

# 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>

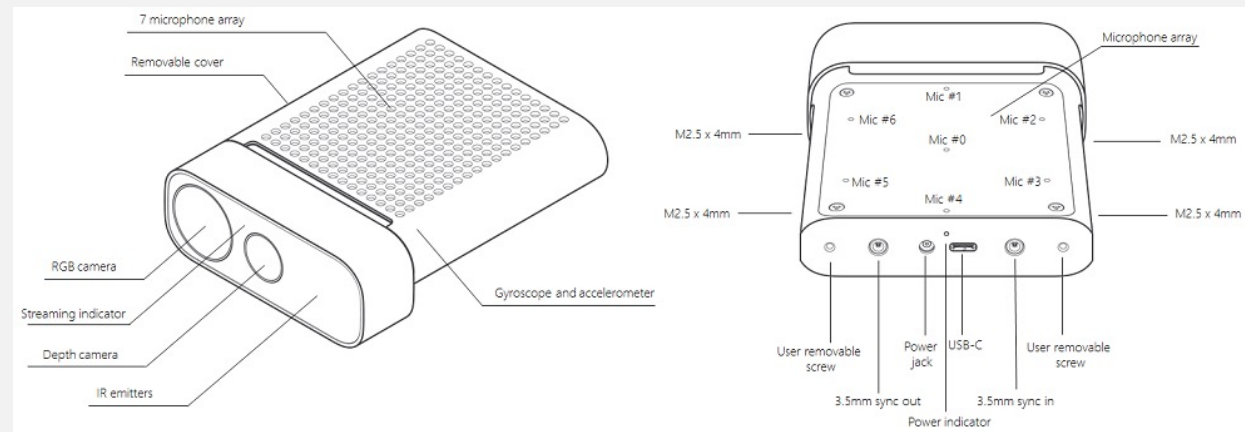


Image from <https://docs.microsoft.com/en-us/azure/kinect-dk/hardware-specification>



# 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](https://developer.apple.com/documentation/arkit/content_anchors/tracking_and_visualizing_faces)



# TWO EXERCISES



# REALSENSE EXERCISE

- 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>





# LIDAR + ARKIT EXERCISE

- You can download the ARKit example here  
[https://developer.apple.com/documentation/arkit/content\\_anchors/visualizing\\_and\\_interacting\\_with\\_a\\_reconstructed\\_scene](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>

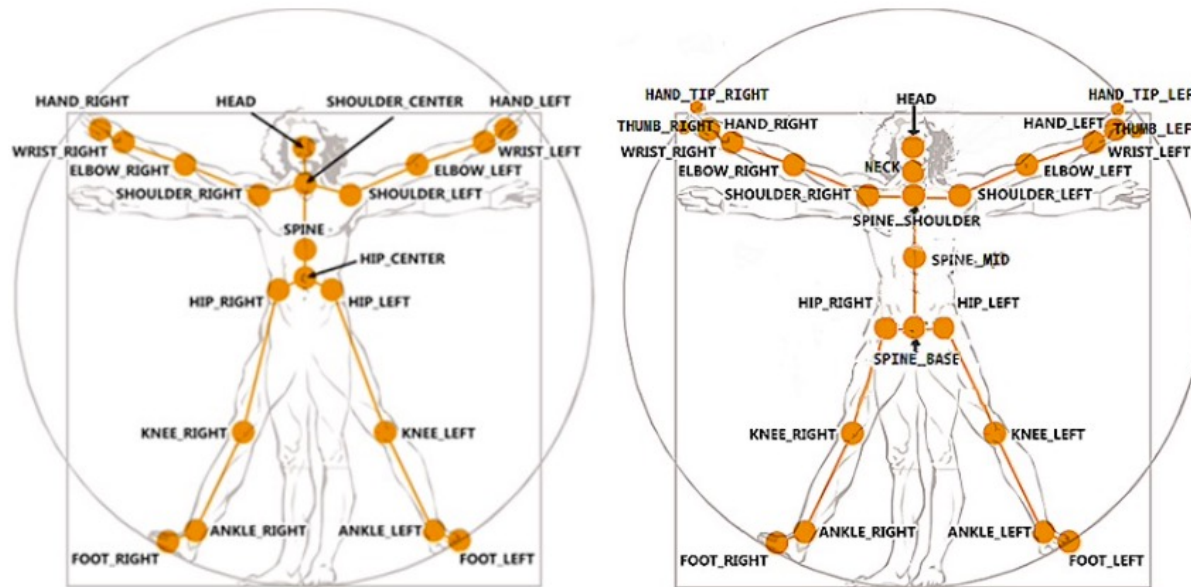


# BODY TRACKING



# 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: 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>



# 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>



# MIXAMO CHARACTERS (AND UNITY)

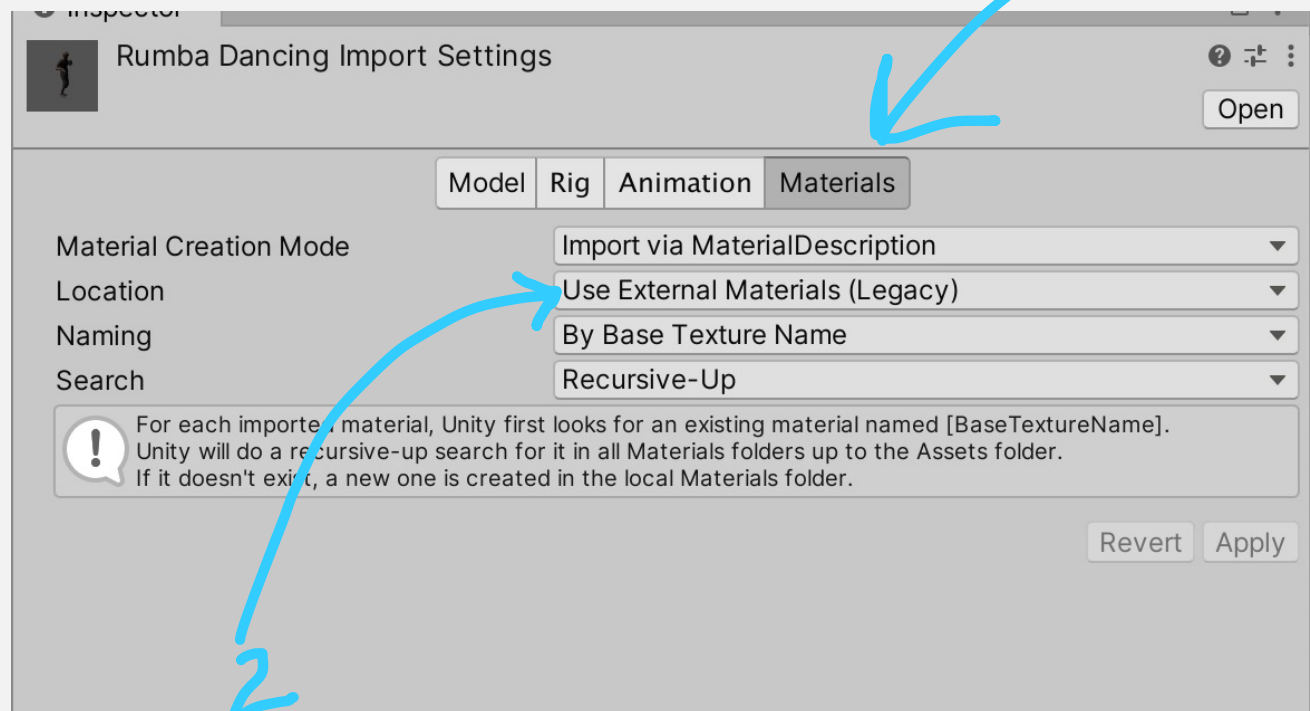
Adobe Mixamo offers different rigged avatars and different human animations, that you can download as FBX file.

To import the FBX in a Unity Project you can just copy the file in the Unity Assets directory.

Import the Rig as seen in slide “6-lesson-rigging2022.pdf” from page 18.

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

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



# BODY TRACKING EXERCISES





# AR BODY TRACKING EXERCISE

- ARKIT:  
[https://developer.apple.com/documentation/arkit/content\\_anchors/capturing\\_body\\_motion\\_in\\_3d](https://developer.apple.com/documentation/arkit/content_anchors/capturing_body_motion_in_3d)
  
- ARFOUNDATION:  
<https://github.com/Unity-Technologies/arfoundation-samples/tree/main/Assets/Scenes/HumanTracking>



# 3DCAM. BODY TRACKING EXERCISE

NUITRACK:

If you have an RGB-D camera, you can download the NuiTrack package: •

<https://github.com/3DiVi/nuitrack-sdk/blob/master/Unity3D/NuitrackSDK.unitypackage>

Unity 2019.4 recommended

- 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



# BODY TRACKING EXERCISE

## NUITRACK:

- Open Assets/NuitrackSDK/Tutorials/Avatar Animation/Scenes/RiggedModel.scene and look at:
  - NuitrackScripts -> Nuitrack Manager.cs
  - RiggedAvatar -> RiggedAvatar.cs
- Open the package manager
  - Advanced -> Show preview packages
  - Install «Animation Rigging»
- Select RiggedAvatar from the hierarchy.
  - Enable it
  - From the top menu: Animation Rigging -> Bone Renderer Setup

