

RGB-D CAMERAS - BODY TRACKING

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RGB-D CAMERA



DEPTH CAMERA

- What is a depth camera?
The depth camera provides information on the *distance* (Z) dimension in addition to traditional RGB images.
It means that they are able to detect the distance between the camera itself and a subject.

Depth cameras are also called RGB-D cameras or 3D cameras.

- Factors that affect the Depth data quality:
 - Lighting
 - Distance
 - Different materials or Shapes
- Different types of depth cameras are available, as the Kinect (1, 2, Azure), Orbbec Astra and RealSense; recently also some smartphone have a depth camera.



KINECT

The First version of Kinect was released in 2010 as a controller for Xbox 360, the second version was released in 2013 for Xbox One, primarily for gaming purposes.

It allows to track user's movements with the device's SDKs, and it has been widely used in the exergames research domain, since it was one of the first devices at accessible prices to support body tracking.

Kinect 1 and 2 are no more supported by Microsoft and now the new Kinect Azure has been released, that is connected to the Azure AI services.

<https://azure.microsoft.com/en-us/services/kinect-dk/#overview>

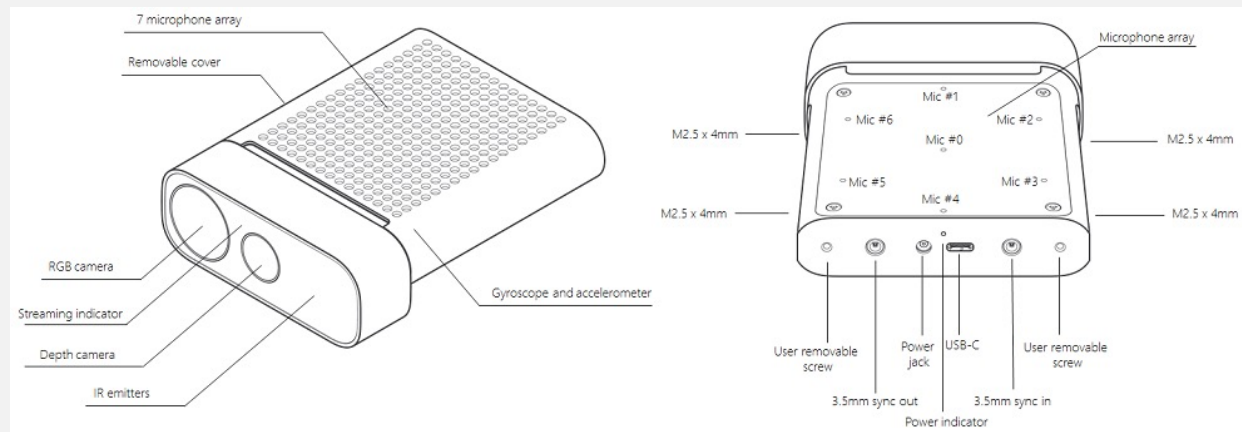


Image from <https://docs.microsoft.com/en-us/azure/kinect-dk/hardware-specification>



REALSENSE D435

The Intel released the RealSense D435 in 2018 as a part of the D400 series.

It has been exploited on robotic platforms and drones, since it is particularly small (9cm x 2,5 cm) and with reduced weight.

It has custom SDK that supports different platforms and languages (python, node.js, c# ...) and it supports also Unity3D and Unreal, <https://www.intelrealsense.com/developers/>



Image from <https://www.intelrealsense.com/depth-camera-d435/>



LIDAR AND TRUE DEPTH

- LiDAR stands for Light Detection and Ranging. This technology uses the pulse from a laser to detect the environment and perform calculations used to create 3D models and maps of objects and environments.

<https://geoslam.com/what-is-lidar/>

- The True Depth camera is a depth camera included in the front camera of iPhone to perform Face Detection, ARKit library includes supports for depth face's data management.

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

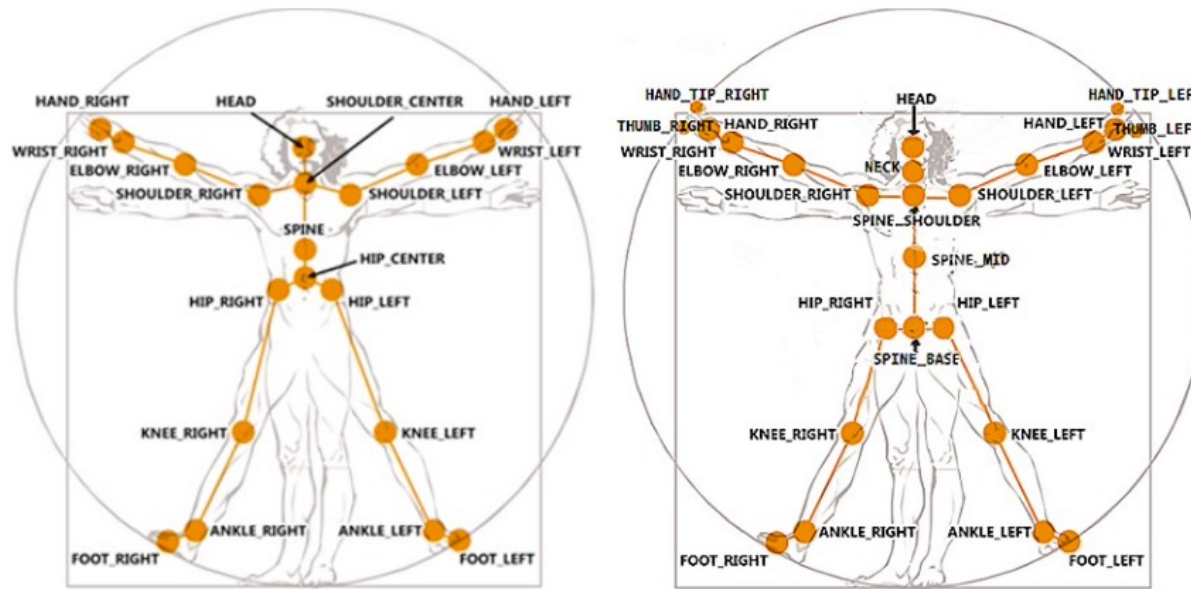


BODY TRACKING FROM 3D STREAM



BODY TRACKING

- What is a body tracking?
As the term indicates, it represents the tracking of position and movements of user's body, and a joints model (keypoints) of the body is exploited for the representation.



Kinect 1

Kinect 2



BODY TRACKING: NUITRACK

NUITRACK: <https://nuitrack.com>

It is a 3D tracking middleware for skeleton tracking and gesture recognition for Android, Windows, and Linux. It aims to establish an API for communication with 3D sensors. (On license)

It supports also Unity with a unitypackage.

Other useful links:

<https://github.com/3DiVi/nuitrack-sdk>

<https://github.com/3DiVi/nuitrack-sdk/tree/master/Unity3D>



BODY TRACKING FROM 2D STREAM



BODY TRACKING: OPENPOSE

OpenPose : <https://arxiv.org/pdf/1812.08008.pdf>

It is a real-time multi-person system to jointly detect human body, hand, facial, and foot keypoints (in total 135 keypoints) on single images. It offers 2D pose estimation and 3D pose reconstruction and estimation.

It supports also Unity with a specific plugin.

GitHub link:

<https://github.com/CMU-Perceptual-Computing-Lab/openpose>



BODY TRACKING: GOOGLE AI

Google AI : <https://developers.google.com/ml-kit/vision/pose-detection>

It is a real-time multi-person system to detect the pose of a subject's body in real time from a continuous video or static image. It offers 2D pose estimation, the Z is an experimental value calculated in image pixels indicating the distance of the hips from the camera.

Other useful links:

<https://ai.googleblog.com/2020/08/on-device-real-time-body-pose-tracking.html>



ONE EXERCISE IN TWO VERSIONS
(MACOS AND WINDOWS)



PRELIMINARY STEP: IMPORT RIGGED CHARACTER IN UNITY



UNITY ANIMATION AND RIGGING

- A rig consists in a series of joints mimicking human bones; the character's mesh is connected to the bones (with the weight paint) and moves together with them.
- In Unity the rigged and skin properties need to be setup properly when importing an FBX cheater rigged with a tool as Blender or Maya.



DOWNLOAD A MIXAMO RIGGED CHARACTER

Adobe Mixamo offers different rigged avatars and different human animations, that you can download as FBX file.

You can download a Mixamo rigged character FBX file from:

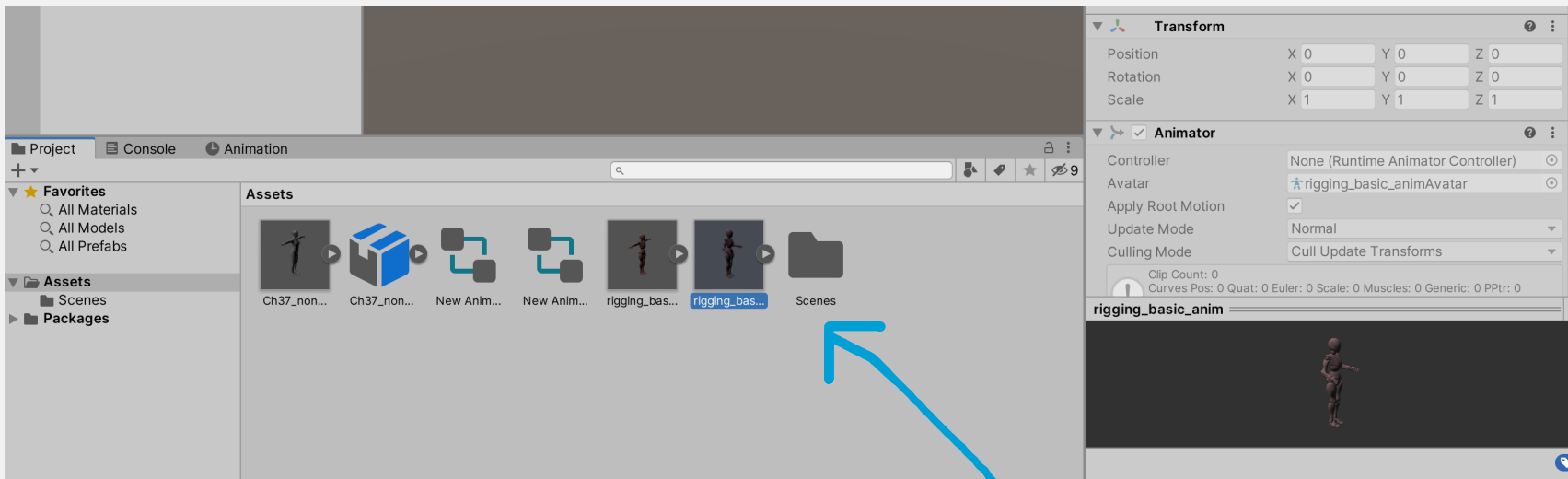
<https://www.mixamo.com>

N.B: user free subscription is required to download characters and animations.



CHARACTER'S SETUP

1. Import the FBX by dragging it into the Project Window of the Unity Project
2. Select it
3. In the Inspector panel, click on the Model tab and uncheck the Import camera and Import light (we didn't exported the camera and light in our FBX) – **optional , you can skip this step–**
4. **If you have performed the step 3 then click on “Apply” button**

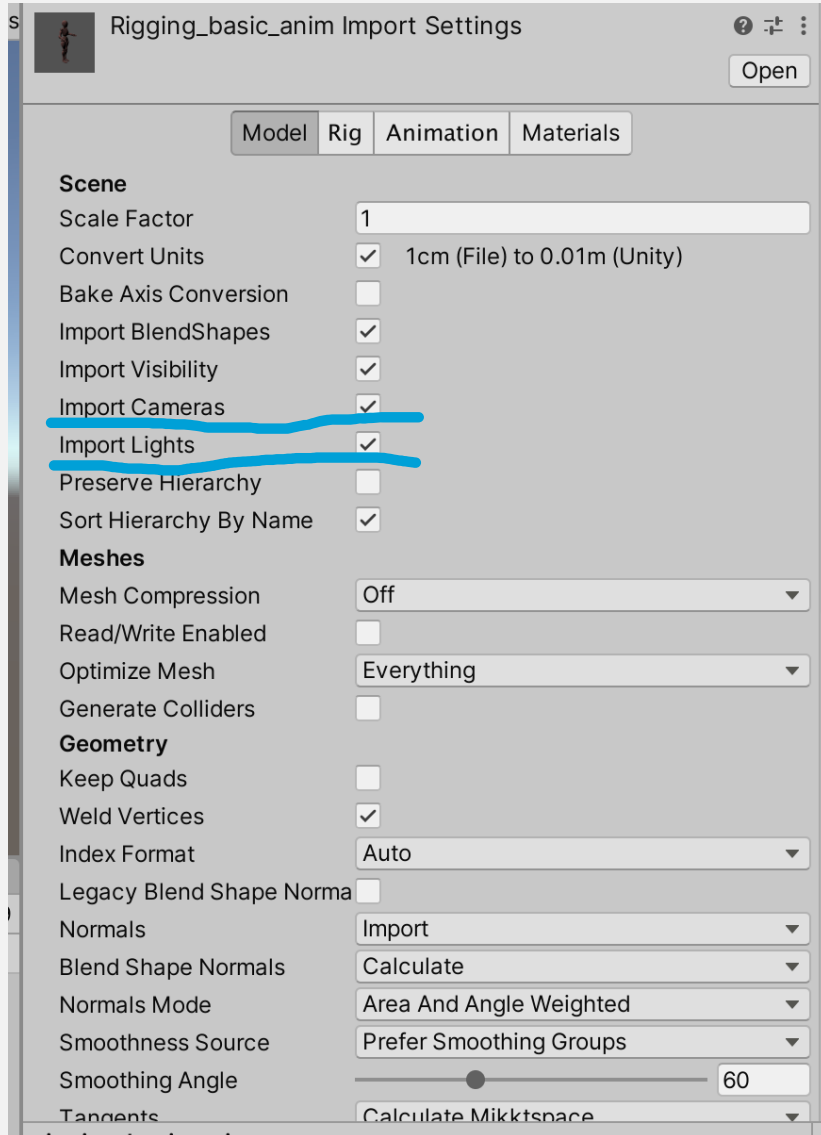


Drag here

1



OPTIONAL (STEPS 3,4)

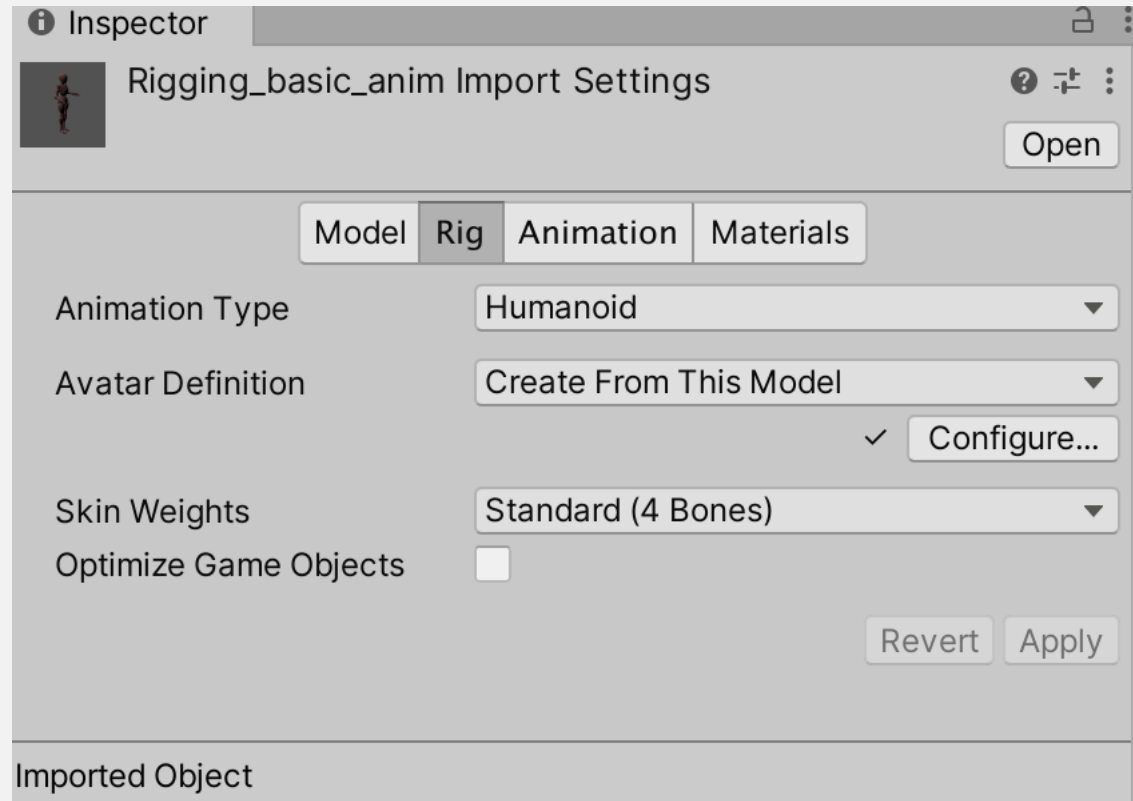


Scroll down to find the Apply button



CHARACTER'S SETUP

5. Now click on Rig
6. Change the **Animation Type** to **Humanoid**
7. Change **Avatar Definition** to **Create from this model**
8. Apply



CHARACTER'S SETUP

9. Now an "Avatar" appears in the Project Window



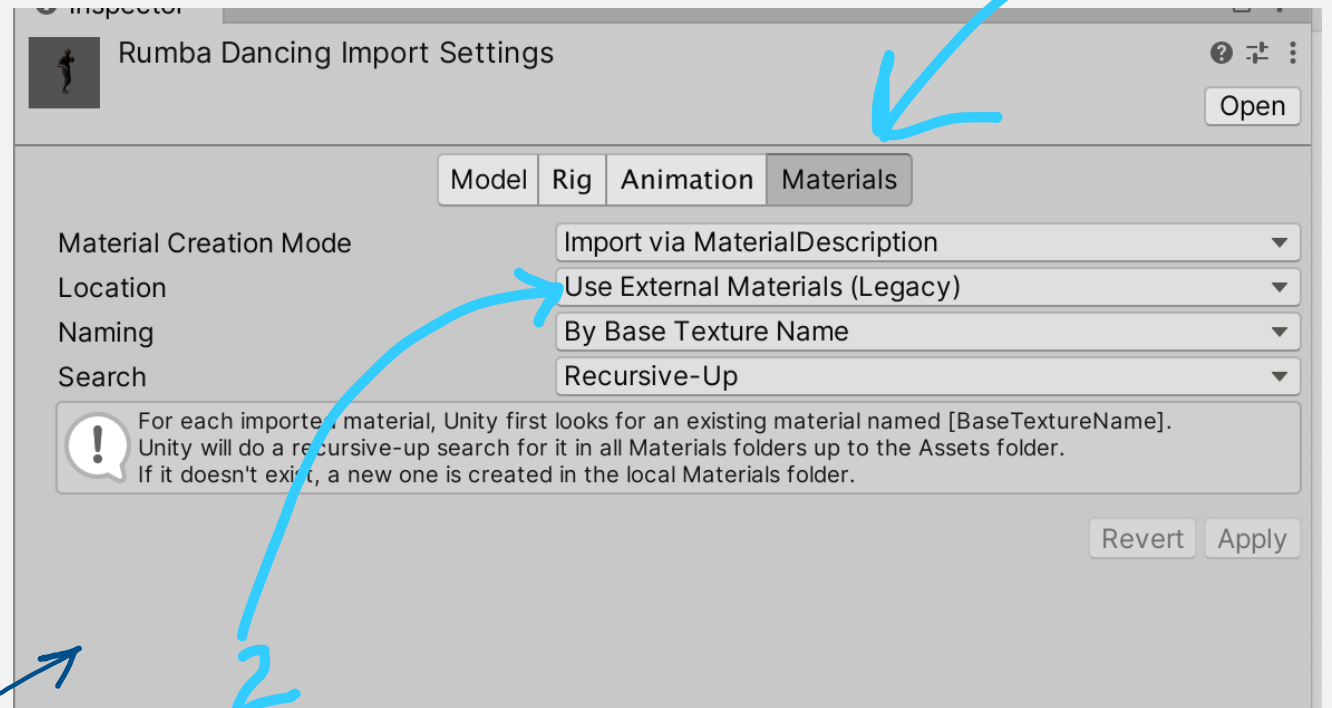
MIXAMO CHARACTERS (AND UNITY)

If the Mixamo avatar into your Unity Project **has not the Materials** you can export them by:

1. Click on Textures: “Extract Textures”
2. If a popup appears confirm with “fix it”

Otherwise, if the first method is not working:

1. click on **Materials**
2. choose the option: Location -> **Use External Materials (Legacy)**
3. Click on **Apply**



<https://forum.unity.com/threads/mixamo-unity-does-not-import-any-textures.516301/>



UNITY AND ARKIT EXERCISE (IOS - MAC ONLY)



AR BODY TRACKING WITH ARKIT (MACOS ONLY)

- ARKIT Body Tracking device requirements:
 - IOS 13.0+ or IPADOS 13.0+
 - device with A12 chip or later (iphone XR, XS, 11, SE2020 and next generations)



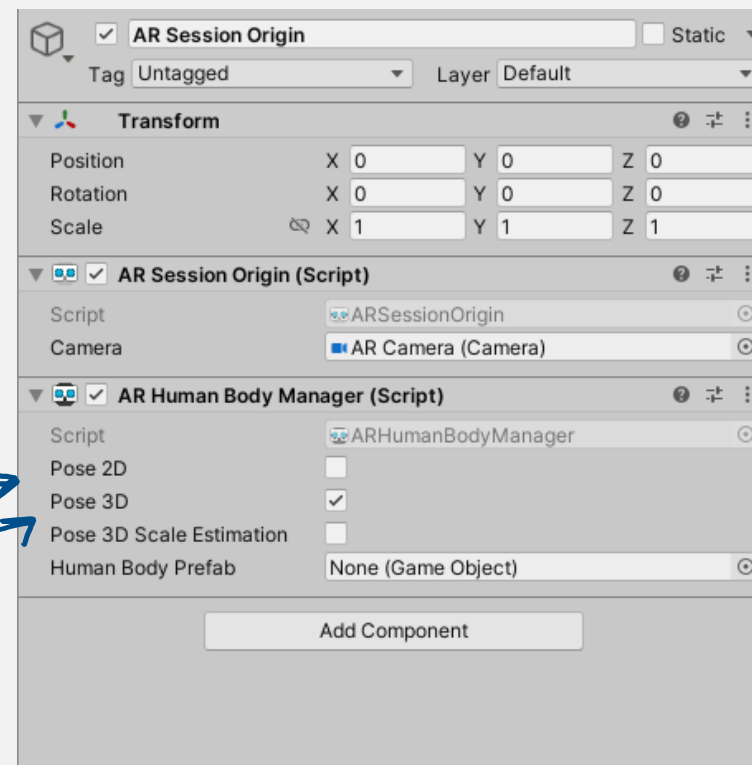
SETUP PROJECT

1. Import ARFoundation and ArKit packages from the Package Manager (see slides from the previous laboratory)
2. Create an Empty Unity scene:
 - Add ARSession
 - Add AR Session Origin



HUMAN BODY TRACKING

1. Click on the ARSessionOrigin:
2. In the Inspector click Add Component then write AR Human Body Manager and select it
3. **Uncheck** “Pose 2D” and “Pose 3D Scale Estimation” is checked
4. **Check** “Pose 3D”



NUITRACK EXERCISE (WINDOWS ONLY)



NUITRACK BODY TRACKING EXERCISE

If you have an RGB-D camera, you can develop in Unity with NUITRACK:

1. Install nuitrack into you Windows PC:

<https://github.com/3DiVi/nuitrack-sdk/blob/master/doc/Install.md>

2. Setup the Unity project following the documentation here (OPTIONAL- we deepen the Unity package installation guide in the next slide):

https://github.com/3DiVi/nuitrack-sdk/blob/master/doc/Unity_Basic.md



NUITRACK BODY TRACKING EXERCISE

NUITRACK:

- You can download the NuiTrack package: <https://github.com/3DiVi/nuitrack-sdk/blob/master/Unity3D/NuitrackSDK.unitypackage>
- Create a new project in Unity (2020.3.1 or later recommended - **I will use Unity 2021.3.17**)
- In the project go to Assets -> Import Custom Package - > select NuiTrack unitypackage
- Connect supported sensor
- In the top menu, select "Nuitrack/Activate Nuitrack"
- In the top menu, select "Nuitrack/Play Test Unity Scene" (or manually open in Project Tab "Assets/NuitrackSDK/NuitrackDemos/AllModulesScene" and click Play button) (If something doesn't work, follow the on-screen instructions)



NUITRACK BODY TRACKING 2 EXERCISES

- Open Assets/NuitrackSDK/Tutorials/First Project
- Open NativeAvatar/TranslationAvatar.cs
- In the Update() function:
 - CurrentUserTracker has a static variable CurrentSkeleton
 - CurrentSkeleton is updated every frame, and it contains the information about the posture of the player
- Run in editor

- Open Assets/NuitrackSDK/Tutorials/Avatar Animation/Scenes/RiggedModel.scene and look at:
 - NuitrackScripts -> Nuitrack Manager.cs
 - RiggedAvatar -> RiggedAvatar.cs
- Run in the editor



(OPTIONAL) ADDITIONAL INFO



REALSENSE WITH UNITY (WINDOWS ONLY)

- You can download the SDK 2.0 here: <https://www.intelrealsense.com/developers/>
- Then you can download the Unitypackage: <https://github.com/IntelRealSense/librealsense/releases>
- Import the package in a new Unity Project (supported versions are from 2017 to 2020 LTR)
- Some trouble-fix, SLAM not working with D435
<https://github.com/IntelRealSense/librealsense/issues/4209>

What is SLAM: the “Simultaneous Localization and Mapping” encompasses the study of instruments and algorithms that try to solve for an agent’s (aka robot or autonomous vehicle) location and orientation in 3D space, while simultaneously creating and updating a “mental” map of the unknown surrounding environment.

<https://dev.intelrealsense.com/docs/intel-realsensetm-visual-slam-and-the-t265-tracking-camera>



AR BODY TRACKING WITH ARKIT (MACOS ONLY)

- ARKIT in Xcode with Swift:
https://developer.apple.com/documentation/arkit/content_anchors/capturing_body_motion_in_3d

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



LIDAR + ARKIT WITH SWIFT (MACOS ONLY)

- You can download the ARKit example here
https://developer.apple.com/documentation/arkit/content_anchors/visualizing_and_interacting_with_a_reconstructed_scene
- Lidar + unity: <https://forum.unity.com/threads/ar-foundation-support-for-iphone-12-pro-with-lidar.987810/>
<https://github.com/Unity-Technologies/arfoundation-samples/tree/main/Assets/Scenes/ARKit>

