Paper ID: 71704
student

IAF ASTRODYNAMICS SYMPOSIUM (C1)
Interactive Presentations - IAF ASTRODYNAMICS SYMPOSIUM (IP)

Author: Mr. Akan Selim
ROKETSAN Roket Sanayi ve Ticaret A.S., Türkiye, selim16@itu.edu.tr

Prof. İbrahim Özkol
Istanbul Technical University, Türkiye, ozkol@itu.edu.tr

REAL-TIME OPTIMAL CONTROL OF A 6-DOF STATE-CONSTRAINED CLOSE-PROXIMITY RENDEZVOUS MISSION

Abstract

Optimization-based control has achieved outstanding successes in paving the way for the next generation of Mars landing operations, rendezvous and docking operations, and reentry planning with unprecedented precision and robustness. It is undoubtedly an enabling technology for autonomous planetary landing and orbital maneuvers, but still faces severe challenges when it comes to complex pure-state constraints, time delay, and unmodeled dynamics that need to be taken into account. Although reinforcement learning based has demonstrated enormous success for stochastic environments with unknown dynamics, i.e. asteroid landing, it encounters similar problems when it comes to taking the state constraints into account. Reward engineering applications have shown some great success with no guarantees of satisfaction of them. Convex optimization, on the other hand, requires one to model the dynamics and transform the nonconvex constraints into convex ones. Those that can't be convexified are solved via successive convexification, which makes things near-optimal for solving the problem in real-time. Since pseudospectral optimal control is a well-known and flight demonstrated technique, we resort to Caratheodory-Π scheme by utilizing Bellman Pseudospectral Method with an initial guess generation based on Extreme Learning Machines (ELM) to make autonomous mission planning possible for the complex constrained space operations. Employing this scheme, one can easily incorporate unmodeled dynamics and recalculate the optimal control based on the current estimations. Unlike MPC schemes, this approach optimizes the trajectory without managing any finite horizon, which is what makes pseudospectral methods powerful.