IAF ASTRODYNAMICS SYMPOSIUM (C1)
Guidance, Navigation and Control (1) (1)

Author: Mrs. Liangyue Wang
Harbin Institute of Technology, China, wangly@hit.edu.cn

Dr. Yanning Guo
Harbin Institute of Technology, China, guoyn@hit.edu.cn
Prof. Guangfu Ma
China, magf@hit.edu.cn
Mr. yueyong LYU
Harbin Institute of Technology, China, lvyy@hit.edu.cn
Dr. Haibo Zhang
1.Beijing Institute of Control Engineering, 2.National Key Laboratory of Science and Technology on Space Intelligent Control, China, China, zhanghaibo606@gmail.com

DUAL-QUATERNION BASED FINITE-TIME ADAPTIVE CONTROL FOR SPACECRAFT AUTONOMOUS PROXIMITY MANEUVER WITH PYRAMID-TYPE CONSTRAINTS

Abstract

The autonomous proximity maneuver phase is the prerequisite part of the on-orbit service, and it presents a set of challenges. One such challenge is that the service spacecraft is required to complete the proximity task within the specified time while satisfying some attitude-position coupled constraints, such as field of view (FOV), collision avoidance constraint. This paper addresses the problem of six degree of freedom (6-DOF) finite-time pose control with multiple constraints. Firstly, the FOV and collision avoidance constraints are represented as pyramid envelope, which is closer to the real case than the commonly used cone and sphere envelope with less conservative. In particular, a novel method is presented to model the pyramid envelope in the dual-quaternion frame. Then, based on the pyramid constraints model properties, a new convex artificial potential function (APF) with only one global minimum is designed, which combines the pose constraints with control design process. An APF based finite-time control law is proposed to control the rotational and translational motion reaching the desired states in specified time without violating the constraints. Moreover, the adaptive update law guarantees the control system's robustness in the presence of disturbance and parameter uncertainties. And the practical finite-time stability is demonstrated through the finite-time Lyapunov theory. Numerical results are carried out to show the effectiveness of the proposed control law.