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Author: Ms. Martina Mammarella
Politecnico di Torino, Italy

Dr. Elisa Capello
Politecnico di Torino, Italy
Dr. Hyeongjun Park
Naval Postgraduate School, United States
Prof. Giorgio Guglieri
Italy
Prof. Marcello Romano
United States

# SPACECRAFT PROXIMITY OPERATIONS VIA TUBE-BASED ROBUST MODEL PREDICTIVE CONTROL WITH ADDITIVE DISTURBANCES

**Abstract**

Proximity maneuvers of two autonomous spacecraft have been extensively studied in the past years, in which both the strict requirements in terms of spacecraft dynamics variations and the limitations due to the actuation system have taken into account. Since the phase of proximity involves a rapid evolution of the kinematics and dynamics, linear control methodologies have limited performance achievement. In particular, rendezvous and docking (RVD) problems require high level of robustness in order to ensure the satisfaction of the mission constraints for any modeled possible disturbance and uncertainty that can affect the system. For this reason, Tube-based Robust MPC represents an appealing strategy to handle disturbances and to ensure robust constraints satisfaction. In our paper, a suitable strategy of control via Tube-based Robust MPC, in which the robustness of the system is guaranteed in presence of additive disturbances, is proposed. The idea of this research is to reduce the computational effort adopting a time-varying control law in which the feedback gain matrix is evaluated off-line. A Linear Matrix Inequalities (LMI) approach is applied to the state feedback stabilization criterion for the stability analysis and the evaluation of the feedback matrix. The experimental verification has been carried out considering the final phase of the rendezvous and docking maneuver and using two Floating Spacecraft Simulators (FSS) that float over a polished granite monolith surface reproducing a quasi-frictionless motion. A Vicon motion capture system provides accurate position and orientation data and a discrete time Kalman filter processes the data and provides a full state estimate. An extensive verification campaign, both in simulation and experimentation on this physical test bed, has been accomplished to validate the performance of the control system and its compatibility for real-time implementation. Thus, the efficiency of the control system is measured comparing the control effort and the computational time (in terms of CPU time).