.8	2 months ago
.gitignore	Update packages to 4.1.1 verified	17 months ago
CONTRIBUTING.md	Added CONTRIBUTING.md	2 years ago
LICENSE.md	Update license copyright to 2020	2 years ago
README.md	Update to Unity 2021.2 and AR Foundation 5.0.0-pre.8	2 months ago

README.md

AR Foundation Samples

About
Example content for Unity projects based on AR Foundation

- Readme
- View license
- 2.1k stars
- 419 watching
- 761 forks

Releases
No releases published

Packages
No packages published

Contributors 14



WHAT IS ARFOUNDATION

AR foundation allows to work with different AR platforms inside Unity3D

You can install ARFoundation in Unity's Package Manager directly inside your project.

In addition to that Package, you should install also the Plugin you need, as ARKit for IOS apps or ARCore for Android apps development.

Supported Platform Packages

The following platform packages and later implement the AR Foundation features indicated above:

Package Name
ARCore XR Plugin
ARKit XR Plugin
ARKit Face Tracking
Magic Leap XR Plugin
Windows XR Plugin

ARFOUNDATION SETUP

1. Go to Window > Package Manager
2. In the Package Manager select “Packages: Unity Registry” then search the term AR
3. Install ARFoundation
4. Install ARKit or ARCore, depending on your target device
5. Now open the Scene “SampleARScene”
6. Add a GameObject > XR > AR Session
AR Session supports enabling and disabling XR on the target device
7. Add a GameObject > XR > AR Origin
Because AR devices provide their data in "session space", which is an unscaled space relative to the beginning of the AR session, the ARSessionOrigin performs the appropriate transformation into Unity space

ARFOUNDATION SETUP

8. Go to File > Build Settings > Switch Platform to the target device (Android / iOS)
9. Now in the Build Settings click on Player Settings to open that panel
10. In the Player Settings in iOS under the voice “Other Settings” → “Configuration” check the box corresponding to “Requires ARKit support”
11. Now Edit > Project Settings > XR Plug-in Management enable the Provider Plugin setup, i.e. check the box ARKit or ARCore
<https://docs.unity3d.com/Packages/com.unity.xr.foundation@4.1/manual/index.html#provider-plugin-setup>
12. Before building the project in the Player Settings under the voice “Other Settings” → “Identification” you can change the Bundle Identifier, that should be a unique identifier of your project.
13. Now you can build the Project

<https://docs.unity3d.com/Packages/com.unity.xr.foundation@4.1/manual/index.html#using-ar-foundation>

ARFOUNDATION XR SIMULATOR

AR foundation from latest 2022 allows to simulate AR projections on an emulated environment in your Unity Project using the Editor Run

Enable XR Simulation:

- Go to Edit > Project Settings to open the Project Settings window.
- In the Project Settings window, select XR Plug-in Management.
- Under Plug-in Providers, enable XR Simulation.

<https://docs.unity3d.com/Packages/com.unity.xr.arfoundation@5.1/manual/xr-simulation/simulation.html>

TROUBLESHOOTING

- [iOS] If after the build your project is black, you should enable the Provider Plugin setup, in the “Project Settings” click on “XR Plug-in Management” then click on iOS or on Android and respectively check the box ARKit or ARCore (step 11)
- [Android] If after the build you get an error on ARCore as “BuildFailedException:ARCore Required apps require a minimum SDK version of 24.” or “Failed getting available Android API levels. Could not find Android SDK Tools.”

You can solve it: Project Settings > Player Settings > Android, under the voice “Other Settings” → “Identification” change the “Minimum API Level” to Nougat level 24

- [Android] “BuildFailedException:You have enabled the Vulkan graphics API, which is not supported by ARCore.”

Under the voice “Other Settings” → “Rendering” change the Graphics API and remove Vulkan