Lab 2 - Calibration

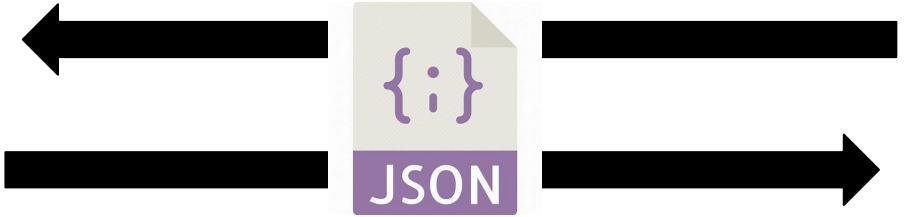
Meta Quest 3 Spatial Anchor

Lab Schedule

- 9/12 Lab 1 - Marker Detection
- 9/19 Lab 2 - Calibration
- 9/26 Lab 3 - Game Design 1
- 10/3 Lab 4 - Game Design 2
- 10/10 National Holiday (No Class)
- 10/17 UIST (No Physical class)
- 10/24 Midterm Demo

What we will do

(2) 3D coordinates from Spatial anchors



(4) ArUco positions detected by RealSense

(1)
ArUco positions
marked by user

(3) Find the
transformation matrix
from RealSense space
to Unity space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Outline

- Installation & Setup
- Camera & Controllers Tracking
- Spatial Anchor
- Calibration
- Server Client
- To Do

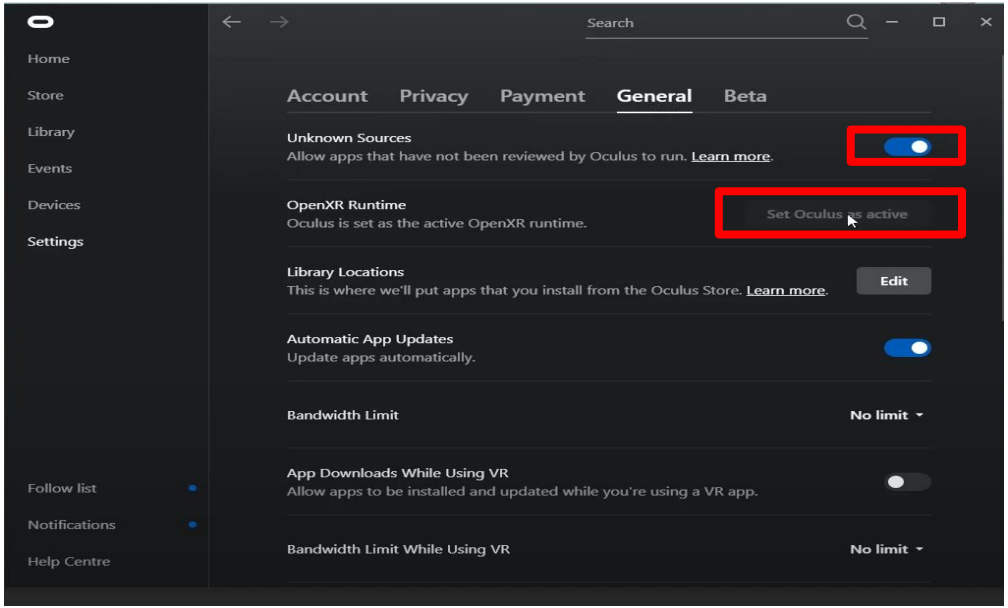
Installation & Setup

Quest Link

- Download Quest Link app and connect headset. Link

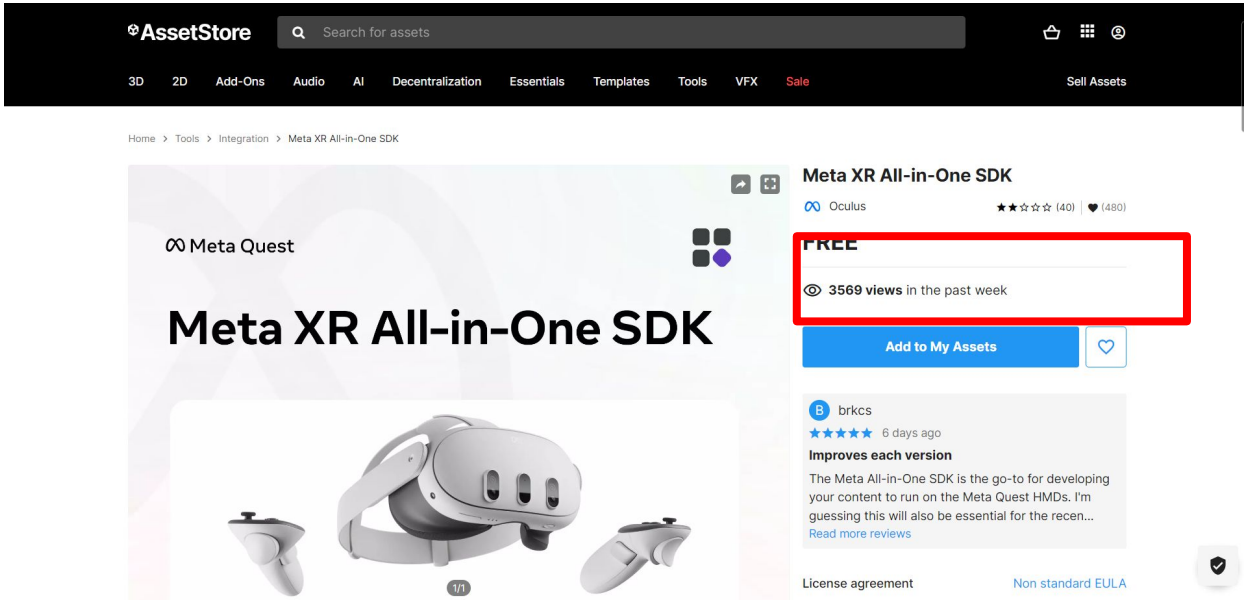
Settings

- Go to Settings > General.
- Allow Unknown Source, and switch OpenXR Runtime to “Set Oculus as Active”.

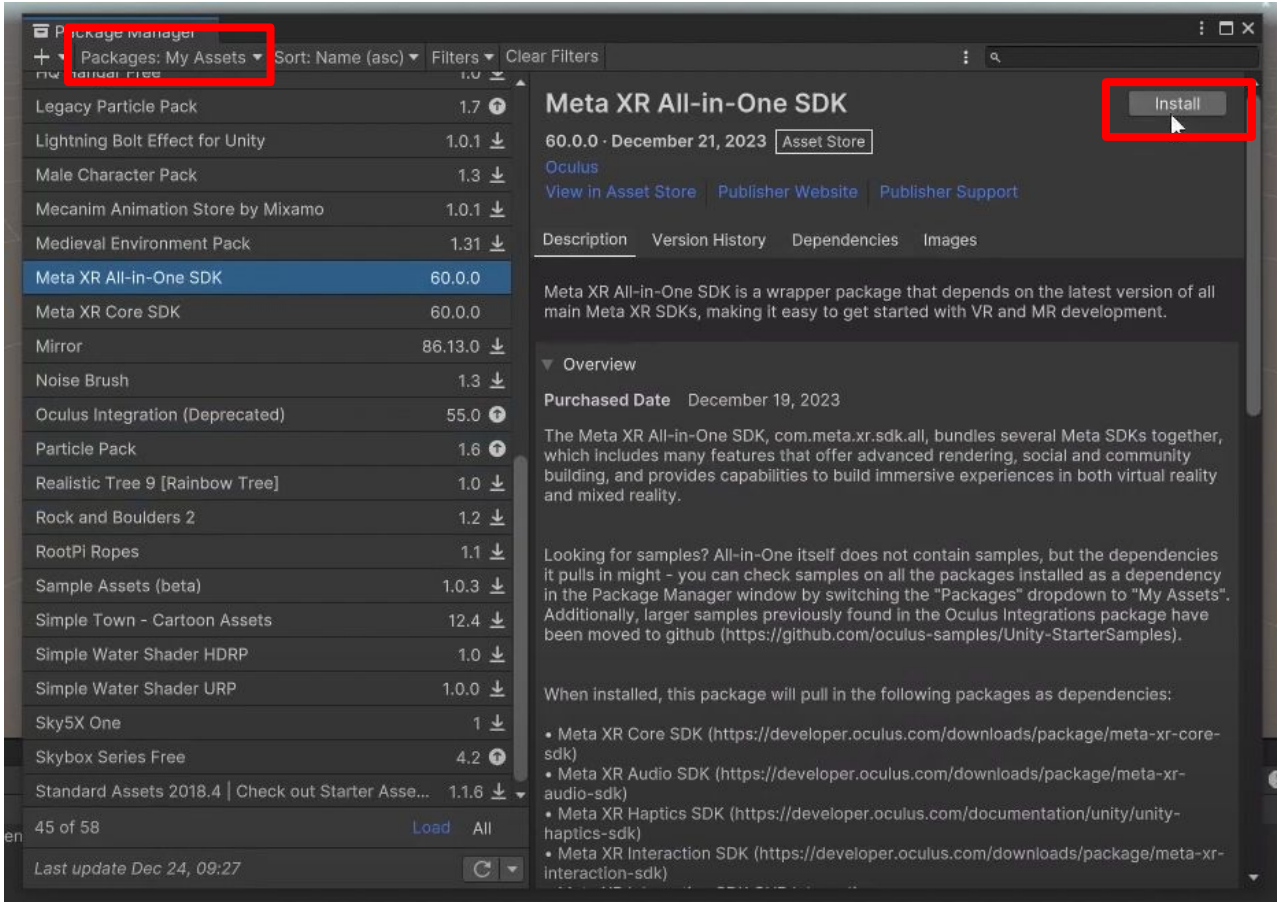


Meta XR All-in-One SDK Link

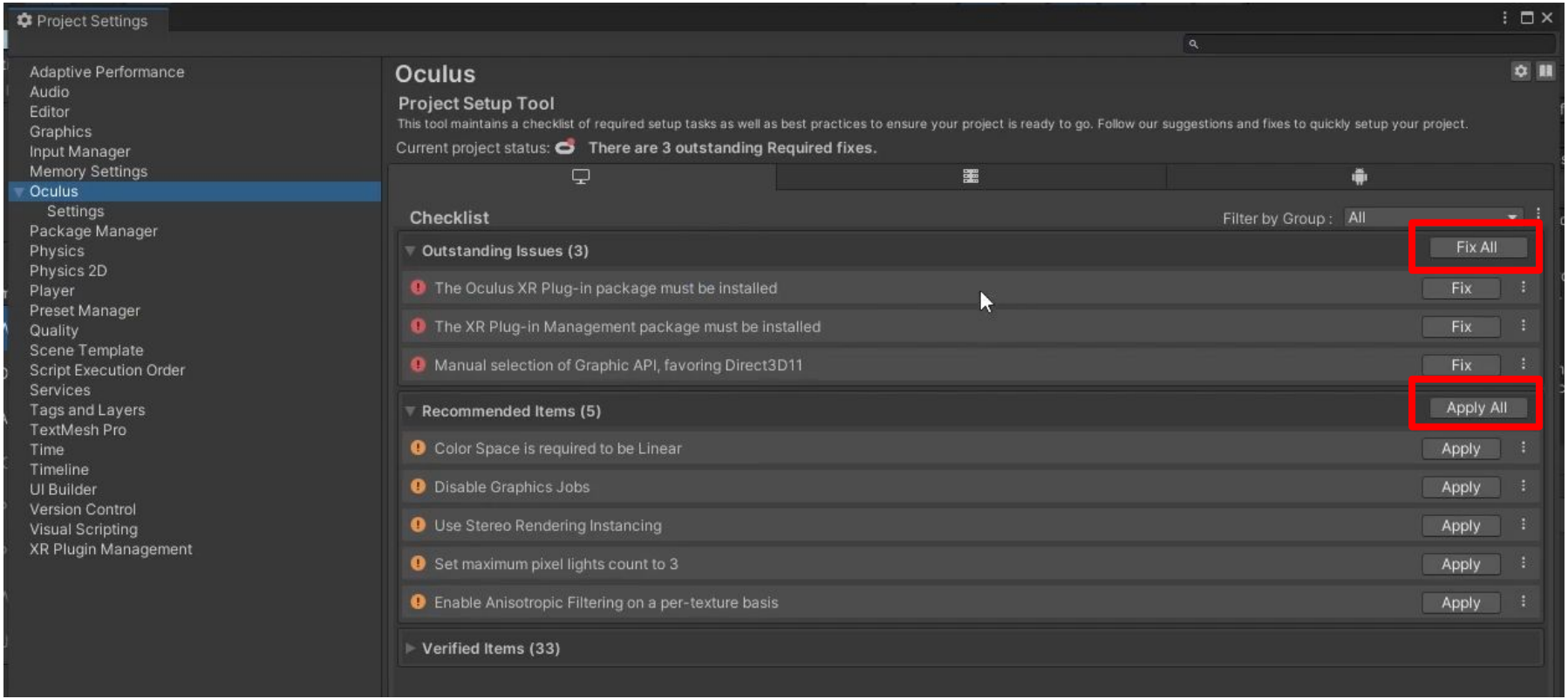
- **Download and import to Unity project. Link**



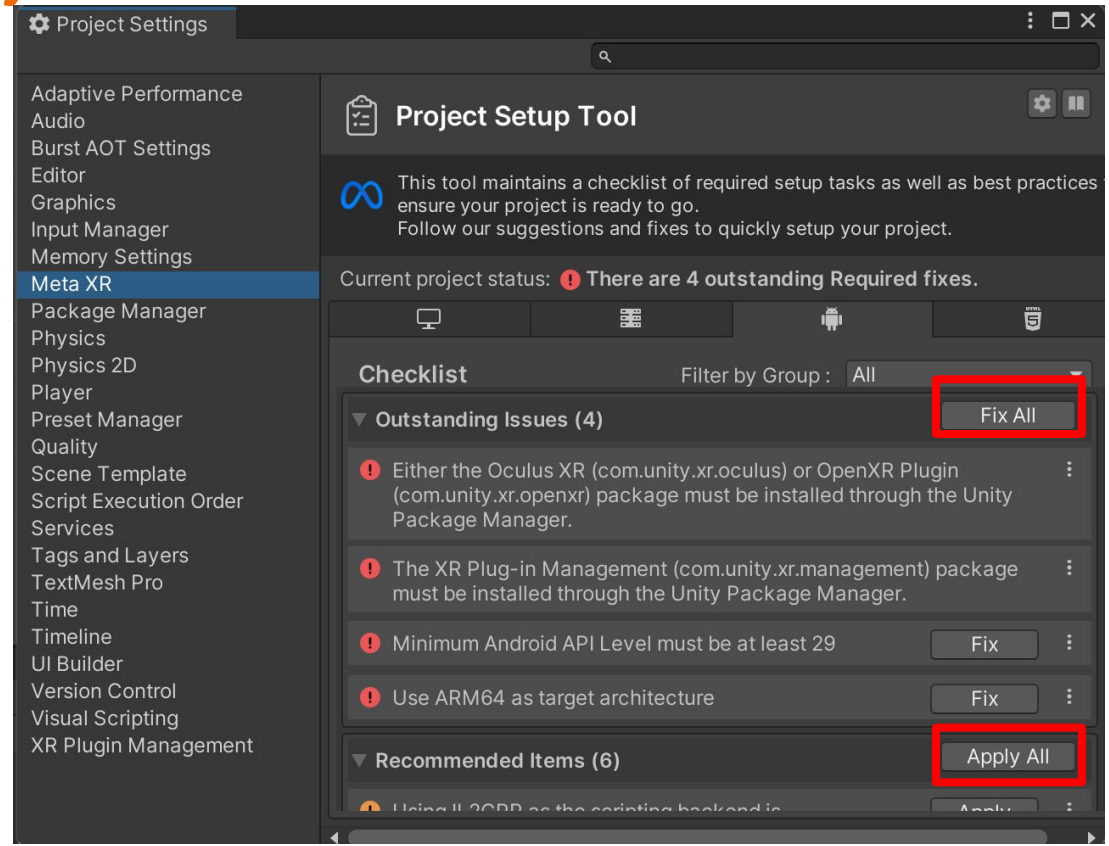
Install Package



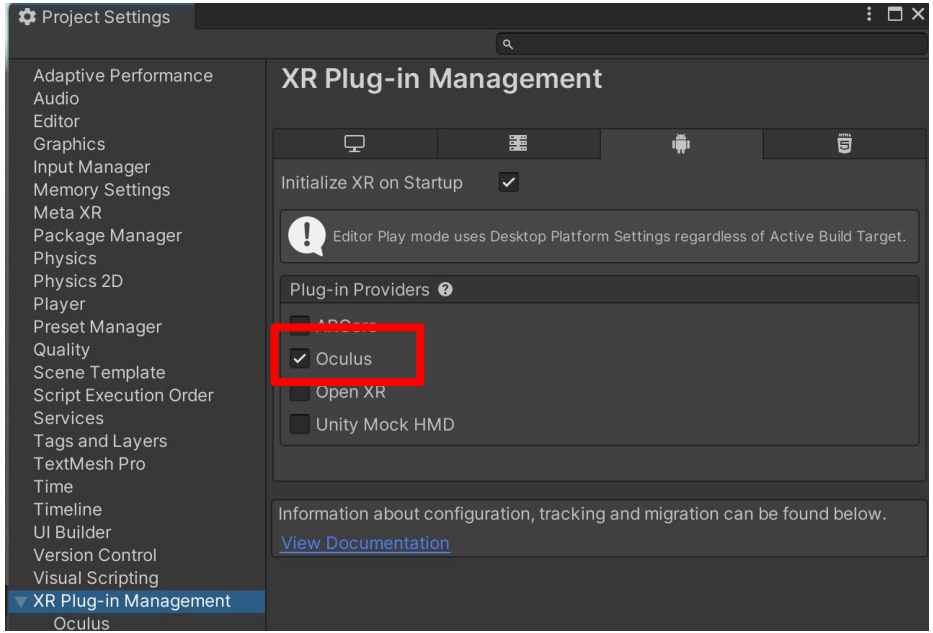
Fix and Apply

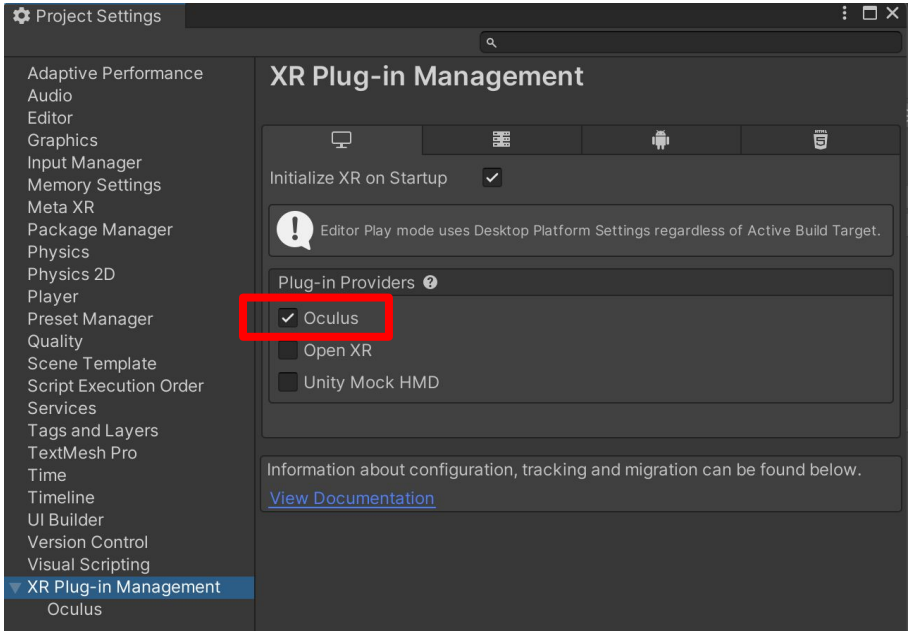


Fix and Apply

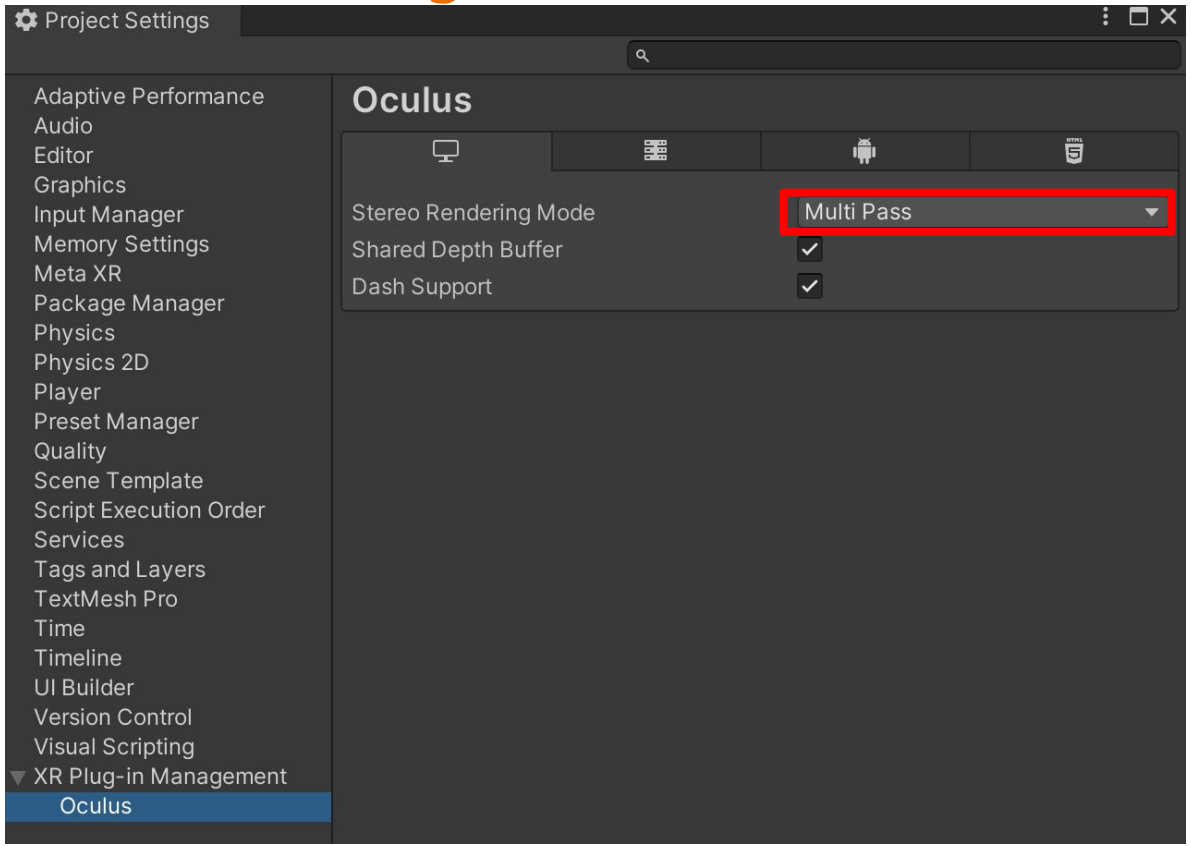


XR Plug-in Management

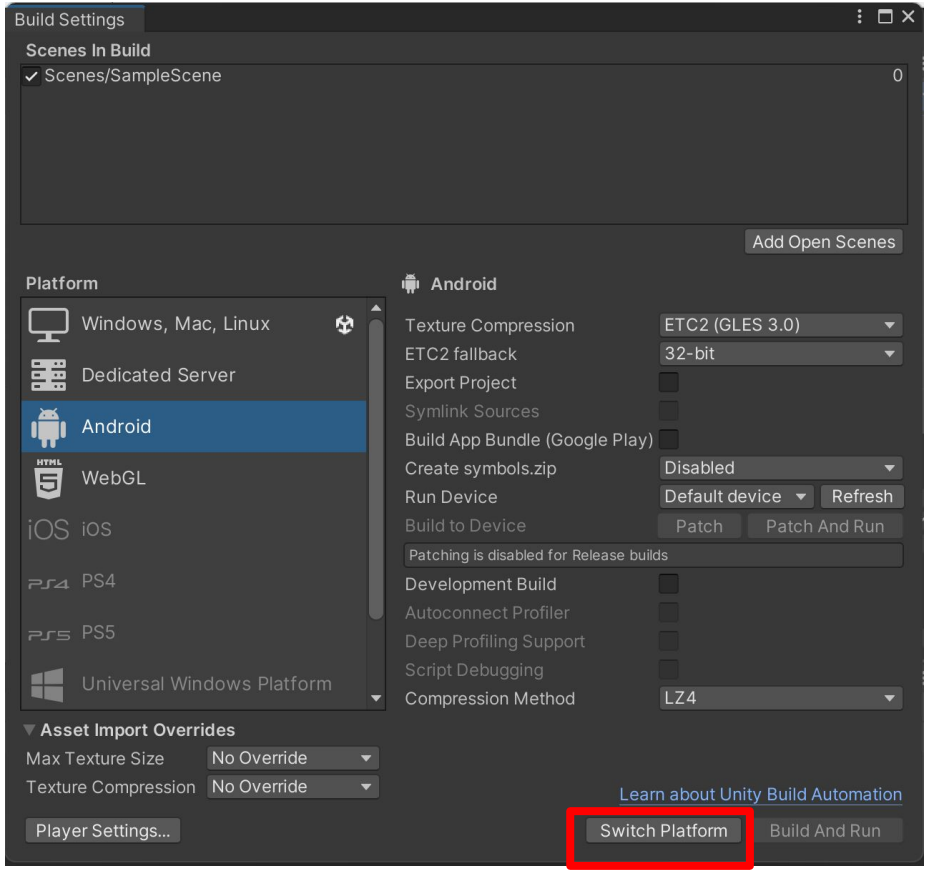




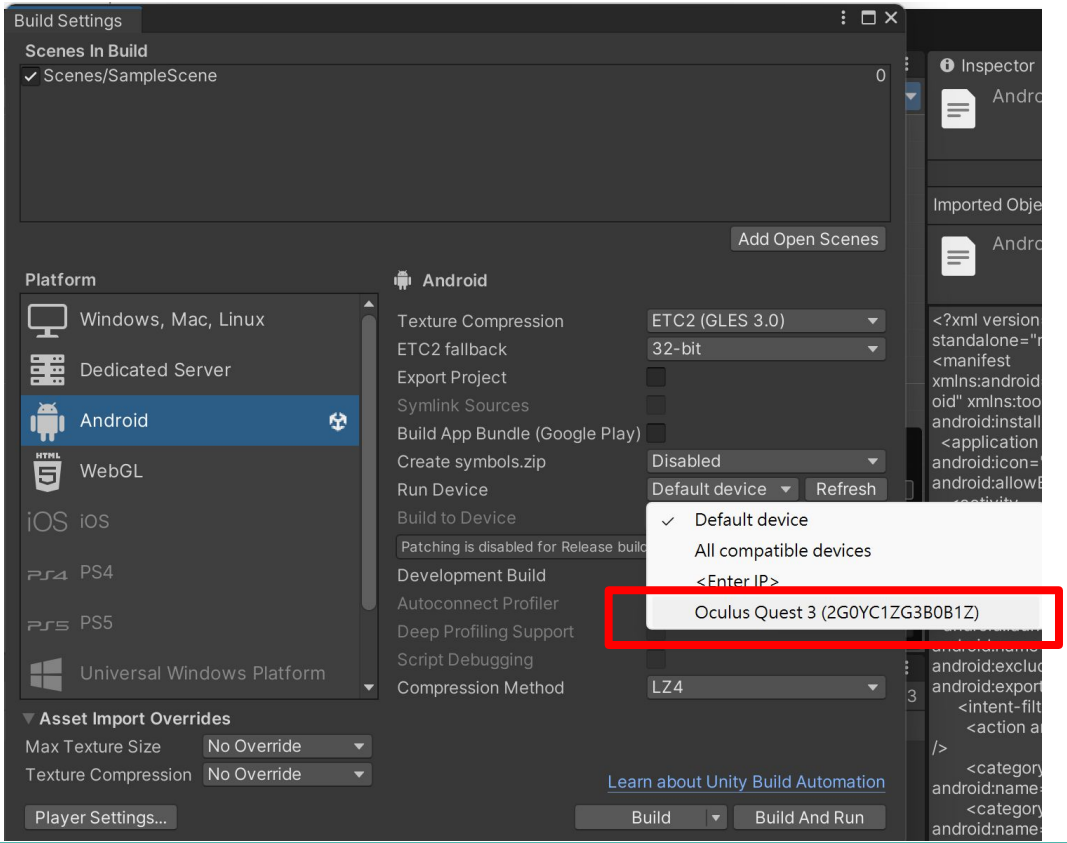
Change Stereo Rendering Mode



Switch to Android Platform

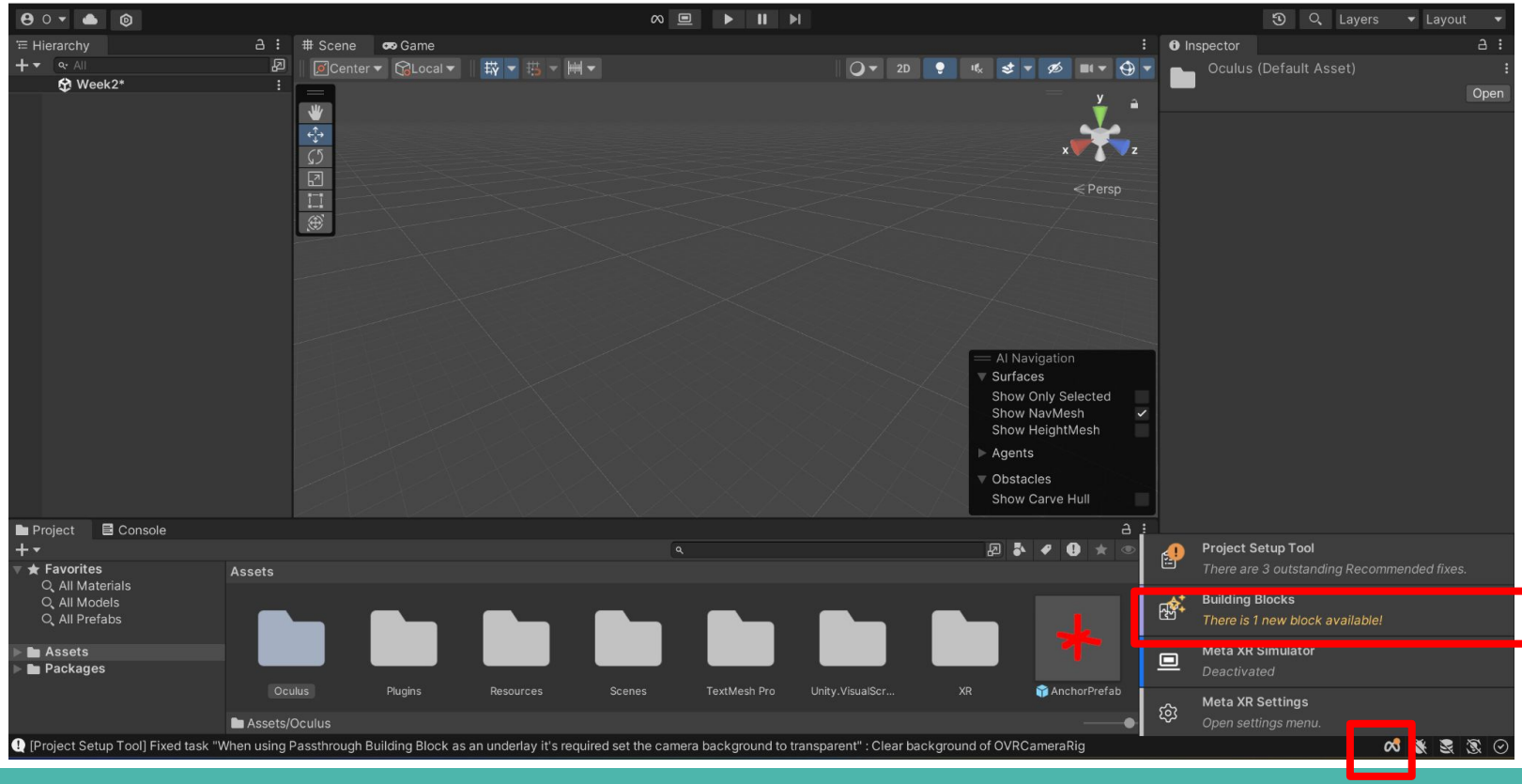


Refresh “Run Device”and select Quest 3

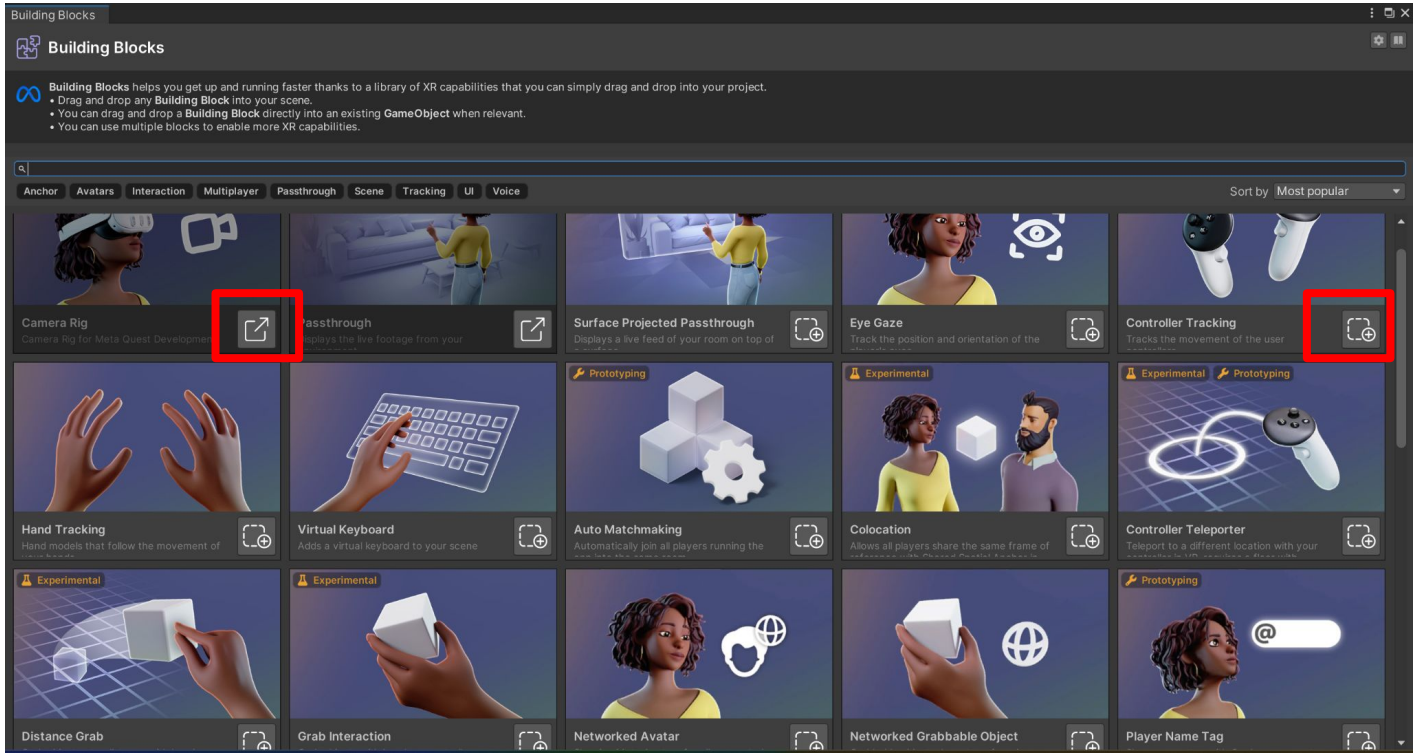


Camera & Controllers Tracking

Meta Building Blocks



Select Camera Rig and Controller Tracking

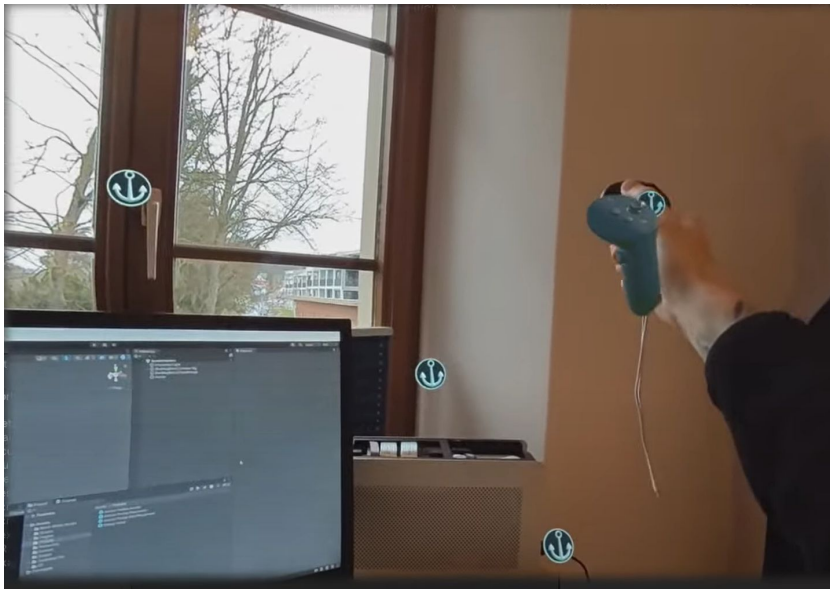



Y
X
B
A

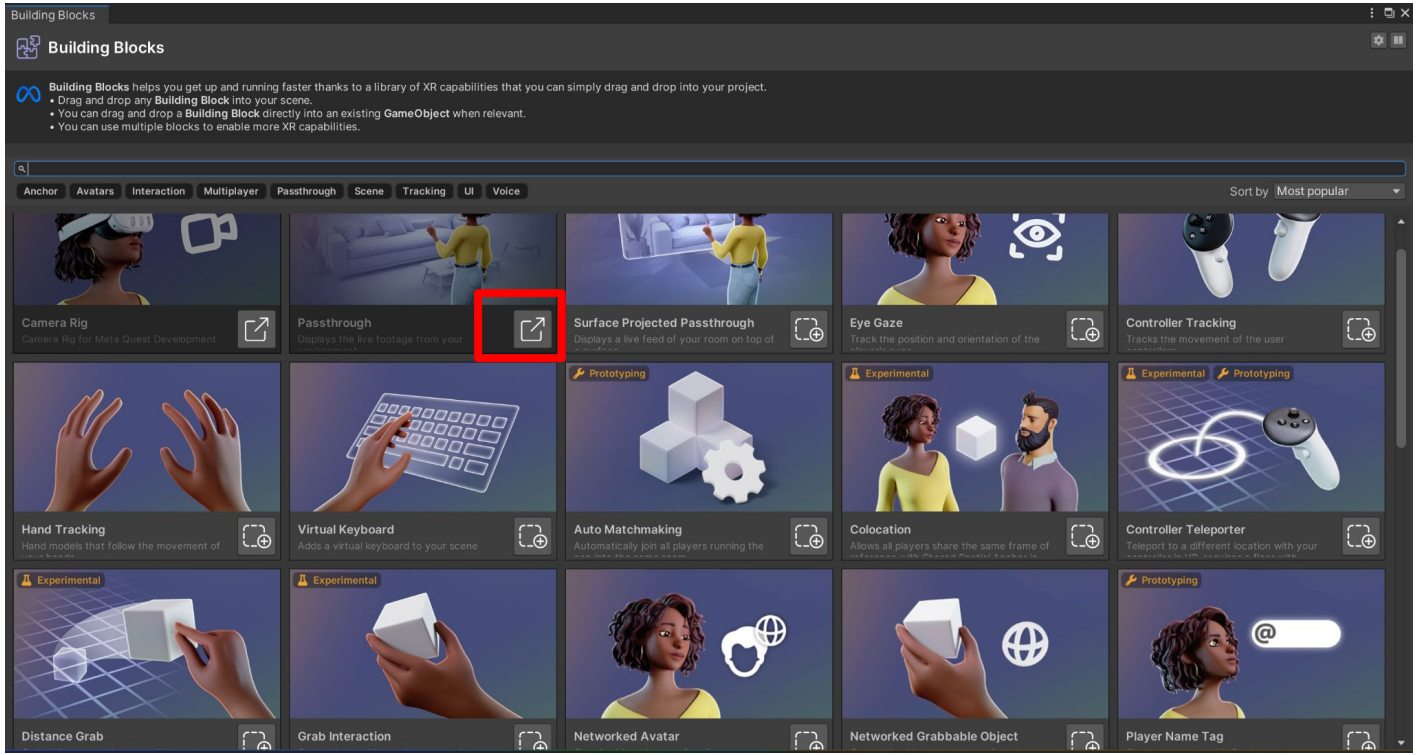
Spatial Anchor

Spatial Anchors

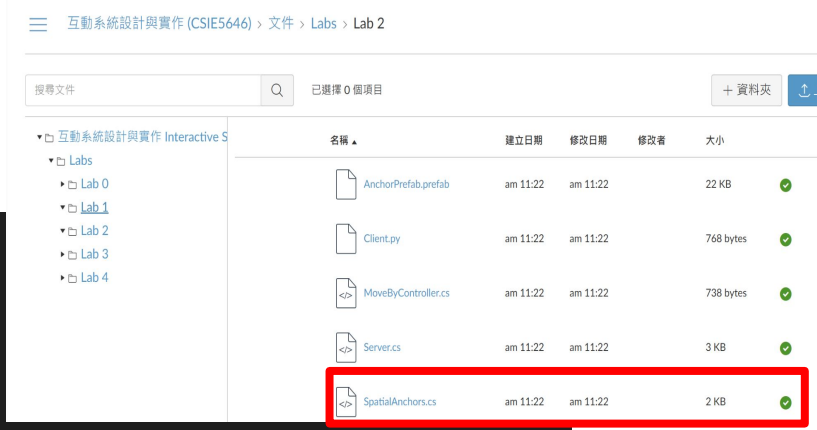
- Stable points in real world tracked by Quest 3



Add Passthrough



SpatialAnchors.cs




```
7   public class SpatialAnchors : MonoBehaviour
8   {
9       //Specify controller to create Spatial Anchors
            3 references
10      [SerializeField] private Controller controller;
11      // Spatial Anchor Prefab
            1 reference
12      public GameObject anchorPrefab;
13
14      // Update is called once per frame
            0 references
15      void Update()
16      {
17          // Create Anchor when user press the index trigger on specified controller
18          if(OVRInput.GetDown(OVRInput.Button.PrimaryIndexTrigger, controller))
19          {
20              CreateSpatialAnchor();
21          }
22      }
23
            1 reference
24      public void CreateSpatialAnchor()
25      {
26          GameObject anchor = Instantiate(anchorPrefab, OVRInput.GetLocalControllerPosition(controller)
27                                                      , OVRInput.GetLocalControllerRotation(controller));
28          anchor.AddComponent<OVRSpatialAnchor>();
29      }
30  }
```

OVRInput

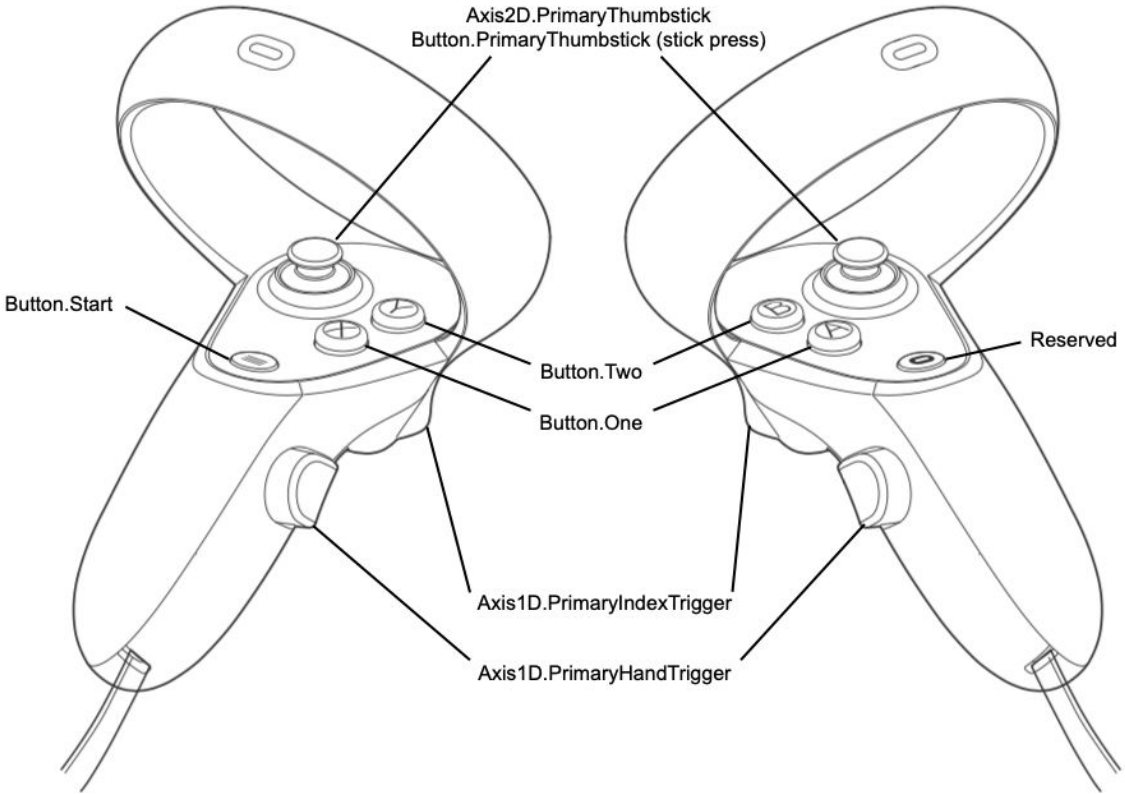
- OVRInput.Get()
  - Return true if currently pressed.
- OVRInput.GetDown()
  - Return true if pressed this frame.
- OVRInput.GetUp()
  - Return true if released this frame.

```
14      // Update is called once per frame
        0 references
15      void Update()
16      {
17          // Create Anchor when user press the index trigger on specified controller
18          if (OVRInput.GetDown(OVRInput.Button.PrimaryIndexTrigger, controller))
19          {
20              CreateSpatialAnchor();
21          }
22      }
23
```

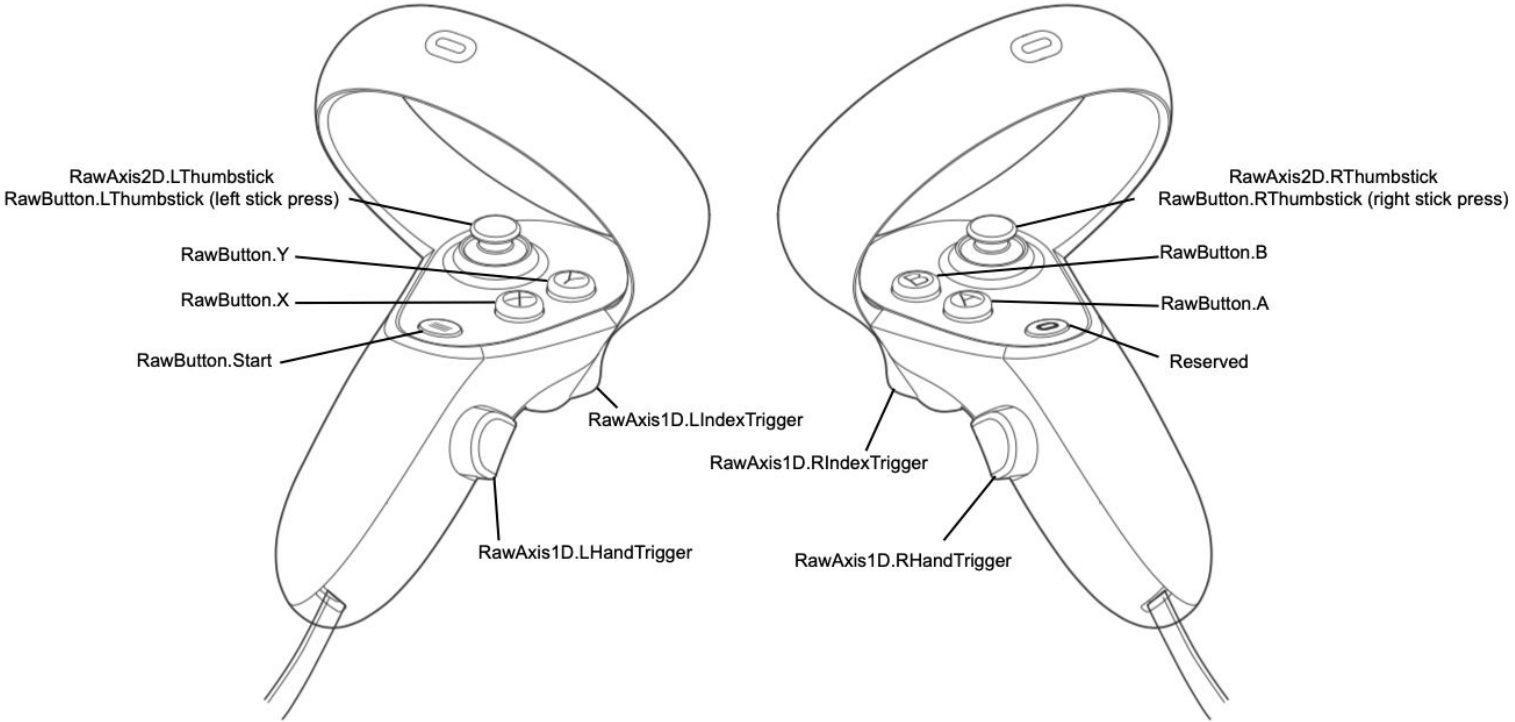
Control Input Enumerations

Control	Enumerates
`OVRInput.Button`	Traditional buttons found on gamepads, controllers, and back button.
`OVRInput.Touch`	Capacitive-sensitive control surfaces found on the controller.
`OVRInput.NearTouch`	Proximity-sensitive control surfaces found on the controller.
`OVRInput.Axis1D`	One-dimensional controls such as triggers that report a floating point state.
`OVRInput.Axis2D`	Two-dimensional controls including thumbsticks. Reports a Vector2 state.

Controller Input Mapping



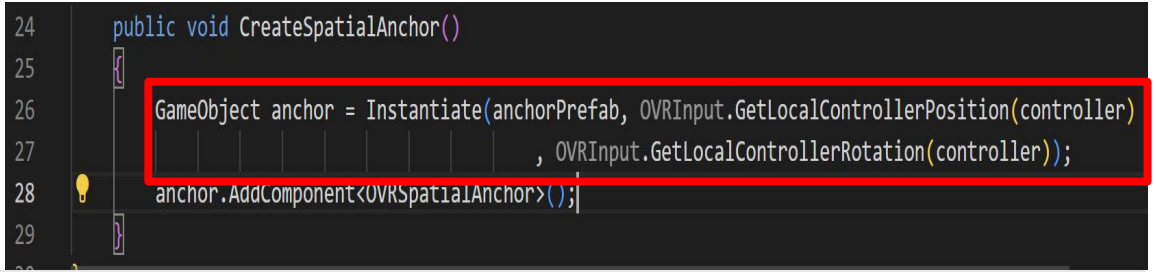
Controller Input Mapping (Raw)



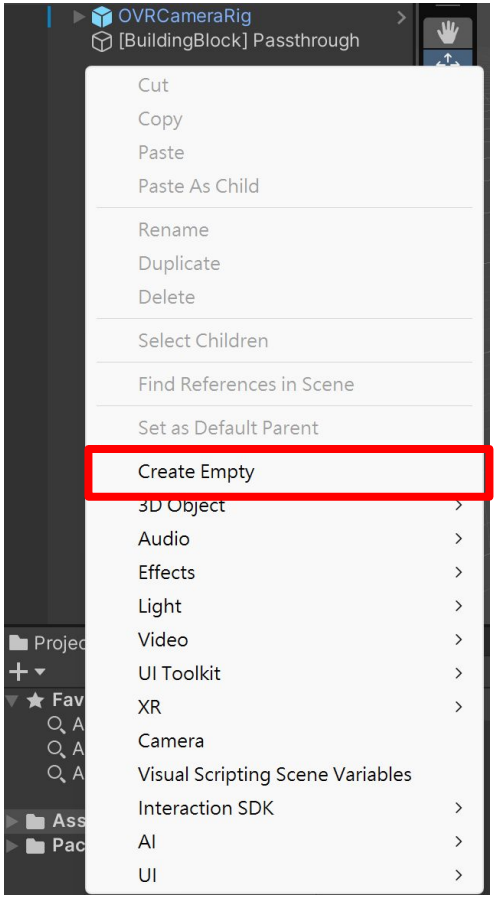
Instantiate

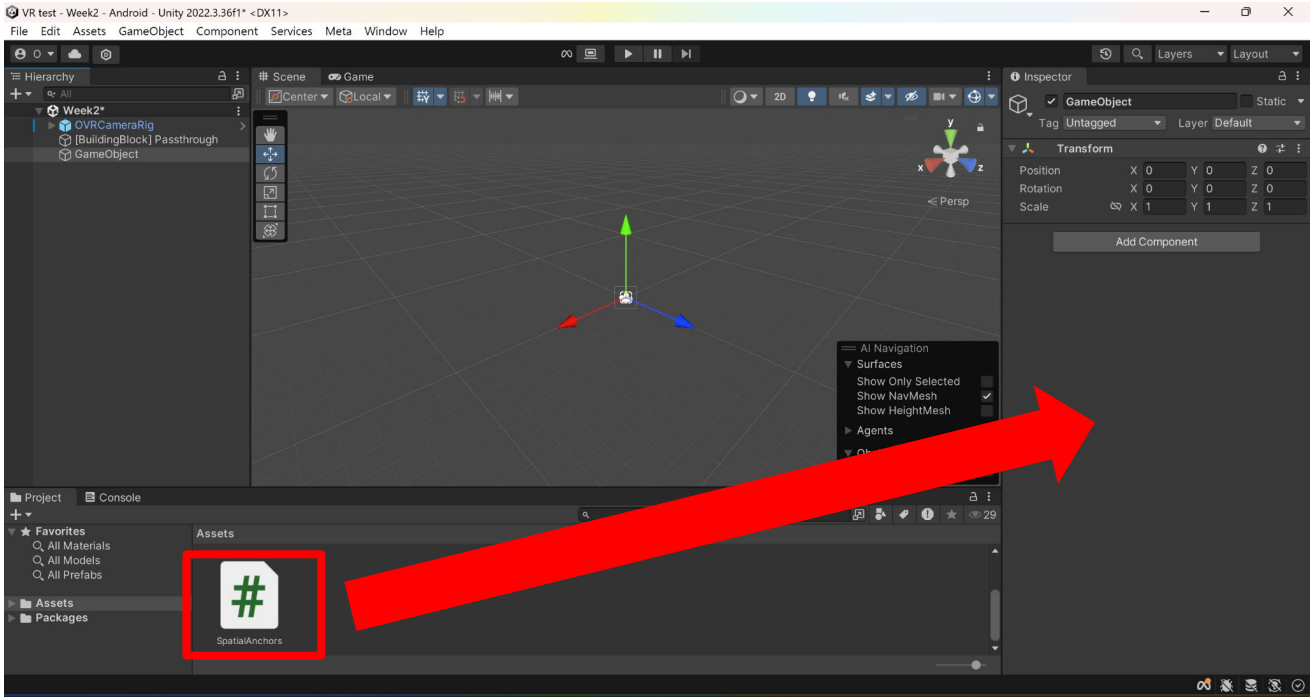
Instantiate(Object original, Vector3 position, Quaternion rotation, Transform parent)

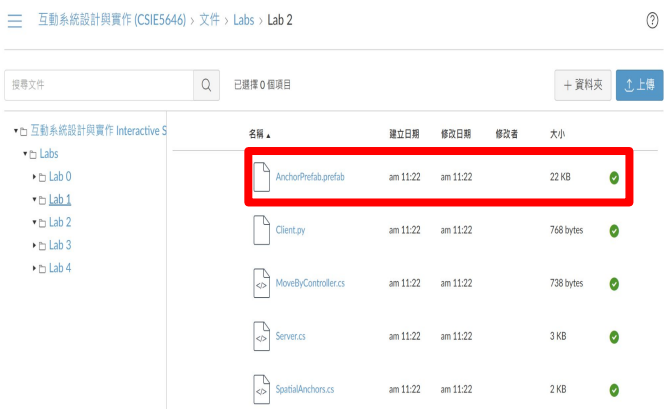
Instantiate(Object original, Vector3 position, Quaternion rotation)



original	An existing object that you want to make a copy of.
position	Position for the new object.
rotation	Orientation of the new object.
parent	Parent that will be assigned to the new object.
instantiateInWorldSpace	When you assign a parent Object, pass true to position the new object directly in world space. Pass false to set the Object's position relative to its new parent.


OVRCameraRig
[BuildingBlock] Passthrough
Cut
Copy
Paste
Paste As Child
Rename
Duplicate
Delete
Select Children
Find References in Scene
Set as Default Parent
Create Empty
3D Object
Audio
Effects
Light
Video
UI Toolkit
XR
Camera
Visual Scripting Scene Variables
Interaction SDK
AI
UI


VR test - Week2 - Android - Unity 2022.3.36f1* <DX11>
File Edit Assets GameObject Component Services Meta Window Help
Hierarchy
Week2*
OVRCameraRig
[BuildingBlock] Passthrough
GameObject
Scene
Game
Persp
AI Navigation
Surfaces
Show Only Selected
Show NavMesh
Show HeightMesh
Agents
Inspector
GameObject
Tag Untagged
Layer Default
Transform
Position
Rotation
Scale
Add Component
Project
Console
Favorites
All Materials
All Models
All Prefabs
Assets
Packages
SpatialAnchors


互動系統設計與實作 (CSIE5646) › 文件 › Labs › Lab 2
搜尋文件
已選擇 0 個項目
+ 資料夾
上傳
互動系統設計與實作 Interactive S
Labs
Lab 0
Lab 1
Lab 2
Lab 3
Lab 4
名稱
建立日期
修改日期
修改者
大小
AnchorPrefab.prefab
am 11:22
am 11:22
22 KB
Client.py
am 11:22
am 11:22
768 bytes
MoveByController.cs
am 11:22
am 11:22
738 bytes
Server.cs
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SpatialAnchors.cs
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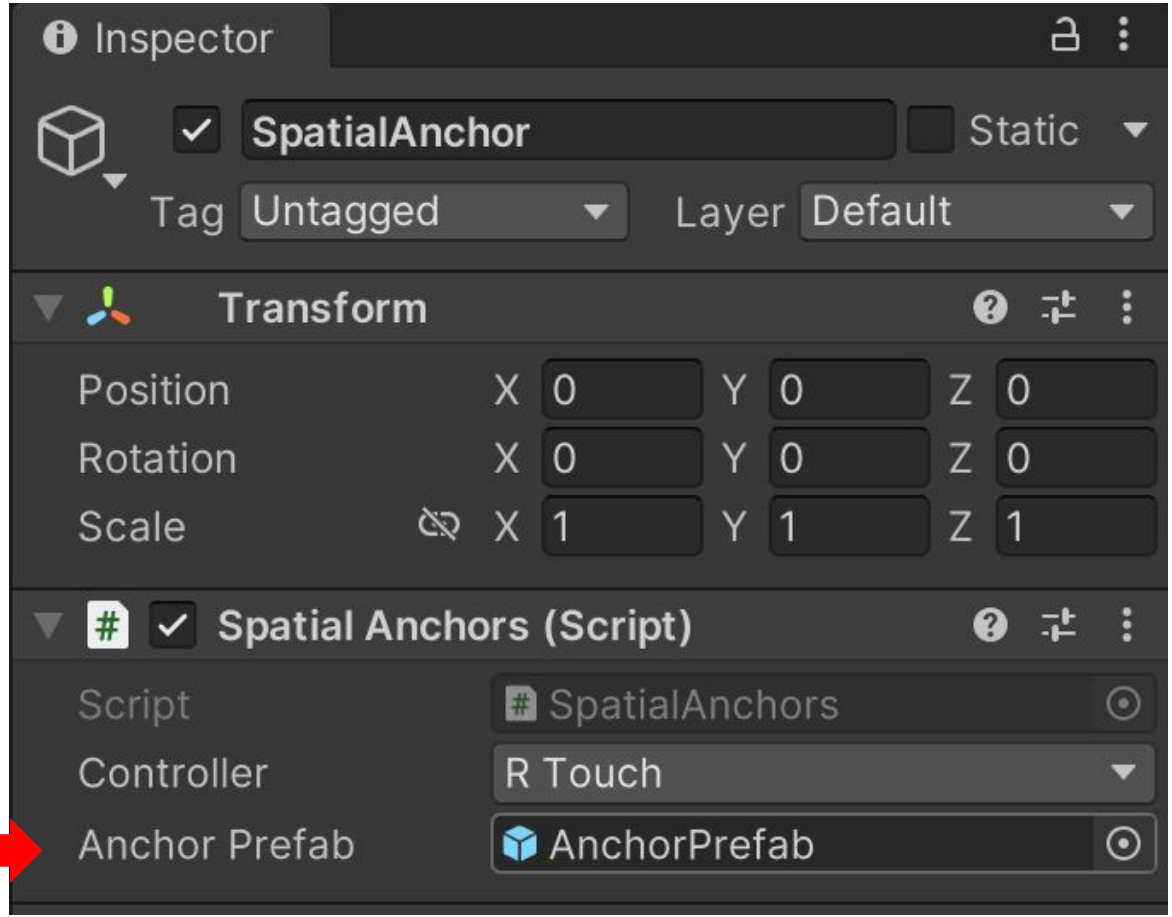
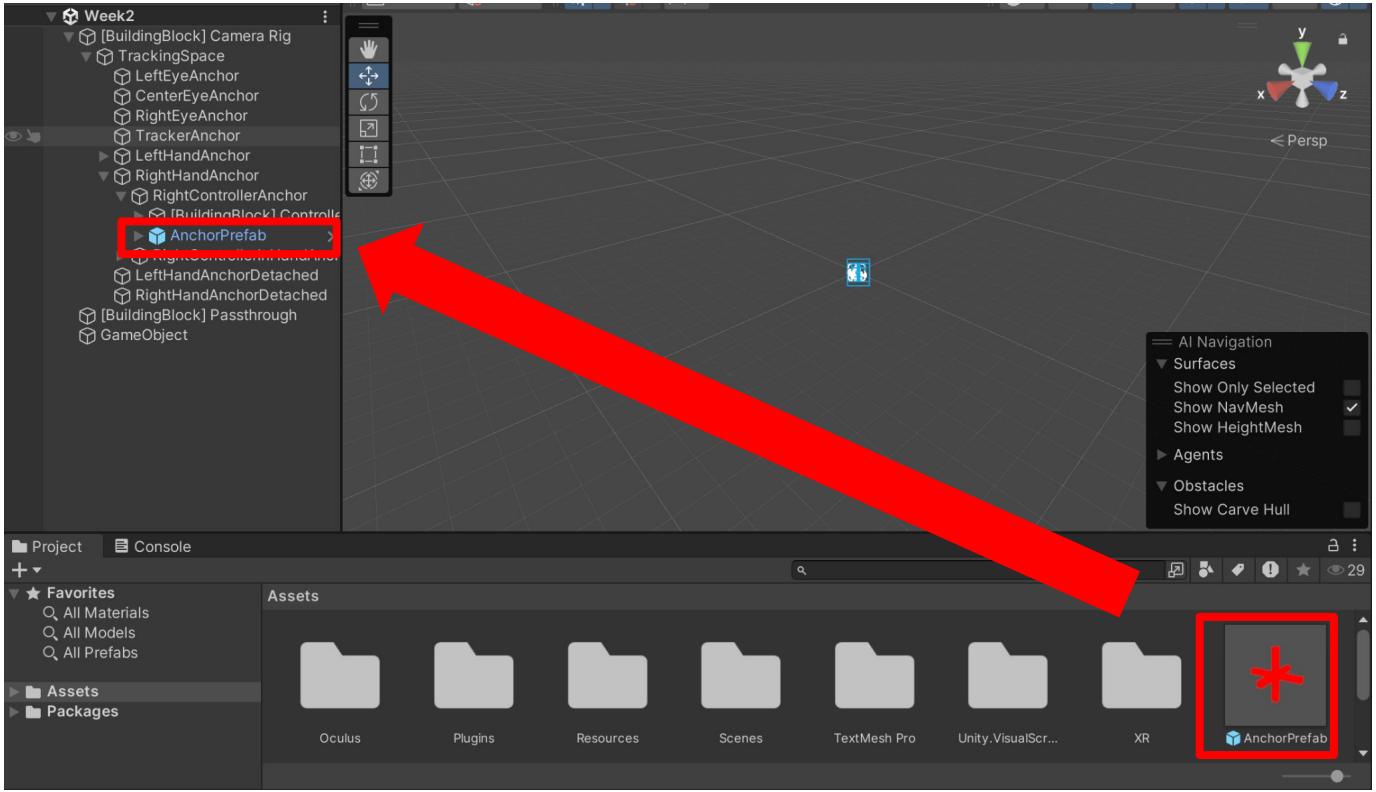
2 KB


AnchorPrefab

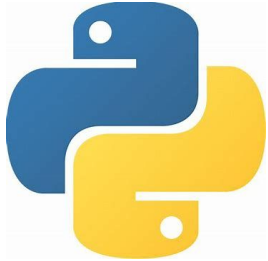

Inspector
SpatialAnchor
Static
Tag
Untagged
Layer
Default
Transform
Position
X 0
Y 0
Z 0
Rotation
X 0
Y 0
Z 0
Scale
X 1
Y 1
Z 1
Spatial Anchors (Script)
Script
SpatialAnchors
Controller
R Touch
Anchor Prefab
AnchorPrefab

Indicate where the anchor will be create.

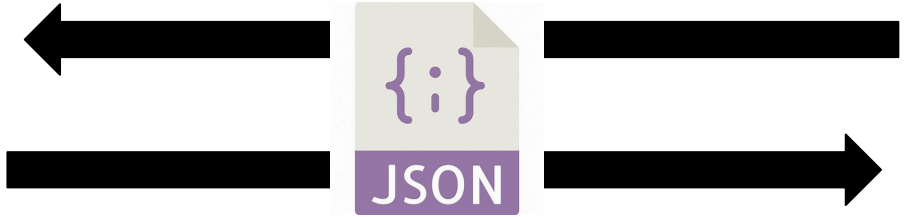


Calibration

Calibration Architecture



(2) 3D coordinates from Spatial anchors



(4) ArUco positions detected by RealSense

(1)
ArUco positions
marked by user

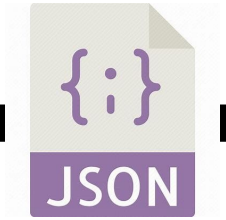
(3) Find the
transformation matrix
from RealSense space
to Unity space

Finding transformation matrix

	RealSense			Unity	Meta
ArUco 1	(x, y, z)	· T	=	(x, y, z)	Spatial Anchor 1
ArUco 2	(x, y, z)	· T	=	(x, y, z)	Spatial Anchor 2
ArUco 3	(x, y, z)	· T	=	(x, y, z)	Spatial Anchor 3
			⋮		
ArUco n	(x, y, z)	· T	=	(x, y, z)	Spatial Anchor n

Solve n linear equations to find 3D Transformation matrix T.

Spawn new objects



Detected New ArUco

$(x, y, z) \cdot T = (x, y, z)$

Create New Game Object At (x, y, z)

Server Client

Server Client

Client

Server

Unity

A simple server that send message to clients every two second.

```
17      const string hostIP = "127.0.0.1"; // Select your IP
        1 reference
18      const int port = 80; // Select your port
```

Unity

```
// Receive message from client
int i;
while ((i = stream.Read(buffer, 0, buffer.Length)) != 0)
{
    data = Encoding.UTF8.GetString(buffer, 0, i);
    Message message = Decode(data);
    // Add received message to que
    lock(Lock)
    {
        MessageQue.Add(message);
    }
}
client.Close();
```

Unity

```
private void Update()
{
    // Send message to client every 2 second
    if(Time.time > timer)
    {
        Message msg = new Message();
        msg.some_string = "From Server";
        msg.some_int = 1;
        msg.some_float = .1f;
        SendMessageToClient(msg);
        timer = Time.time + 2f;
    }
    // Process message que
    lock(Lock)
    {
        foreach (Message msg in MessageQue)
        {
            // Unity only allow main thread to modify GameObjects.
            // Spawn, Move, Rotate GameObjects here.
            Debug.Log("Received Str: " + message.some_string + " Int: " + message.some_int + " Float: " + message.some_float);
        }
        MessageQue.Clear();
    }
}
```

Unity - To Do

- Send Spatial Anchor positions to Python
- Create Anchor from ArUco coordinates send by Python
  - Create all anchors from Python under the same parent.
  - Implement script to move the parent. (For manual calibration)
- Implement your own message format.
  - ArUco Id
  - x,y,z coordinates
  - Rotation
  - etc.

```
24      // Define your own message
25      [Serializable]
        8 references
26      public class Message
27      {
            2 references
28          public string some_string;
            2 references
29          public int some_int;
            2 references
30          public float some_float;
31      }
```

Python

A simple client that echo message from server.

```
8    HOST = "127.0.0.1"  # The server's hostname or IP address
9    PORT = 80           # The port used by the server
```

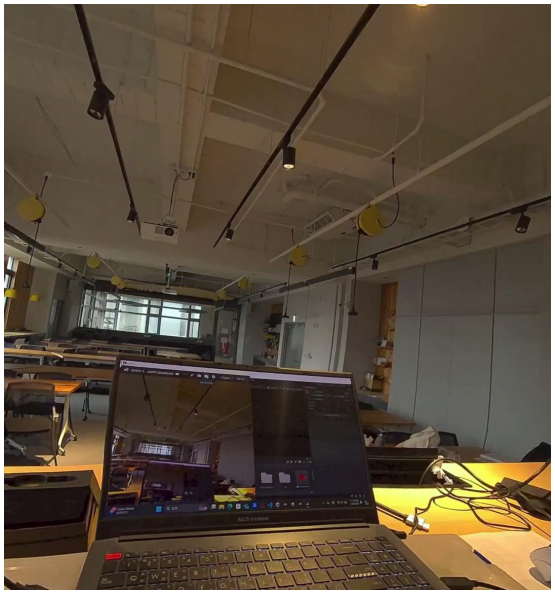
Python - To Do

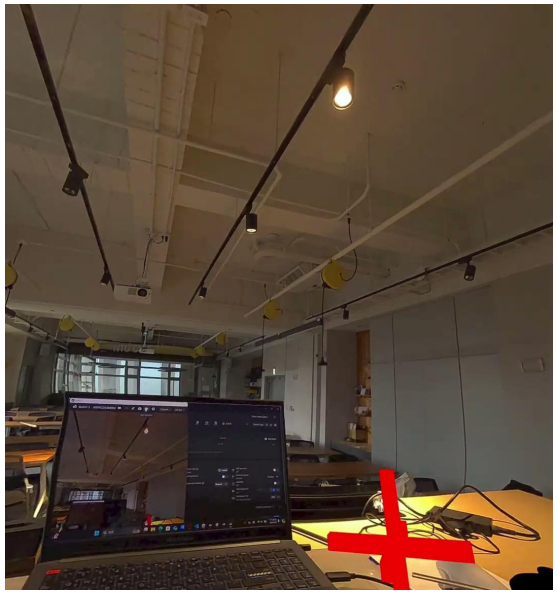
1. Receive Spatial Anchor positions from Unity.
2. Find the 3D transformation matrix that maps RealSense space to Unity Space.
    a. Use numpy.linalg.lstsq to find the least square solution.
3. Use the 3D transformation matrix to transform ArUco position detected by RealSense to Unity space.
4. Send ArUco position detected by RealSense to Unity.

To Do

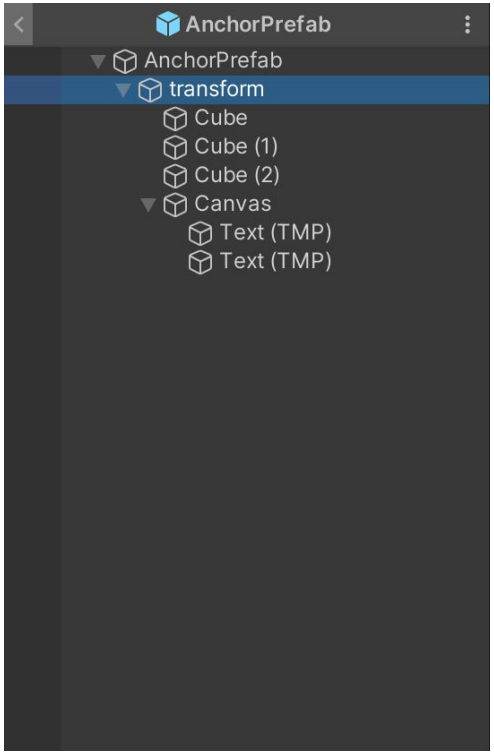
Basic - 1

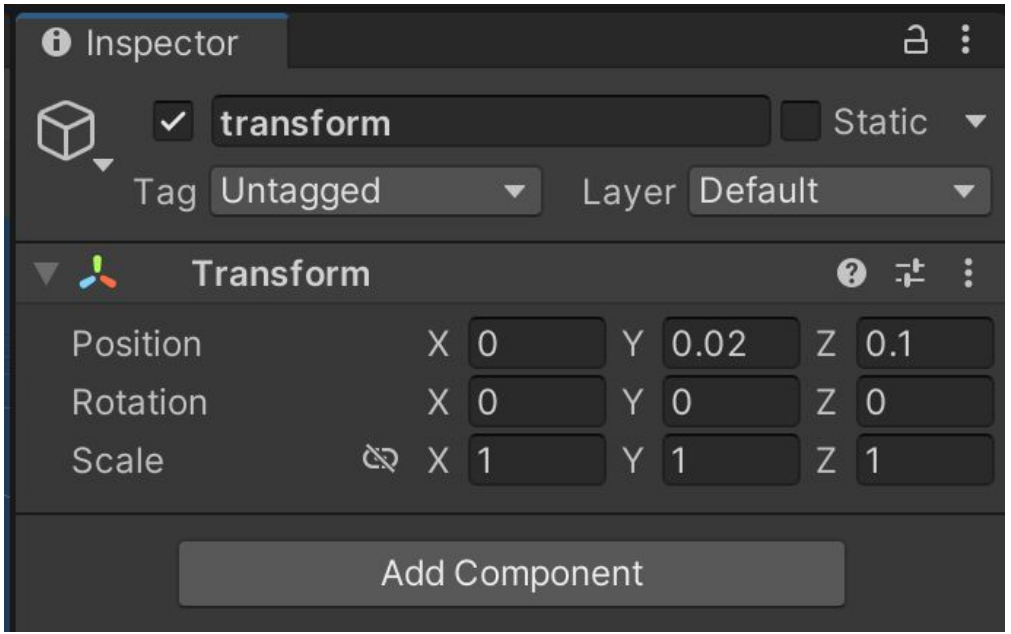
- Modify the Transform in Anchor Prefab, and add physical objects to controller for user to create anchor at contact area.





Modify the Transform in Anchor Prefab





Basic - 2

Implement the calibration process.

- User can mark ArUco position with spatial anchors.
- User can see and adjust manually the anchors detected by RealSense in VR.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Report

- Summarize what you did in this lab.
  - Show the basic and bonus you implemented.
  - Use screenshots & video demos to show your results.
- What you did to improve this device. Or how you can improve this device.
- Anything related to this lab.

Hints

- Instantiate all objects from RealSense under the same parent.
- Add a script to move the parent object by Quest controller.
  - Every child will move with the parent.
  - Add rotation and movement on z-axis.

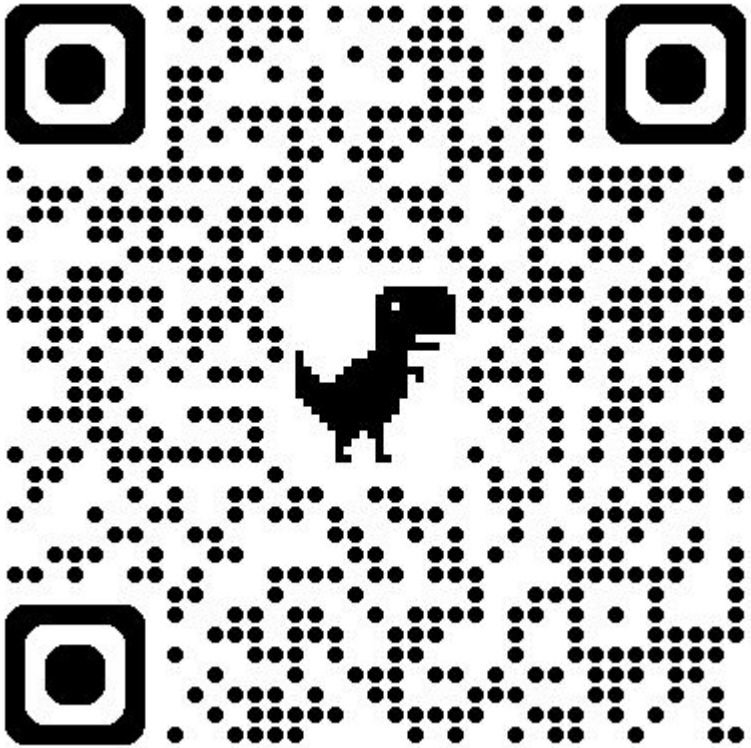
```
void Update()
{
    // Get value from controller thumb stick.
    Vector2 axis = OVRInput.Get(OVRInput.Axis2D.PrimaryThumbstick, controller);
    // Move the GameObject on xy plane.
    transform.Translate(new Vector3(axis.x, 0, axis.y) * speed * Time.deltaTime, Space.World);
}
```

Hints

Server client message should support future applications.

- Spawn new objects in game according to the ArUcos IDs detected.
  - Is it a new one ? or the previous frame didn’t detected it ?
- Track the movement and rotations of ArUco IDs.
  - How to distinguish between error and real movement ?
- Destroy game objects if the ArUco IDs are removed.
  - Is it removed ? or player accidentally blocked it ?

Feedbacks



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