WEEKLY REPORT DE BENEDETTI MATTEO

WEEK 16: 16/12/2019 - 20/12/2019

IMAGE OVERLAP PERCENTAGE:

The Image Overlap Percentage (IOP) does not change for the same IFD at different speed, as long the camera position and orientation are constant, which is the case of the LocCam.

The following table contains the IOP corresponding to a specific IFD in the LocCam case.

IFD [meters]	IOP [percentage]
0.01	99.5183
0.03	98.5573
0.06	96.6314
0.1	95.1901
0.2	90.3966
0.3	85.6191
0.5	76.1132
0.75	64.3218
1.0	52.6323

The tests in the previous report showed that the VO performances, using the LocCam, decreased for IFD bigger than 0.3 m and IOP smaller than 85%.

BETTER LOOK AT SMALL IFD AT HIGH SPEED

The tests performed last week (traverse at 0.07 m/s using the LocCam and varying the Vo frequency to achieve different IFDs and IOPs) were then also analyzed focusing on small IFDs.

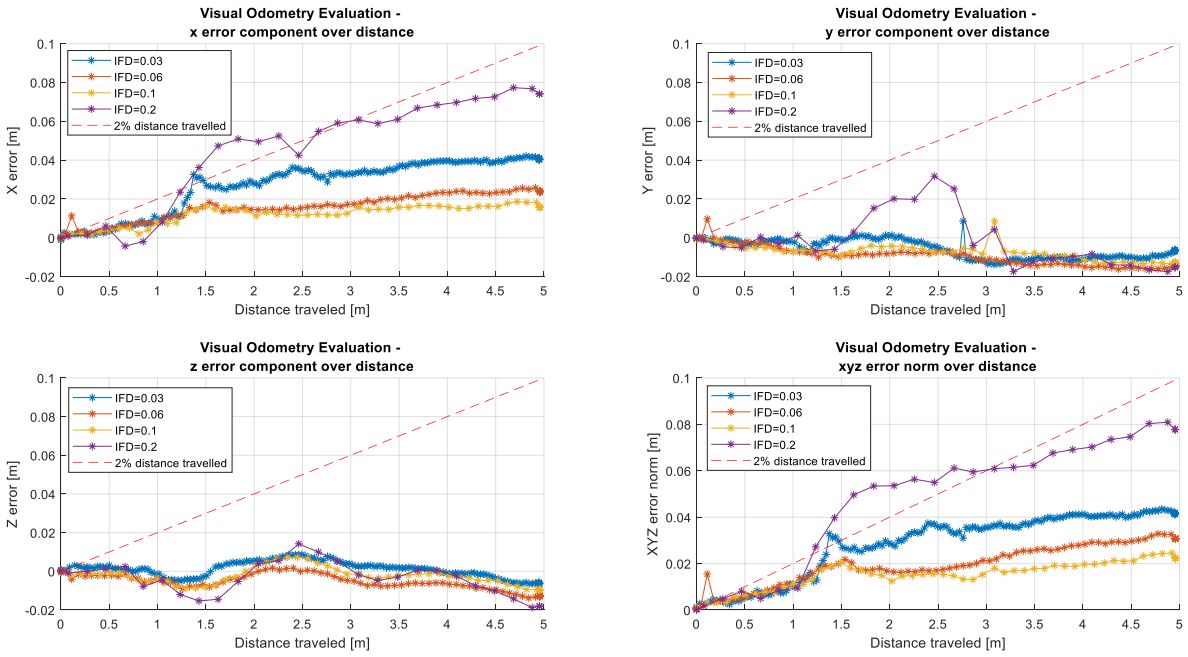


Figure 1: Small IFD test at high speed, position error

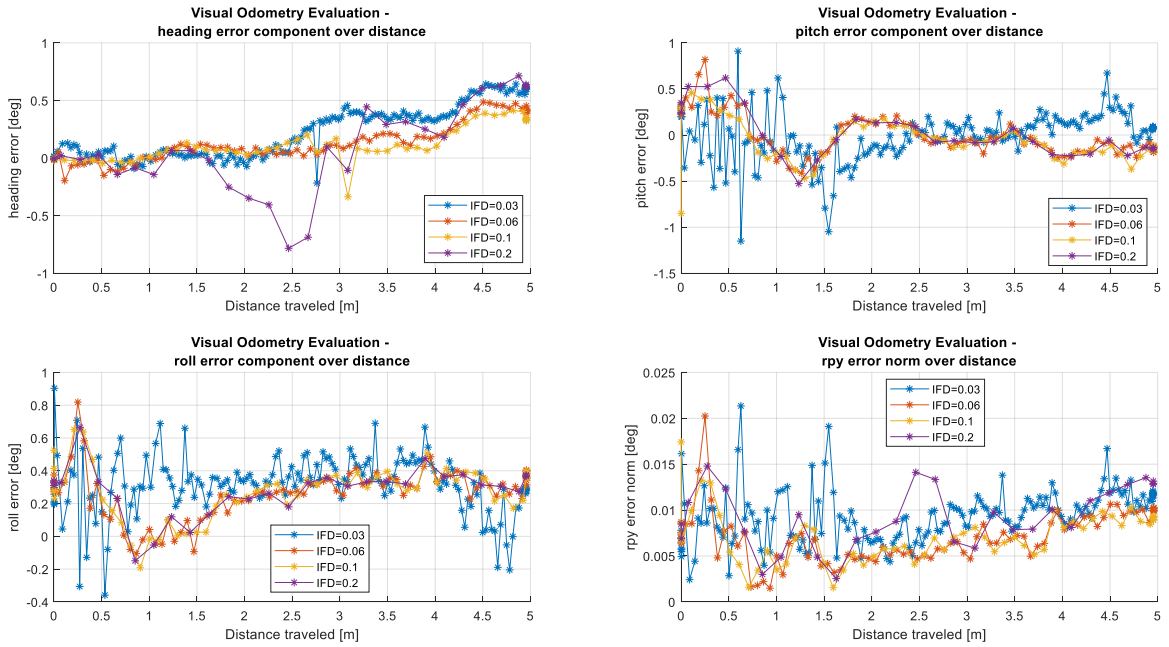


Figure 2: Small IFD tests at high speed, orientation error

These tests may suggest that an IFD smaller than 0.1m (and therefore IOP higher than 93%) leads to a small decrease in performances.
Though this behavior is not present at the same magnitude in the next tests at slower speed.

BETTER LOOK AT SMALL IFD AT LOW SPEED

The same tests as before were also run on a low speed sequence at 0.02 m/s, with the following results.

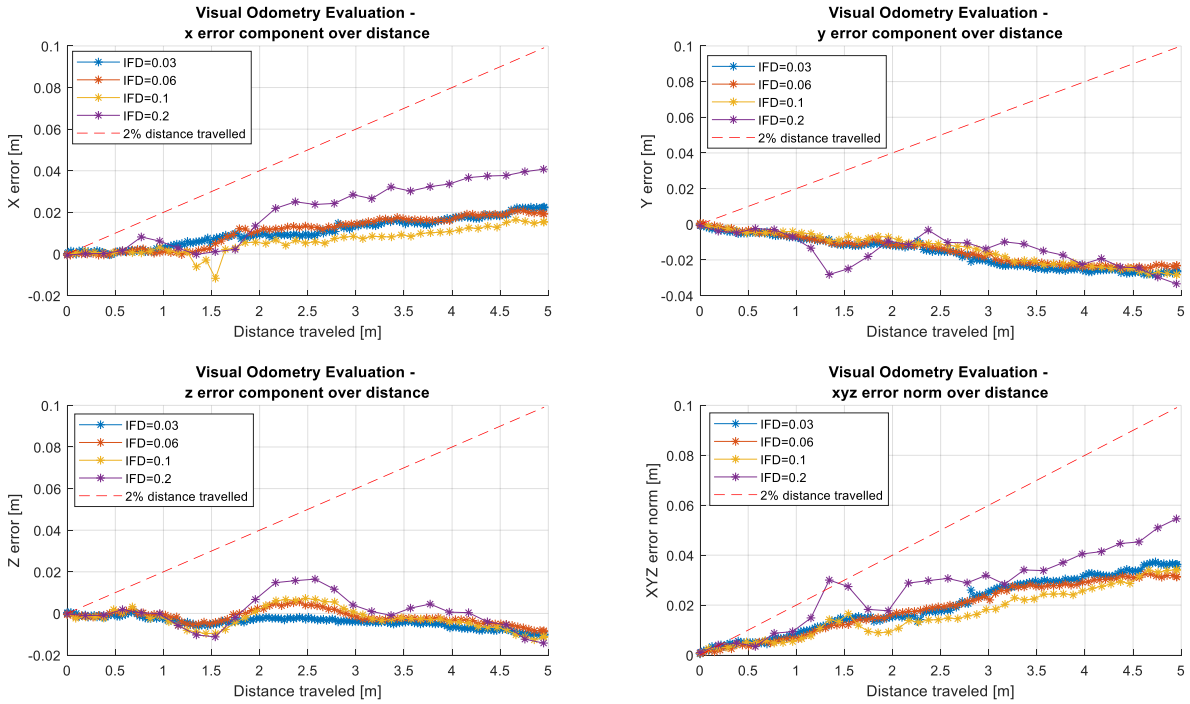


Figure 3: Small IFD tests at low speed, position error

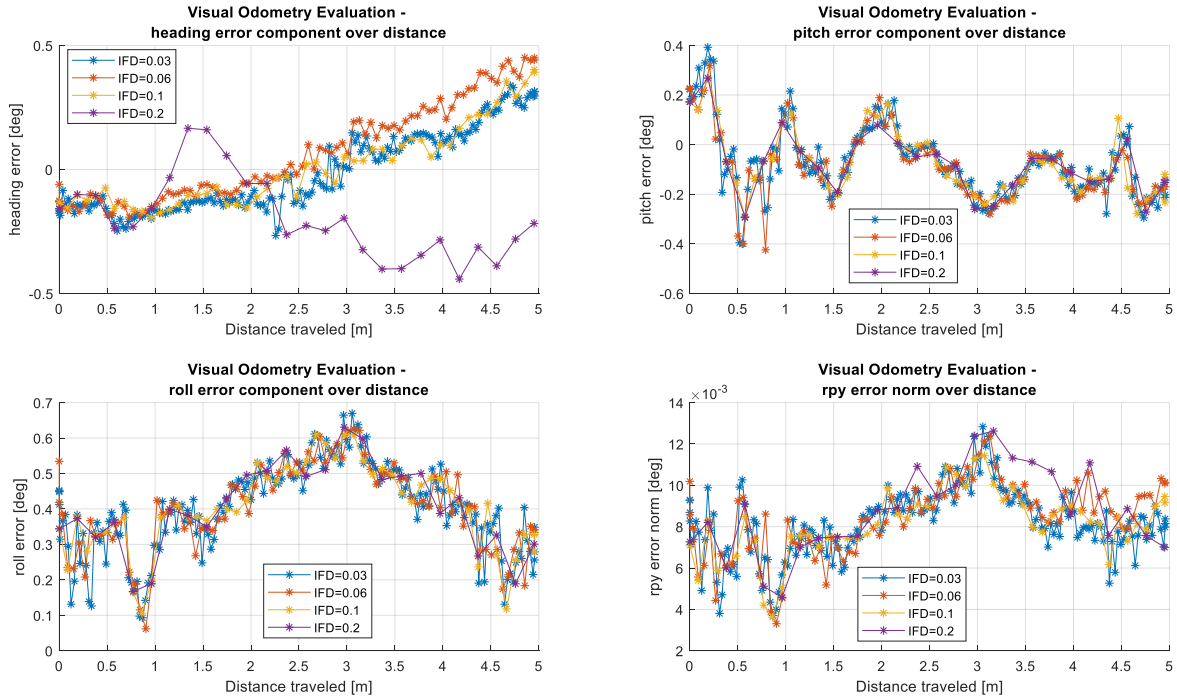


Figure 4: Small IFD tests at low speed, orientation error

In these low speed tests, the IFDs below 0.1m and IOPs above 86% appear to perform very similarly, without any noticeable decrease in case when the IFD gets too low as opposed to what the high-speed tests showed.

BODY-NAVCAM TRANSFORMATION REFINEMENT:

The VO with the NavCam has been fully implemented and the Body-NavCam transform has been refined, as previously done for the LocCam, and a moderate improvement in performances (mostly in the y component) has been obtained.

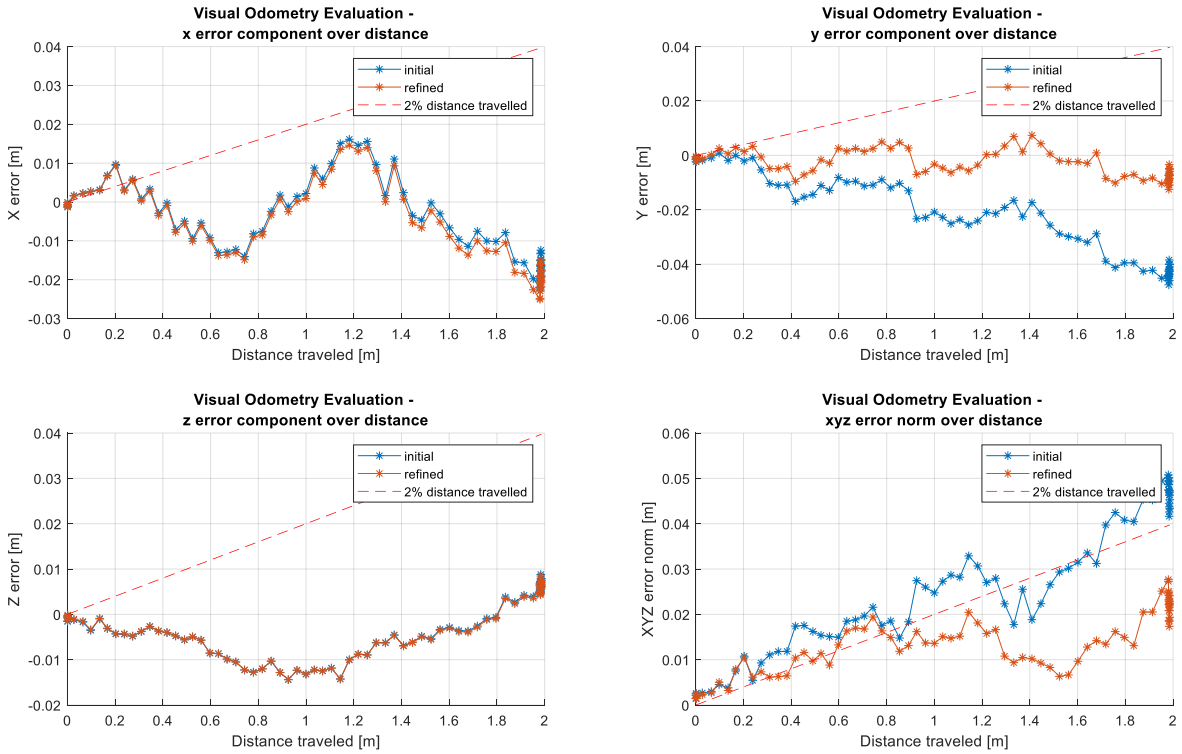


Figure 5: Body-NavCam transformation refinement, position error

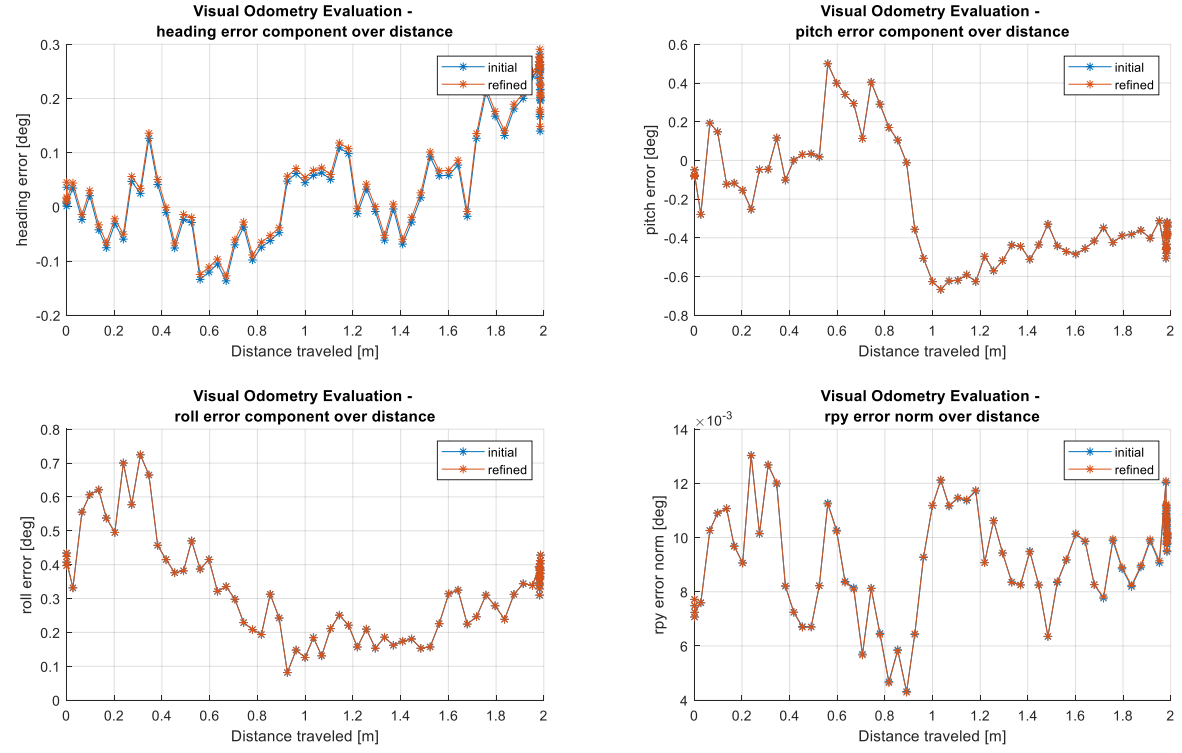


Figure 6: Body-NavCam transformation refinement, orientation error

NAVCAM TESTS AT DIFFERENT PITCH VALUES:

Speed = 0.07 m/s, Pitch varied from 20 deg to 50 deg, VO frequency = 0. 2332 Hz, IFD = 0.3 m
NavCam pitch = 20deg – IOP = 99.99%
NavCam pitch = 30deg – IOP = 94.9343%
NavCam pitch = 40deg – IOP = 83.9429%
NavCam pitch = 50deg – IOP = 72.5842%
LocCam pitch = 30deg – IOP = 85.6191%

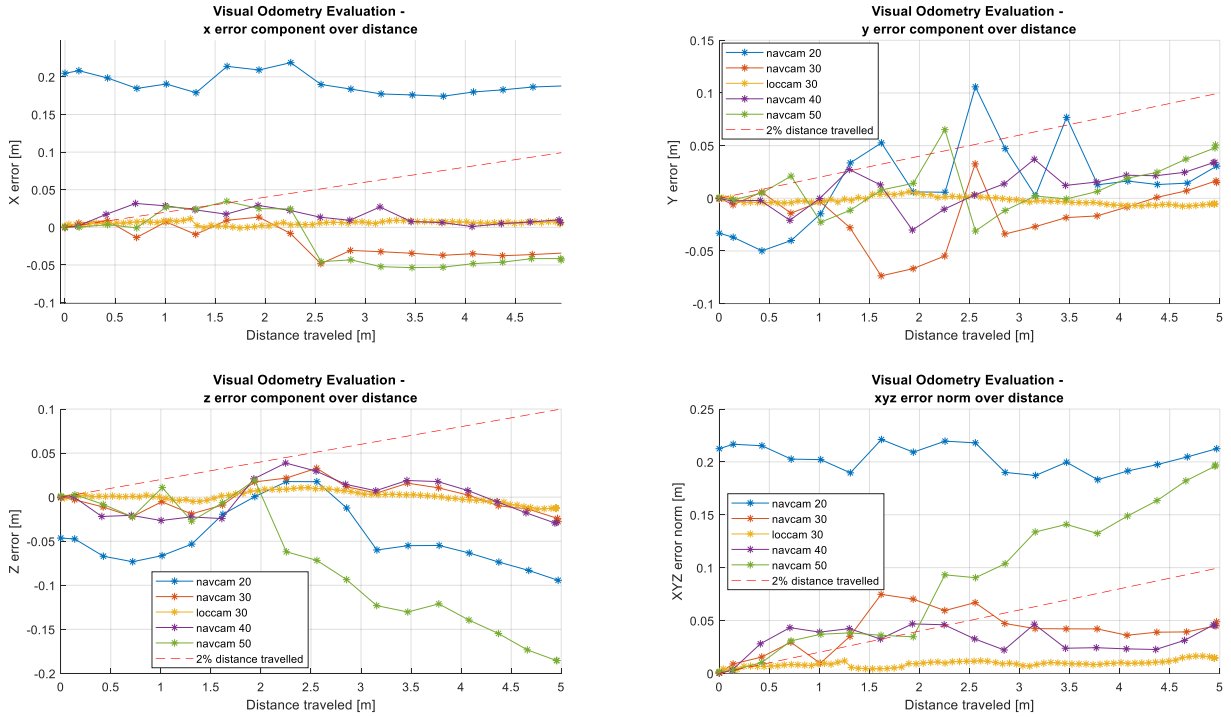
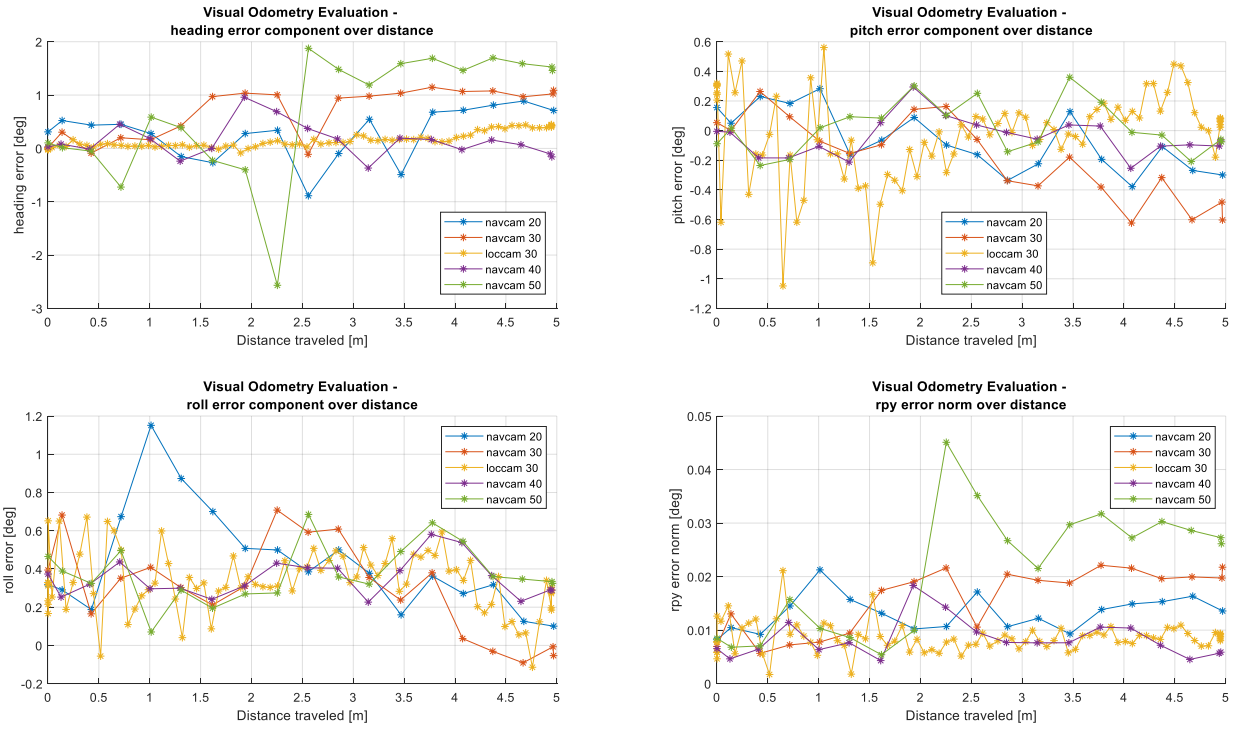


Figure 7: NavCam tests at different pitch values, lower VO frequency



NAVCAM TESTS AT DIFFERENT PITCH VALUES:

Speed = 0.07m/s, Pitch varied from 20deg to 50deg, VO frequency = 1Hz, IFD = 0.07m
NavCam pitch = 20deg – IOP = 99.99%
NavCam pitch = 30deg – IOP = 98.8165%
NavCam pitch = 40deg – IOP = 96.6314%
NavCam pitch = 50deg – IOP = 93.5170%
LocCam pitch = 30deg – IOP = 96.2243%

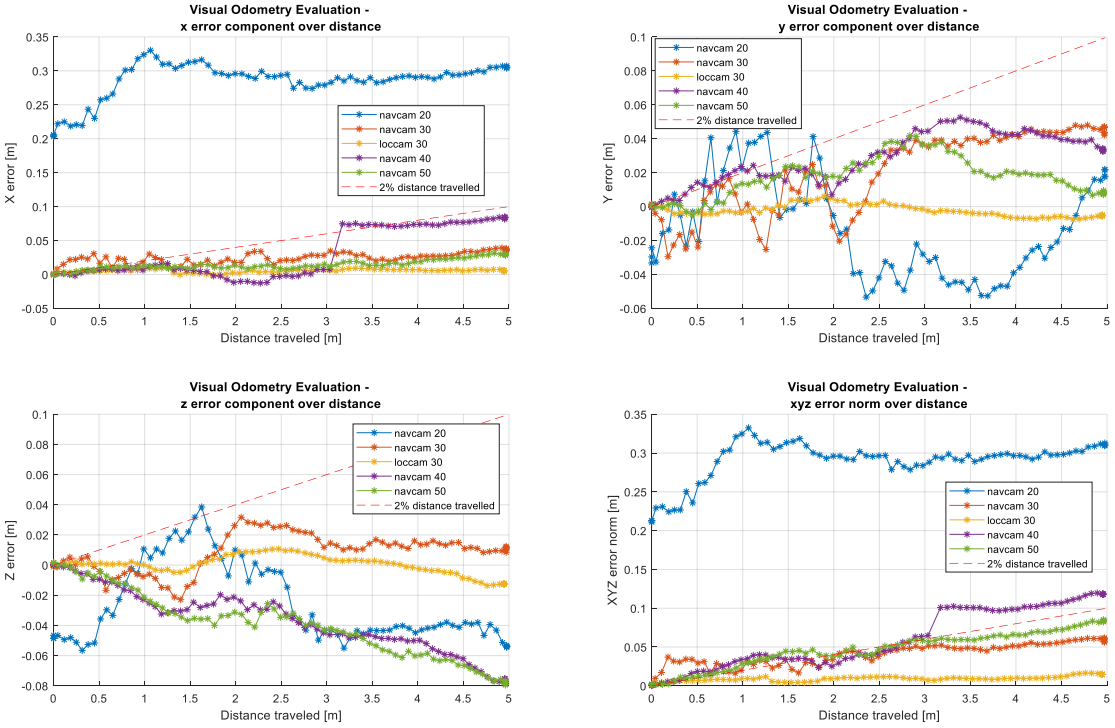
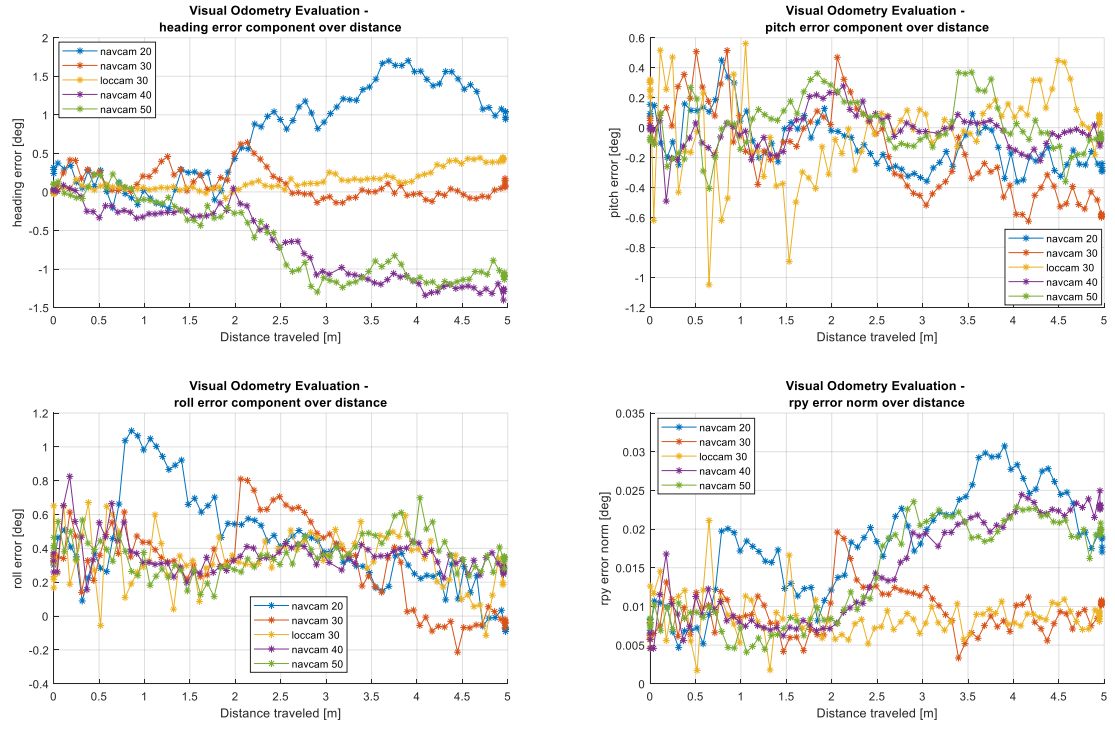


Figure 8: NavCam tests at different pitch values, higher VO frequency



The last two sets of tests with the NavCam at different pitches, IOPs and VO frequency show that the NavCam VO has generally worse performances than the LocCam VO and, while the LocCam is influenced only by the IOP since its mount is fixed to ExoTeR's body, the NavCam does not appear to only be influenced by the IOP, but also by the camera pitch, since a pitch of 20 degrees leads to a big loss in accuracy even at very high IOP.

The reason behind this could be that the camera pitch does not only affect the IOP, but also changes the depth of the features in the frames: a small pitch of 20 degrees means that most of the features are very far and there are not many close features coming from the ground.

COMPARISON BETWEEN LOCCAM AND NAVCAM AT HIGH IOP AND LOW IFD WITH FIXED PITCH:

In the next tests the pitch has been fixed to 37.7 degrees, a value that gave good results in the previous tests and allows to obtain the same IFDs and IOPs that were studied with the LocCam and gave both good (IFD = 0.1m and IOP = 93%) and bad (IFD = 0.3m and IOP = 85%) performances.

This test shows the result for: IOP=93%, IFD=0.1m, speed=0.07m/s, NavCam pitch = 37.7, where the LocCam achieved a good accuracy.

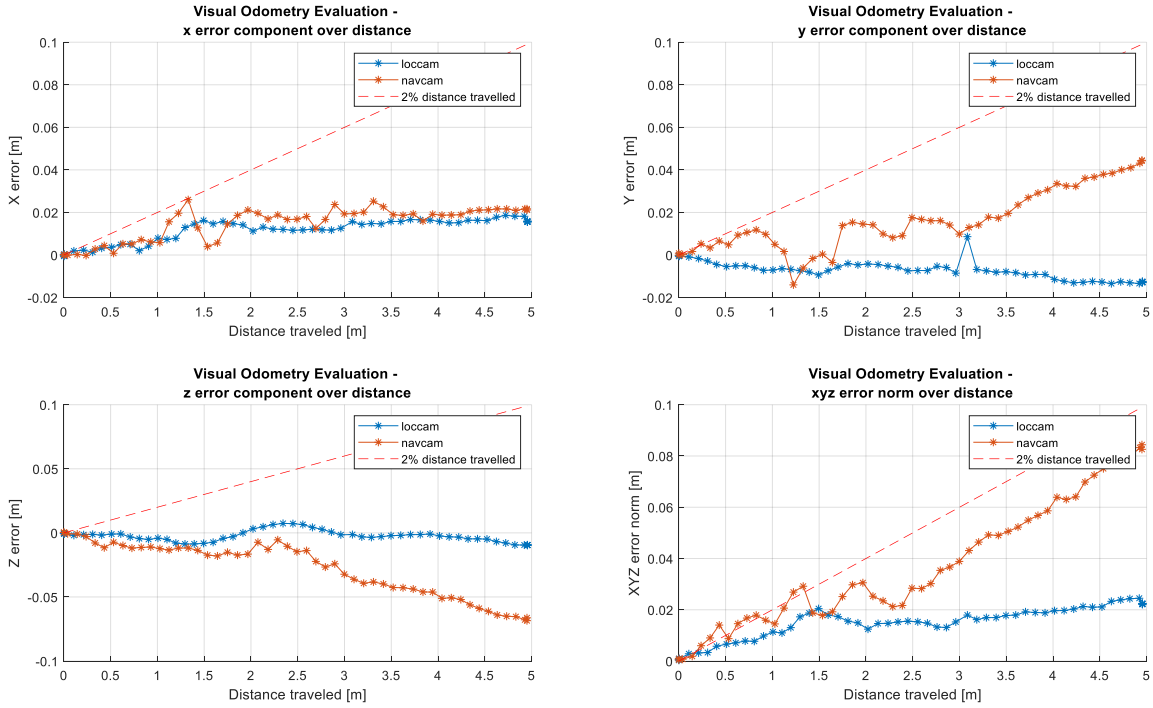
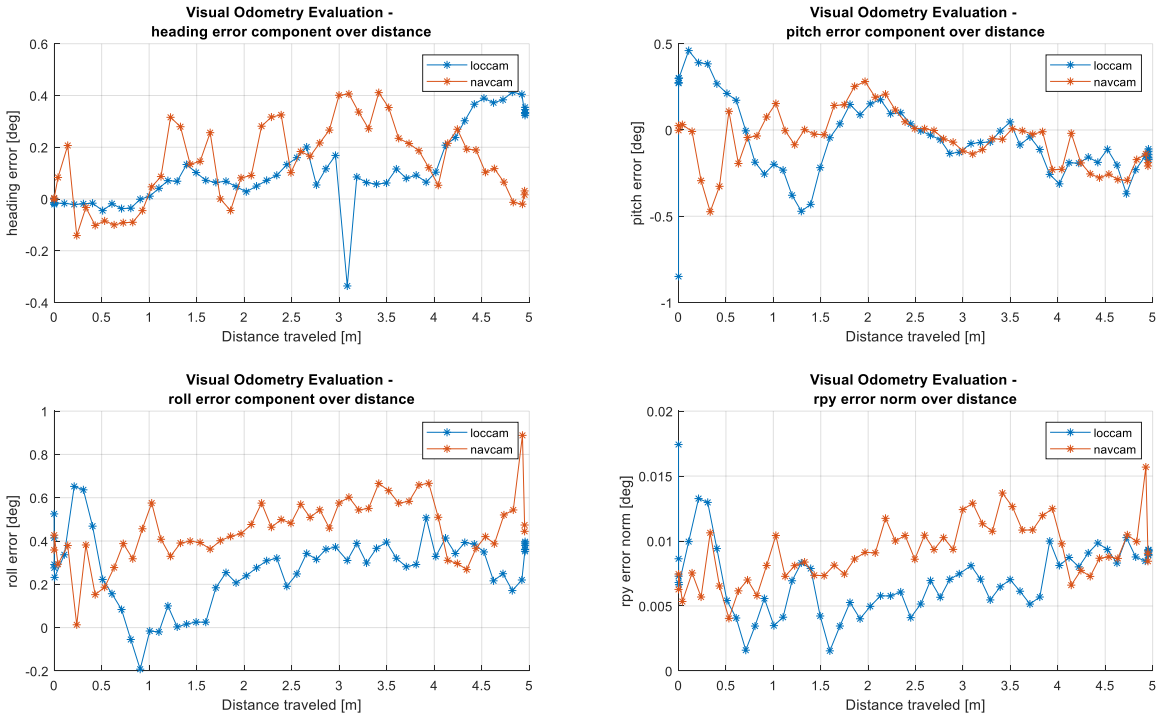


Figure 9: NavCam and LocCam comparison at high IOP and low IFD



COMPARISON BETWEEN LOCCAM AND NAVCAM AT LOW IOP AND HIGH IFD:

This test shows the result for: IOP=85%, IFD=0.3m, speed=0.07m/s, NavCam pitch = 37.7 , where the LocCam accuracy started to degrade.

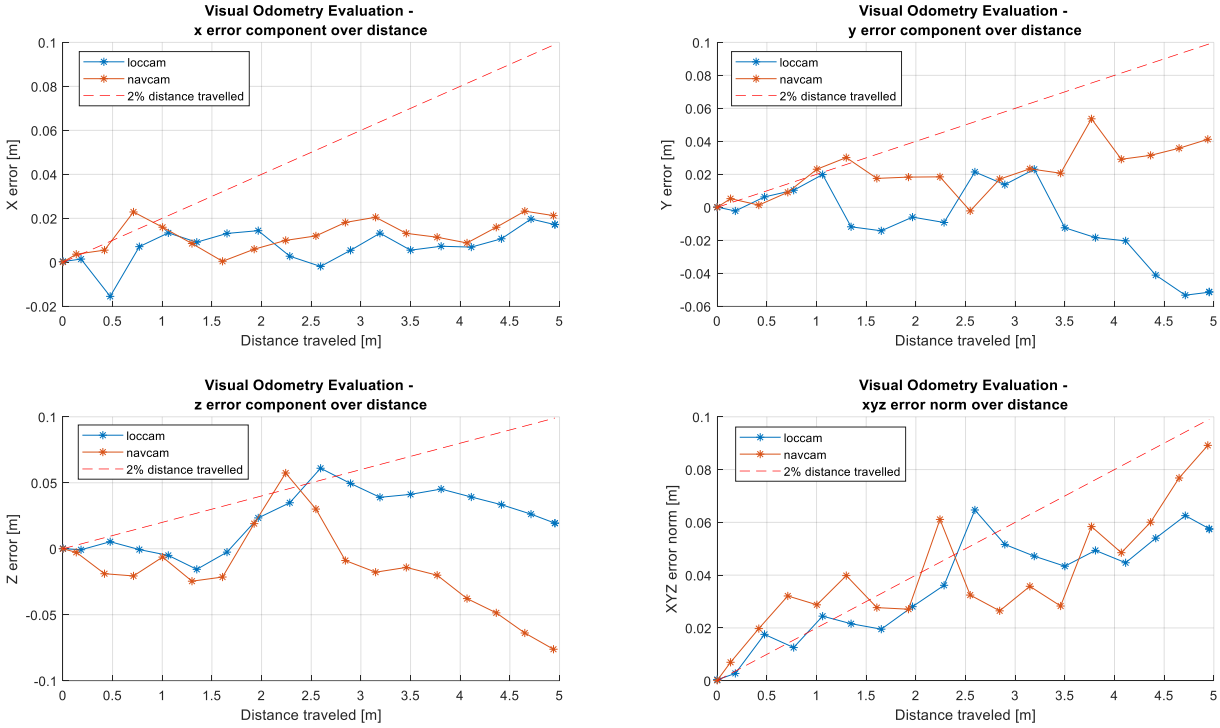
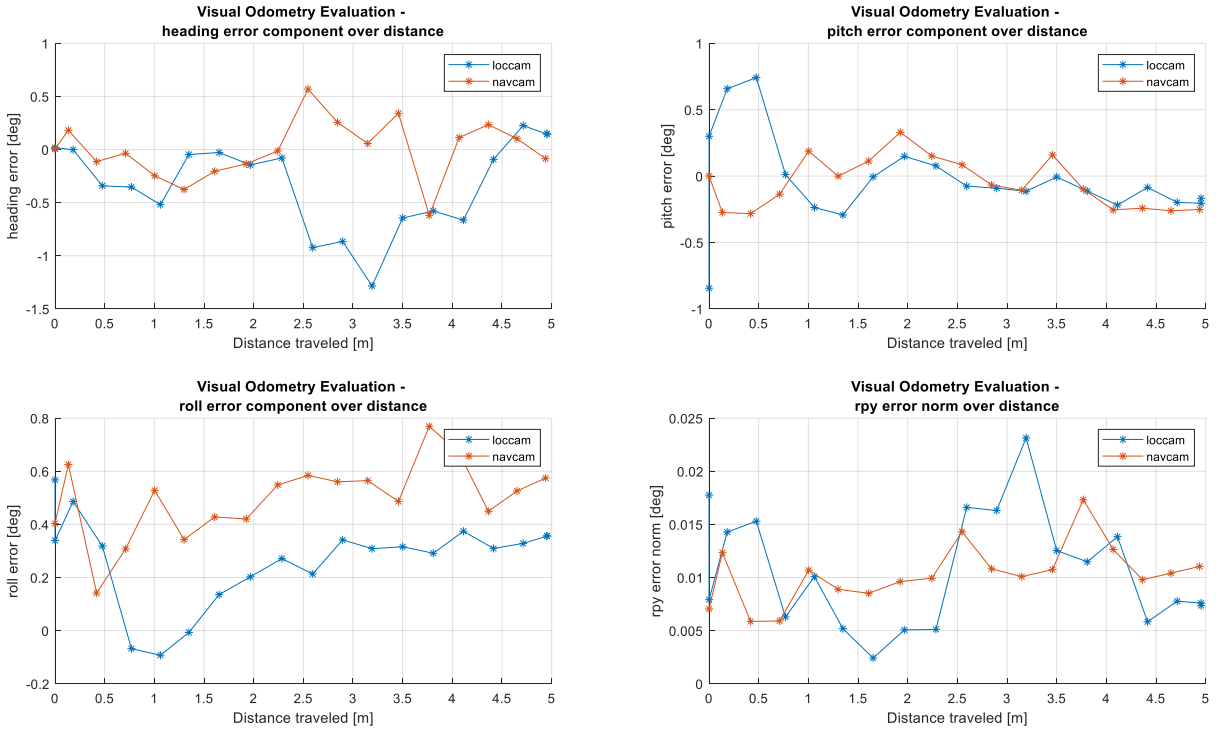


Figure 10: NavCam and LocCam comparison at low IOP and high IFD



These two tests show that the NavCam VO maintains the same performances when changing the IFD and IOP through the VO frequency, while the LocCam VO shows better performances with lower IFD and higher IOP (IFD = 0.1m and IOP = 93%) with respect to higher IFD and lower IOP (IFD = 0.3m and IOP = 85%)

FINAL CONSIDERATIONS ON THE NAVCAM VO:

The NavCam showed in general inferior performances compared to the NavCam.
This is believed could be caused by two possible reasons:

1. The higher position of the camera does not allow close features to be used in the motion estimation, even with a high pitch, which will then lead to a very small IOP and the loss of far features.
2. The camera mounted on the PTU is considerably more sensible to vibrations of the mast when the rover moves, compared to the LocCam bracket which is well fixed to the rover body.

FUTURE OBJECTIVES:

The 2nd possible reason of the NavCam being worse than the LocCam could be investigated by comparing the change in performances when the rover moves on the sand and when in the moves on rocks, which will generate more vibrations, using the LocCam Vo against the NavCam VO.

So far, the tests were focused on one or a few specific parameters in the case of a straight traverse. It could be interesting to then focus solely on the heading estimate error to see if some of the previous studied parameters have a considerable effect on it.
In addition to it, also complex trajectories could be studied and maybe further work could be done with the implementation of the Spartan VO in 3DROCKS, after the first successful test on Friday, where me and a colleague were able to send goals using the Spartan VO, instead of Vicon, for localization.

Anyway, these objectives will be better discussed with my internal supervisor to discuss the results of the last tests with the NavCam and then define the work of the 2 remaining months of the internship.