Paper ID: 50230
oral
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation & Control (2) (8)

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ASSESSMENT AND IMPLEMENTATION OF VIABLE NAVIGATION FILTER OPTIONS FOR CLOSE-PROXIMITY SATELLITE OPERATION USING VISUAL NAVIGATION

Abstract

Through technological progress and increasing demand for sophisticated space systems, the future of space will be shaped by complex satellite applications. Autonomous capabilities play an important role in this development by enabling systems to interact in real-time with their environment. Possible mission scenarios range from maintenance over rendezvous to docking, requiring accurate and fast pose estimation to avoid missing targets and to avoid impacts. Visual navigation systems can be applied for satellite-system pose estimation. Navigation filters are used for such estimates. However, comparisons of navigation filters specifically for space applications are rare. This research project determines the performance difference between navigation filter options in close-proximity space applications with visual navigation in varying mission scenarios.

The project is performed in cooperation with TU Delft and DLR. To determine the viable navigation filters for close-proximity space operations with visual navigation systems, the performance of multiple different navigation filters is assessed theoretically. Afterwards, based on simulation results, the most promising filter options are implemented in the EPOS2.0 test facility. The rendezvous-performance under real-time conditions is determined experimentally under different mission scenarios and input conditions. A performance assessment of each filter for each scenario is performed. Based on this, a meaningful comparison of the respective filter performance is undertaken, and the application of specific filters for specific missions is recommended.

The research is currently performed. The outcome serves as a baseline for selecting navigation filters for satellite visual navigation systems. It is used to identify viable filter options for a mission, and to identify comparative advantages and disadvantages for different filters. Furthermore, it shows a method for trading-off navigation filter performance for space applications. By comparing different filters and by highlighting shortcomings, the research also allows for further development of navigation filters and is thus relevant for academia and industry.

The project investigates and compares different navigation filters in close-proximity visual navigation systems through simulation and model tests. A performance-based recommendation for specific filter application in specific mission scenarios is presented. Based on this, filter selection for missions is facilitated and the development of new filters tailored to space applications is enabled through highlighting shortcomings of existing methods. The space-focused approach enables navigation filter performance improvements in speed and accuracy, which are crucial for the future of space applications as they allow for highly autonomous systems.