RealSense T265 Orientation Information

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June 2019

1 Introduction

This document summarizes information related to the conventions of pose and positioning information of the T265 camera due to poor documentation by Intel.

2 Positioning Information

The +Y axis of the positioning data is always set to be opposite of the gravity vector regardless of the initial orientation of the camera.

In the case that the camera is facing forwards and in the upright position, the X, Y, and Z axis and their directions correspond to the the following axis pictured in Figure 1.

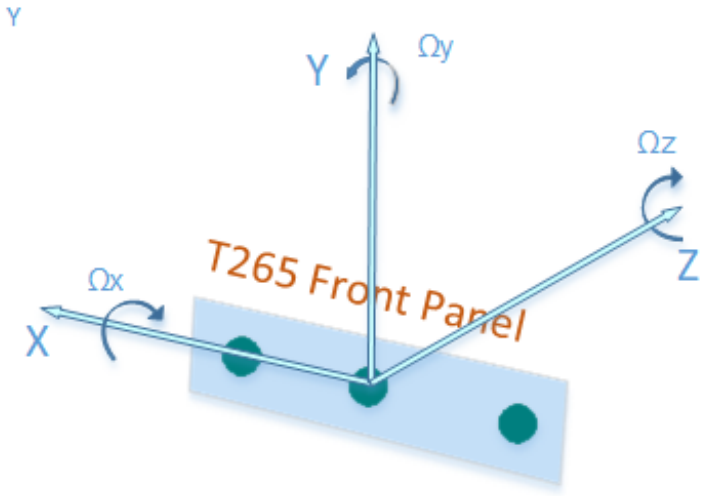


Figure 1: X, Y, and Z Axis of T265 Camera. X Axis points towards the RealSense logo, Y axis points towards top of device, and Z axis points towards back of device

For rotation around the X axis, the origin for position and its coordinate axis are the same as if the device was facing forwards. This is due to the Y and Z axis of the device being rotated such that its Y axis aligns with the negative gravity vector. By aligning the Y axis with the negative of gravity, this has the effect of offsetting the initial rotation of the device.

When the device is rotated around the Y axis there is no effect or need to rotate the coordinate axis. The device simply starts facing in a different direction. The direction that the front of the camera faces when data collection begins determines the negative Z axis, with the Y axis still pointing towards the top of the device (the negative of the gravity vector) and the X axis pointing towards the RealSense logo.

With rotation around the Z axis, the Y axis is again aligned with the negative gravity vector and rotation is performed around the Z axis. This effectively offsets the original rotation that was performed.

The device is also able to deal with singularity cases effectively where the rotation of the device aligns the gravity vector with either the X or Z axis. In the case where the gravity vector is aligned with the Z axis, the axis mapping relative to the device coordinate system seen in 1 is as follows: What was previously the -Z axis becomes the Y axis, what was previously the -Y axis becomes the Z axis, and what was previously the X axis becomes the -X axis. This is effectively rotating -90 degrees around the X axis and -180 degrees around the Z axis. It is not known why the device does not simply apply 90 degrees of roll to align Y with the negative gravity vector. In the singularity case where the -X axis is aligned with the gravity vector, the X axis from 1 becomes the Y axis, the -Y axis becomes the X axis, and the Z Axis remains the same. This is effectively rotating -90 degrees around the Z axis.

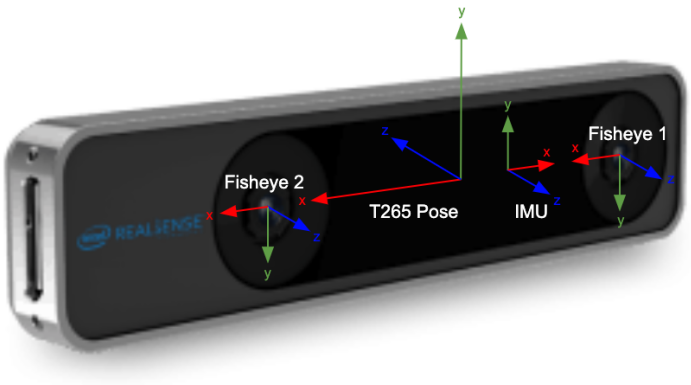
3 Pose Information

The pose of the device has a quaternion of [0 0 0 1] ([x y z w]) when it faces upright and forwards. When data collection begins and the device is in this orientation, regardless of the rotation around the Y axis, its quaternion will be [0 0 0 1].

When the initial pose of the device is rotated around the X axis, the quaternion is updated accordingly as the Y axis is aligned with the negative gravity vector through rotation around the X axis. The same is done for rotation around the Z axis. Again note that rotation around the Y axis has no effect on the quaternion as wherever the front of the device faces when data collection begins is set as the -Z axis.

4 Coordinate Axis of Each Sensor

Figure 2 shows the coordinate axis of each sensor on the T265.



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