Evaluation of different INS and their integration with VOS

The Fraunhofer Institute for physical measurement techniques is currently developing mobile laser scanners for the use in different, challenging environments. There are application for very fast moving vehicles like trains and new developments for underwater and air vehicles. In order to enable as much flexibility as possible the systems are designed to function independent from the host vehicle. This leads to the reconstruction problem of the point-cloud from the single scans. Because the system is independent it has to introduce its own navigation algorithm. The used scanners are mostly profile scanners.

Fraunhofer UAV-Scanner with the camera for VO

Currently the UAV-Scanner from Fraunhofer is based on visual odometry. The system is set up with a monocular approach. This monocular algorithm estimates the position up to a scale factor which is calculated with the help of the laser-scanner. The system is already running reliable. Fraunhofer is now observing the usage of an IMU to improve the system or to use it as a handheld scanner. For this task different grade MEMS-based IMU's were purchased and evaluated. This was done with the help of different test cases and signal analysis of the outputted values.

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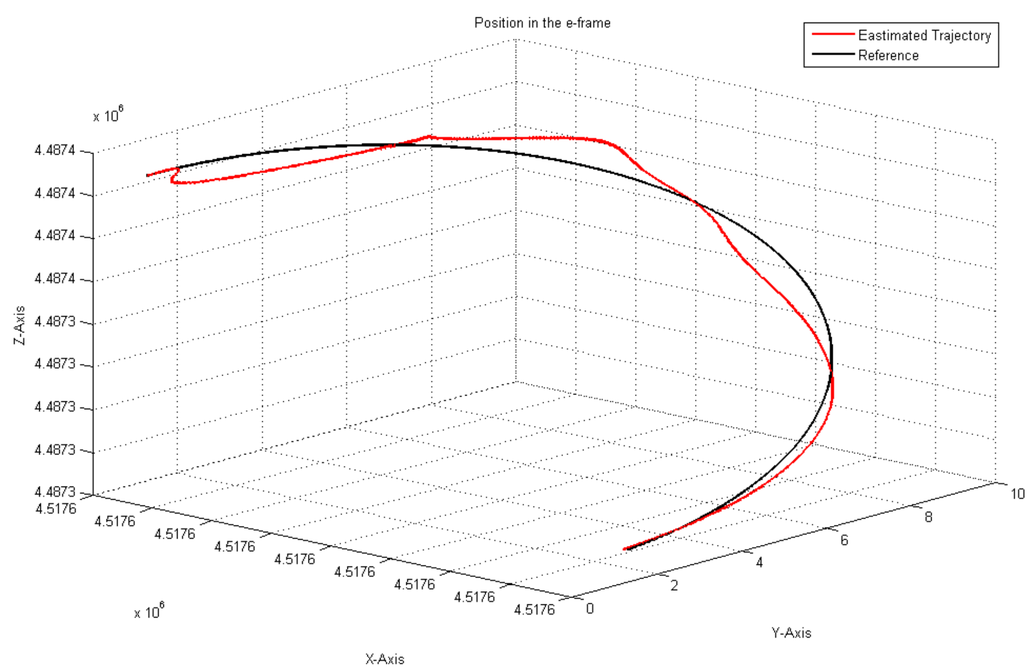
For the fusion of visual odometry and inertial navigation there are many different algorithms. The two basic approaches are loosely and tight coupling.
In this work the two systems were loosely coupled and the VO was treated as black box system. So the feature point positions of the VO-process were not predicted with the inertial measurements. The system estimates the position, velocity and orientation of the body in respect to the earth-frame and the position and orientation of the visual-frame in respect to the e-frame. This frame holds the visual odometry. Additionally the state holds the accelerometer and gyroscope bias in order to improve the inertial navigation.
In addition to this fusion a magnetometer and GNSS were also coupled into the system to observe the global orientation and position in the e-frame directly.
This algorithm was testes with simulated data. This data was modeled with additive bias and white noise.



Reference Track [black] and estimated Track [red] with initial errors from simulated data

The tests showed that the algorithm is able to estimate the bias correctly as well as the trajectory. The next step could be to include the scale factor of the VO in the state to check the accuracy of the estimation with the scanner.
Also the system can be testes with real data from the UAV-Scanner system and an included IMU.