Visual Navigation for On-Orbit Servicing Missions

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Abstract

Increasing complexity and costs of satellite missions promote the idea of looking for opportunities to extend the operational lifetime or to improve the performance of a satellite instead of simply replacing it by a new one. Satellites in orbit can severely be affected by ageing, limited fuel source, or degradation of their hardware components. Also the disposal of spacecraft after the end of lifetime will play a more and more important role in the future, especially, if the involved orbits are of strategic importance. Therefore, satellite on-orbit servicing (OOS) has increasingly caught the interests of both satellite developers and users.

One of the critical issues of a satellite on-orbit servicing mission is to ensure a safe and reliable Rendezvous and Docking (RvD) process. Since RvD operation is known to be the most risky part of an on-orbit servicing mission, the operation must be carefully analyzed, simulated and verified before the mission can be launched.

DLR is developing new navigation algorithms using standard camera systems and advanced 3D sensor systems like PMD (Photonic Mixing Device) or LIDAR sensors. While a camera system provides an optimum related to mass and power consumption, it depends strongly on the illumination condition in space. The 3D sensors deliver instantaneous full 3D information about target pose but they are usually new developments which needs more advanced evaluation of the measurements to achieve good navigation results. In addition the fusion of both results in a better navigation performance.

Furthermore DLR has built a new and more advanced RvD simulation facility called EPOS 2.0 (European Proximity Operations Simulator). The facility uses robotic manipulators to generate the relative motion between two satellites and allows full RvD test and verification capabilities for OOS missions up to a range of 25m. For hardware in the loop simulations the visual navigation sensors and a mock-up of a target satellite are mounted on the robotic manipulators of EPOS 2.0 which realize the required motion in real-time. The complex software functionality for image processing, guidance, navigation and control (GNC) and for the satellite dynamics is developed under Matlab/Simulink environment and auto-coded with Real Time Workshop.
The paper describes the developed navigation algorithms using a CCD camera and 3D sensors like PMD. The developed GNC algorithms for image processing, navigation and control for different ranges are presented. Finally the achieved navigation performances as well as results of the hardware in the loop simulation are demonstrated.

This is the abstract preparation template for the 5th International Conference on Spacecraft Formation Flying Missions and Technologies (SFFMT). The selection for presentation will be based on extended abstracts. Each abstract will be evaluated by the members of the program committee and scored based on quality, originality, and relevance to conference. The abstracts will be ranked according to a score and selected for presentation based on the available space. Please note that failure to follow this format will lead to rejections of the paper without review.