RealSense T265 SLAM Testing

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May 2019

Contents

1 Testing Plan

1.1 Single Axis

Tests can be performed that test the movement of the device forward and back along a single axis. These tests will constrain the movement of the device to a single DOF. This will involve 3 tests:

1. Motion forward and back along the X axis
2. Motion forward and back along the Y axis
3. Motion forward and back along the Z axis

These axis used in these tests will be the axis labels of the ground truth data. These tests will show the performance of the device on each axis and may provide insight into the conditions that the device works best in. This will show how and if the device has better performance on some axis than others.

1.2 Rotation

Testing rotation is easily visualized versus time and does not provide much information when plotted in space. In order to perform these tests the two devices need to begin recording position at the same time. While both recordings can be started manually at approximately the same time, the only way to perfectly align them in time is through software. To align them in time via software, the RF communication device can be connected via USB. The PC connected to the Motiv localization system can send a signal to the Nvidia Jetson to begin data collection. The following tests can be performed:

1. Rotation around the X axis
2. Rotation around the Y axis
3. Rotation around the Z axis
4. General multi axis rotation

1.3 Paths

Testing can be done on paths of varying length to see if the SLAM algorithm improves over time as the device develops a more detailed map of the environment. The following tests will be performed:

1. Movement in a square for a single lap starting on the X axis
2. Movement in a square for multiple laps starting on the X axis
3. Movement in a square for a single lap starting on the Z axis
4. Movement in a square for multiple laps starting on the Z axis

By placing the initial trajectories of the paths along different axis, any problems with initial heading will be able to be understood in greater detail.

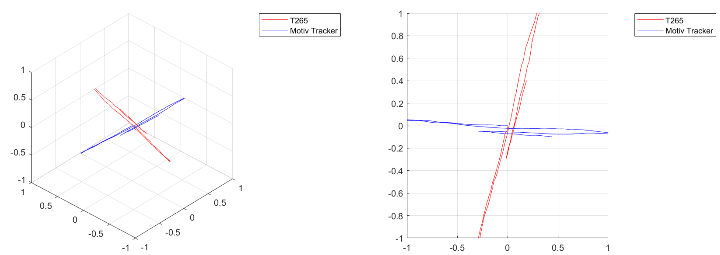
2 Results

2.1 Single Axis

The single axis results show consistency on the Z and Y axis with a large orientation problem on the X axis that skews the trajectory

2.1.1 X Axis

The results of tracing a path back and forth along the X axis several times can be seen in Figure 1



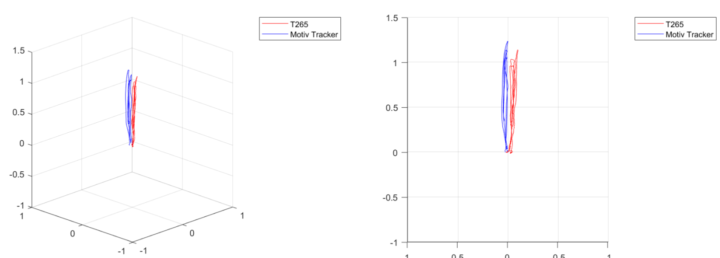
(a) X Axis isometric view (b) X Axis top view

Figure 1: Figures of X Axis Trajectory.

The images in 1 shows that the trajectory of the T265 camera is off from the trajectory of the ground truth data by about 80 degrees. The shape of each trajectory is nearly identical which shows that this is purely a problem with obtaining the initial orientation.

2.1.2 Y Axis

The results of tracing a path back and forth along the X axis several times can be seen in Figure 2

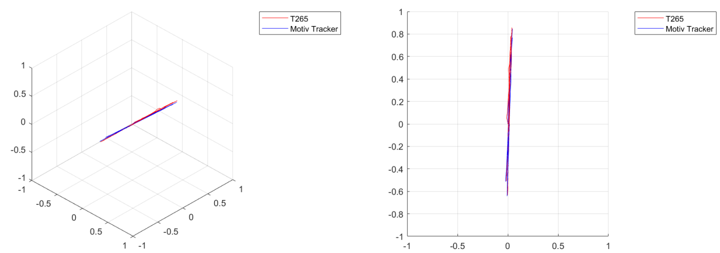


(a) Y Axis isometric view (b) Y Axis side view

Figure 2: Figures of Y Axis Trajectory.

Movement along the Y axis shows a fair amount of accuracy with the path of the T265 deviating from that of the ground truth data by around 10cm maximum. Again, it seems that the shapes of the two trajectories are very similar with differences in heading at the beginning of the path causing the misalignment.

2.1.3 Z Axis



(a) Z Axis isometric view (b) Z Axis side view

Figure 3: Figures of Z Axis Trajectory.

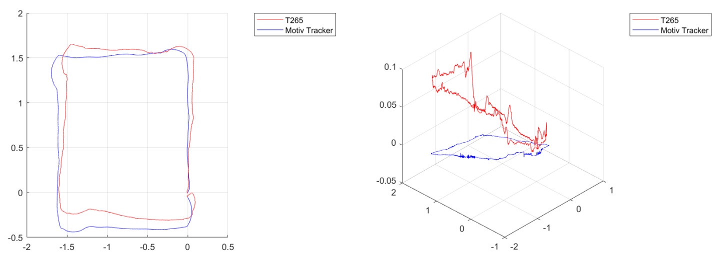
The trajectory along the Z axis by the T265 is nearly identical to the ground truth data. Again, the small amount of error seen is due to the initial heading of the device being different than the true heading from the ground truth data.

2.2 Paths

The path data demonstrate that the problems with orientation in the X axis carry over to large error when the device is brought along square paths in the XZ plane.

2.2.1 A Single Square Path Starting on Z Axis

Figure 4 shows the isometric and XZ plane view of the path data collected by the T265 and the ground truth data.



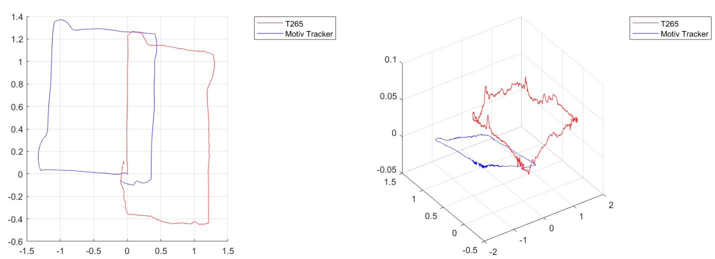
(a) View of path in the XZ Plane (b) Isometric view of plotted paths

Figure 4: Figures of square trajectory starting along Z axis

The result of tracing a square path along the XZ plane while starting along the Z axis shows reasonable accuracy with error due to the initial heading of the T265 not matching the true initial heading seen with the ground truth data. There is considerable difference between the Y axis readings due to the very small scale seen on the Y axis. There is variation of only a few centimetres. The isometric view shows that the T265 is prone to noise levels of a few centimetres.

2.2.2 A Single Square Path Starting on X Axis

Figure 5 shows the large difference between the path plotted by the T265 and the ground truth data.



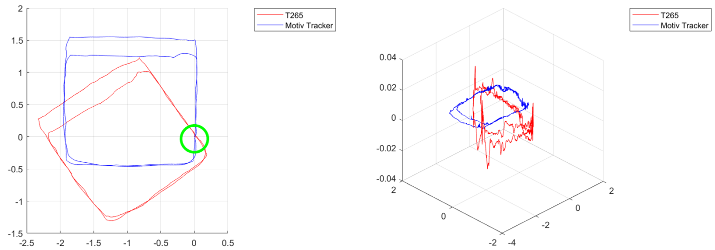
(a) View of path in the XZ Plane (b) Isometric view of plotted paths

Figure 5: Figures of square trajectory starting along X axis

The trajectory of the T265 is off of the ground truth data by 90 degrees. The same initial heading problem seen with tracing a path along the X axis is again present in this test. It seems that when the device begins its motion along the X axis that it has problems with initial heading by around 90 degrees.

2.2.3 Two Square Paths Starting on Z Axis

Figure 6 shows the results of the path collection for two square turns with the starting trajectory on the Z axis.



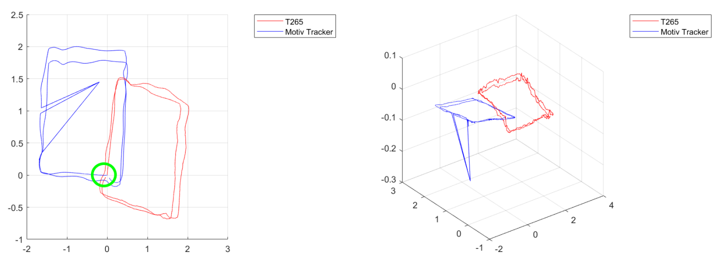
(a) View of path in the XZ Plane (b) Isometric view of plotted paths

Figure 6: Figures of square trajectory starting along Z axis

Again, it can be seen that there are orientation problems for the beginning of the trajectory. The shape of both trajectories are nearly identical but the orientation problem causes the paths to deviate significantly from one another. The isometric view again shows that the T265 device is susceptible to several centimetres of noise. The green circle in Figure 6 highlights that the starting and end points are the same between the two paths with the major difference being orientation.

2.2.4 Two Square Paths Starting on X Axis

Figure 7 shows the results of the path collection for two square turns with the starting trajectory on the X axis. Note that the large triangle on the ground truth data is due to an error with the markers not being detected.



(a) View of path in the XZ Plane (b) Isometric view of plotted paths

Figure 7: Figures of square trajectory starting along X axis

The green circle in Figure 7 shows that the starting and end points of the two paths are again identical. The starting trajectory as well as the angle of each turn is different between the ground truth and T265 data.

2.3 Summary Of Results

The T265 camera is able to track its location accurately on certain trajectories with the majority of error due to initial heading. For most tests, the shape of the paths traced by both the T265 and the ground truth data are nearly identical with the only difference between the two being the initial heading. The general shape and size of the paths plotted by the T265 and the ground truth data are very similar. If the initial heading is off slightly this creates error that builds as the length of the path increases. If a solution is found to improving the initial heading problem of the T265, then it will be able to provide much more reliable positioning results. Currently, the reason for these problems with orientation are not known