VR LOCOMOTION AND VR SICKNESS

MOTION SICKNESS

The motion sickness indicates a feeling of discomfort or illness felt by a human being, that can occur when there is a difference between the expected and the actual motion performed by the human.

In other terms, motion sickness may occur when different (not coherent) information comes from the eyes and from the equilibrium system.

In real life motion sickness can occur while traveling with cars, trains, planes, etc.

Motion sickness can also occur while wearing virtual reality headsets, as the motion in the virtual environment does not correspond to a motion in the real world.

MOTION SICKNESS

Other causes of vr motion sickness can be the latency between the head movement and the movement reflection in the virtual world, or the fatigue of using a vr headset [1], [5].

VR motion sickness is also labeled as VR sickness or Cybersickness.

The reported incidence of cybersickness amongst users of VR is varied, but it is generally accepted that, at least, 60% of participants in a first VR experience will suffer its symptoms to some degree, and although most users adapt to the environment after few immersions, approximately 5% will never do so [1]

VR MOTION

To avoid or reduce the risk of motion sickness, different types of first-person virtual locomotion have been explored, here some [2] [3] [4]

- Joystick or Indirect Locomotion
  The player can move the avatar forward by pressing the joystick, this method is similar to the input of classic games' controllers

- Teleporting or Free teleport
  The player, holding a controller's button, can point to a specific position nearby, on the ground and jump instantaneously to that location when he/she releases the button (or press another button).

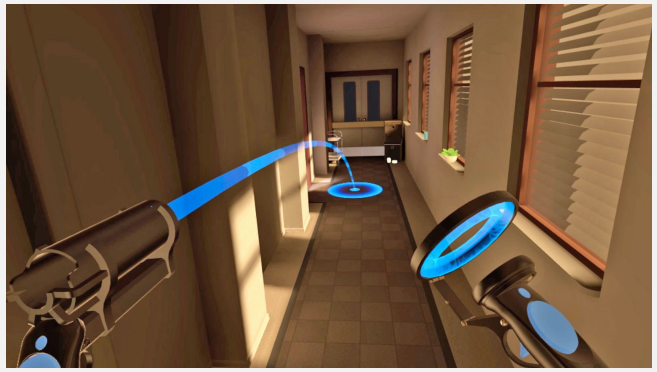
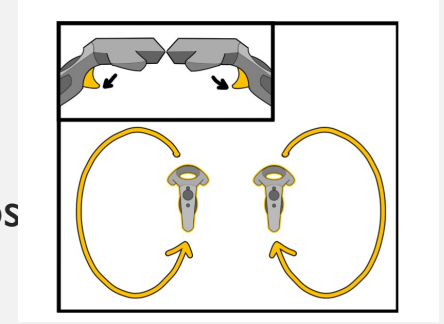


Image 1 from https://www.oculus.com/rift/accessories/?locale=it_IT
Image 2 from https://medium.com/vrdojo/teleportation-or-sliding-locomotion-methods-wont-stop-room-scale-vr-37c6c77761d9

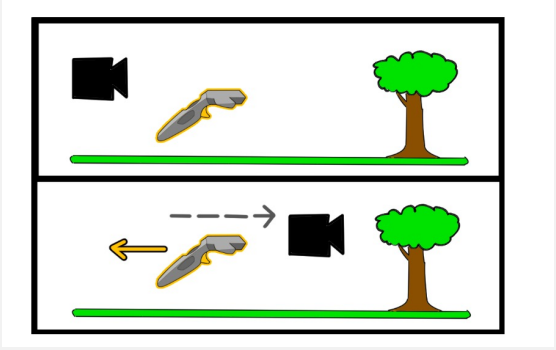
VR MOTION

(Continue) [2] [3] [4]

- Arm-Cycling or Arm swinging
  The player can perform (while holding the controllers) circular movements of the arms simulating walking steps



- Point-Tugging
  When the user holds a controller's button or makes a movement, the avatar translates nearby along an axis (for example the player's gaze direction).



Images 1 and 2 from [2]

VR MOTION

(Continue) [2] [3] [4]

- Walking
  The player and him/her movements are tracked

- Walking in place
  The player and him/her movements are tracked (for example through accelerometer sensors) to recognize walk in place

Image from [4]

VR POSITIONAL TRACKING

Positional Tracking is exploited to detect object's position and rotation in the real word, as the headset, the player's hands or the joypads, etc.

VR Positional Tracking is used to track and translate the player's real-world movements into the virtual environment.

For example, it can be used to convert the walk gesture performed in the real world into a walk translation in the virtual world.

VR Positional tracking can be performed only of VR devices with 6DOF tracking capabilities [6][7]

Therefore, VR Positional Tracking is fundamental also to reduce Motion Sickness.

Through Positional Tracking, in fact, the player's movements in real life (with the 6DOF) are tracked in order to be represented in the virtual environment, reducing the discrepancy between the perceived movements of the equilibrium system and what is seen through the eyes.

3DOF VS 6DOF OF VR HEADSETS

DOF are used in VR to track the movements along the axes that are monitored by the VR input hardware devices.

- 3DOF for VR Headsets indicates that the head movements are tracked along the rotation axes (Roll, Pitch, Yaw).
  Headsets with 3DOF are:
  - Google Cardboard
  - Oculus Go
- 6DOF for VR Headsets means that the head movements are tracked along the rotation axes and along the directional axes (Roll, Pitch, Yaw - X, Y, Z).
  Headsets with 6DOF are:
  - Oculus Rift
  - HTC Vive
  - Oculus Quest 2
  - Hololens (XR headset)

(RECAP) DOF – DEGREES OF FREEDOM

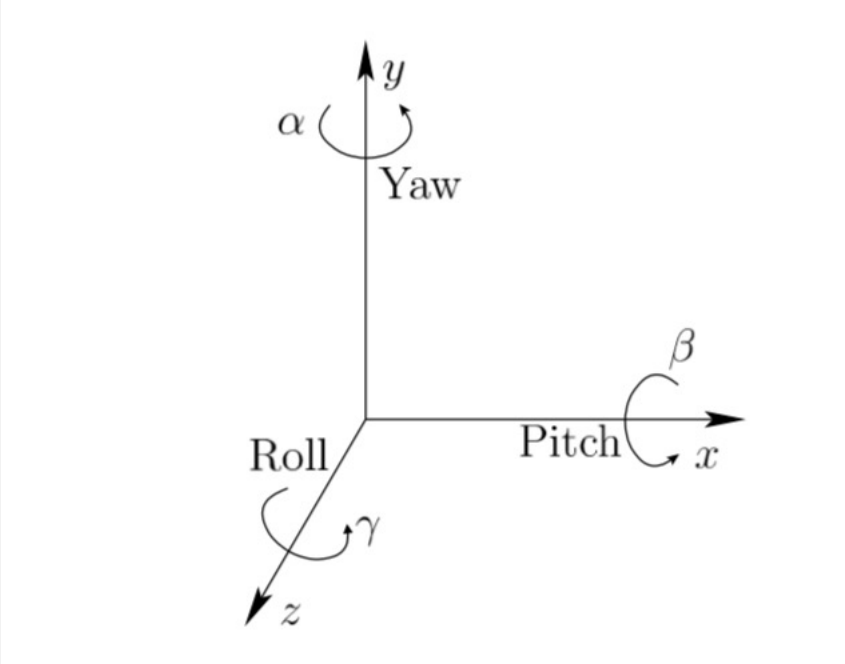
DOF – DEGREES OF FREEDOM

The term *degrees of freedom* (DOF) refers to the possible movements of a rigid body inside the space.

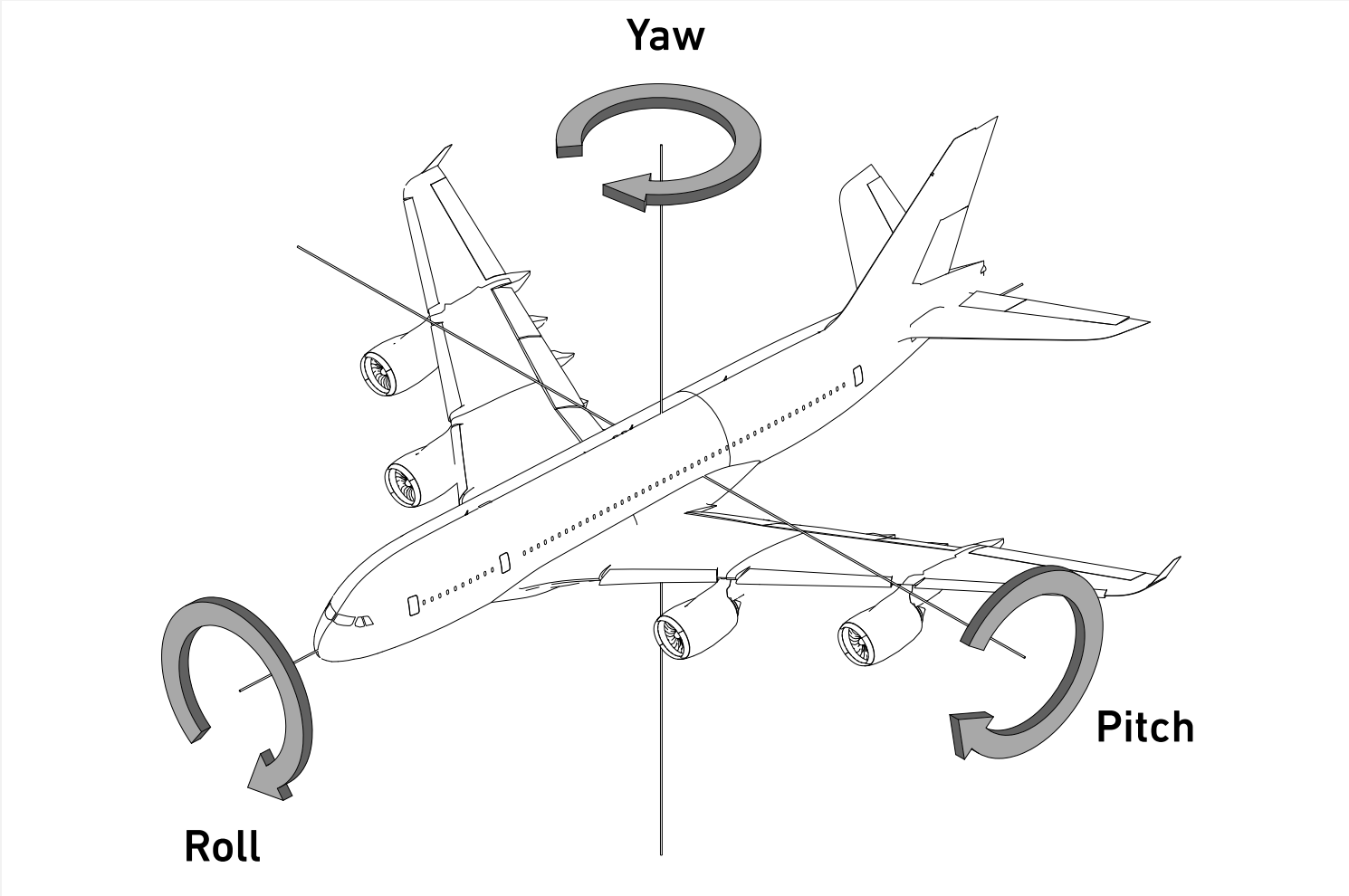
The DOF are counted as the number of rotational axes on which the object can rotate + the number of axes in which direction the object can move.

In the 3D world without constraints a body has **6 DOF** in total (3+3):

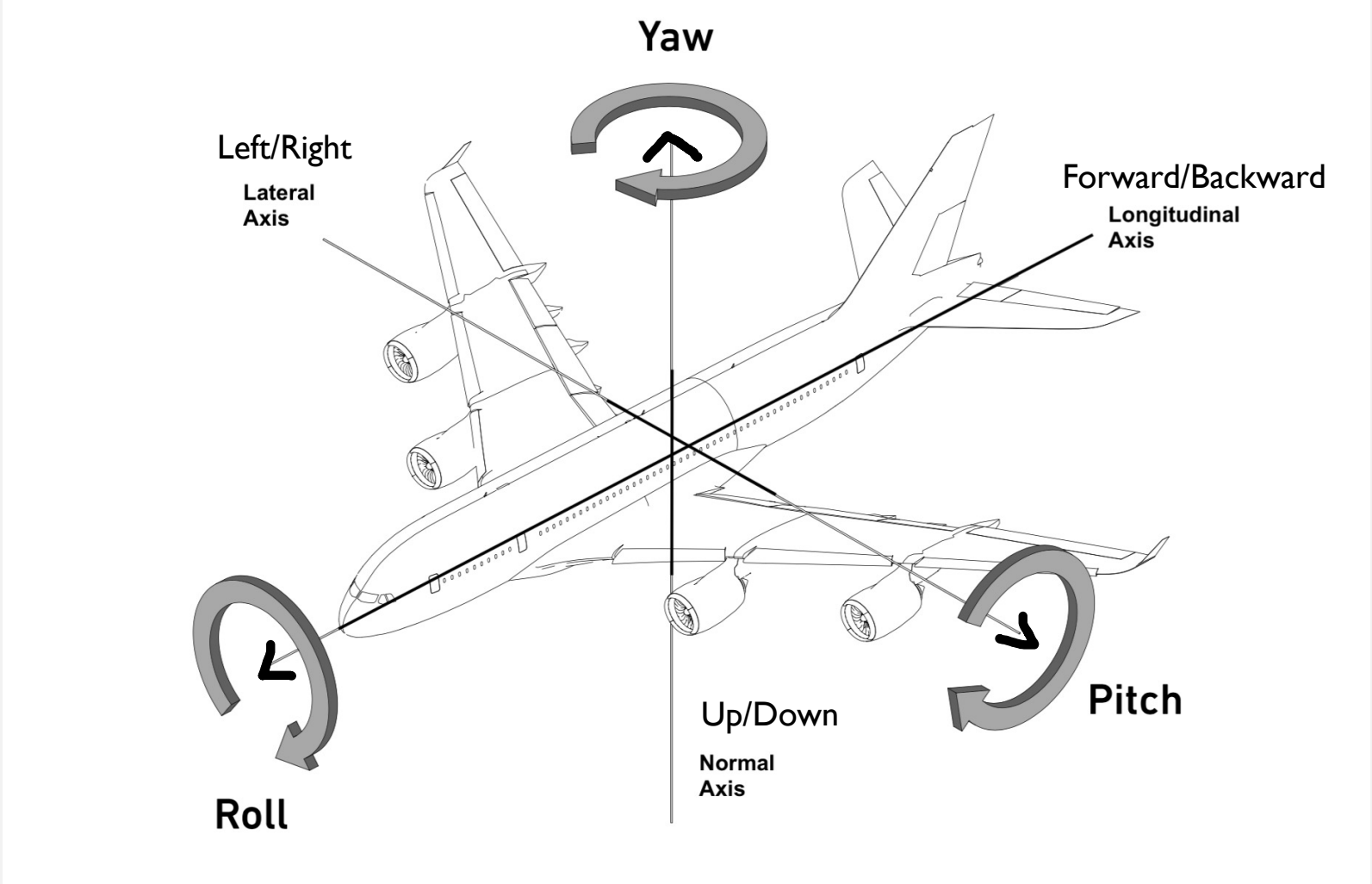
3 DOF indicating body translations and 3DOF indicating body rotations.



ROTATION AXES



ROTATION AND TRANSLATION AXES



3DOF VS 6DOF OF VR HEADSETS

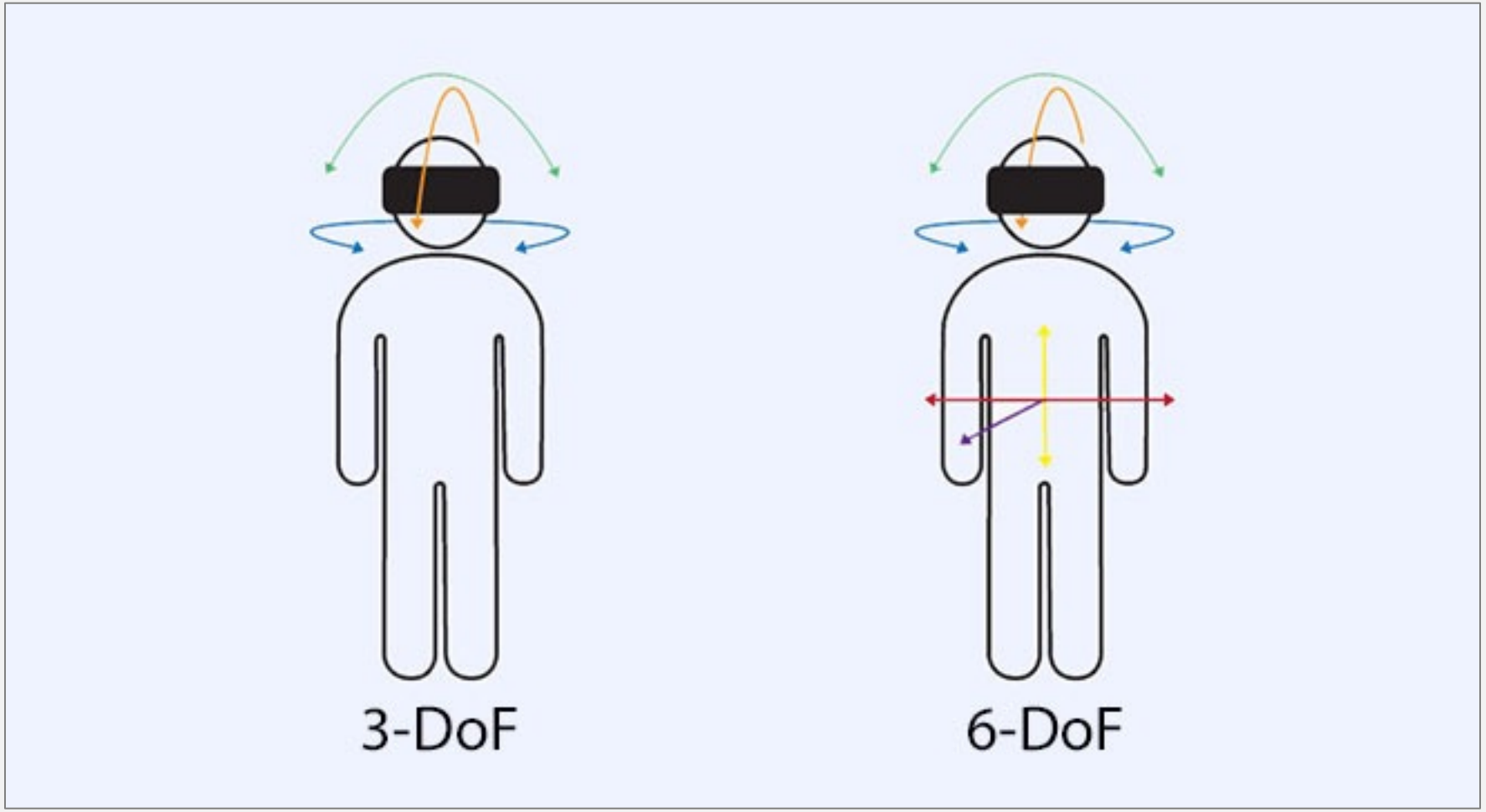


Image showing the difference between 3-DoF (rotational movement) and 6-DoF (rotational and translational movement) with a VR headset.
From https://virtualspeech.com/blog/degrees-of-freedom-vr (visited on 06 april 2021)

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