IAF ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation and Control (2) (2)

Author: Dr. qingqing dang
Northwestern Polytechnical University, China

MULTI-CONSTRAINED AUTONOMOUS SOFT LANDING VIA EXPLICIT REFERENCE GOVERNOR

Abstract

During the last decades, planetary exploration, especially landing on a celestial body, has attracted increasing attention from the space community due to its significant scientific value, e.g. unveiling the origin of our solar system. However, scientifically rich targets may be surrounded by hazardous terrain features or confined in very limited areas. Moreover, remote control from the ground is almost impossible because of telecommunication delay. In order to ensure the safety of landers, these tasks require a long-time observation, waiting, and testing before the final landing. As a consequence, one of the main critical technologies for surface exploration is the precise and autonomous soft landing.

This paper introduces a novel pose (attitude and position) controller for the spacecraft landing problem subject to various constraints. To avoid the unwinding phenomenon of six-DOF motion caused by dual quaternions and make full use of the geometric characteristics of spacecraft dynamics, the soft landing guidance and control problem is approached directly on the Lie Group SE(3). Pointing constraints are involved in the guidance scheme to ensure the vector fixed in body frame avoid the certain direction in inertial frame. Glide-slope and line-of-sight constraints are considered, in which relaxation factors are introduced to make the constraints more reasonable. Besides, a novel altitude-related velocity constraint is proposed. The recently proposed Explicit Reference Governor (EFG) is based on set invariance properties that does not need any real-time optimization. This proposed algorithm relies on a two-layer approach, where the first layer stabilizes the spacecraft dynamics, whereas the second layer enforces constraint satisfaction by suitably manipulating the reference of the inner loop. The second layer is realized by translate the actuator and states constraints into an upper-bounded of the Lyapunov function by suitably manipulating the applied reference. The stability and reachability issues of the corresponding ERG control approach are then discussed. The effectiveness of the proposed constrained control algorithm is then verified through numerical simulations.