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Author: Mr. Leonardo Regoli
University Wuerzburg, Germany, regoli@informatik.uni-wuerzburg.de

POSE ESTIMATION AND COLLISION DETECTION FOR RENDEZVOUS AND DOCKING IN SPACE USING PHOTONIC MIXER DEVICES

Abstract

Proximity operations and rendezvous and docking (RvD) scenarios have been gaining attention among the scientific community in the last years. The development of new technologies has allowed in turn the envisioning of newer and more challenging missions devoted to a variety of applications where a precise relative navigation and the corresponding safety issues need to be addressed.

Among the different possible applications for the aforementioned technologies, research on the field of RvD with non – cooperative spacecraft is particularly active. This is motivated by the growing need to clean Earth orbits of malfunctioning or defunct satellites that pose real hazards to both new and already existing spacecraft. Several projects which are devoted to the demonstration of concepts and technologies to achieve this objective are currently in progress (DEOS, SIS, Sling-Sat).

This paper presents the latest developments framed in a technology demonstration project led by the Germany Space Agency (DLR) called FORROST. Two crucial parts of a proximity operations and RvD system, namely pose estimation and collision detection, are presented working together. The whole program works with the input provided by a Photonic Mixer Device (PMD) camera and provides in real time the current pose of a target as well as the characterization of possible collisions. The final output of the program can be used as an input for a control system to perform either approach maneuvers (when seeking RvD) or collision avoidance maneuvers (when a collision is foreseen).

Additionally to the pose estimation and the collision detection features, the paper also presents test runs and the corresponding results as evaluated in a specially designed testing facility. The facility is based on two industrial manipulators and provides real-time feedback of the manipulators position and a complete characterization of the involved delays as a ground-truth for the correct assessment of the results provided by the algorithms.