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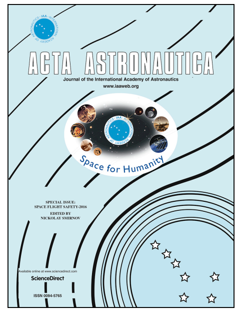

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Sliding Mode Control for Autonomous Spacecraft Rendezvous with Collision Avoidance

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Abstract

This paper studies the relative position tracking and attitude synchronization problem of spacecraft rendezvous with the requirement of collision avoidance. To achieve the implementation of the rendezvous procedure, the docking port of the chaser is required to direct towards the counterpart of the target, while the relative distance between the two spacecraft should be larger than the radius of the danger zone during close proximity phase. In order to address the concerned problem, a novel sliding mode control strategy based on artificial potential function is developed, and more specifically, the sliding manifold of the close-loop system is chosen along the negative gradient of the artificial potential function. Within the Lyapunov framework, the proposed control laws are proved to guarantee the convergence of relative position and attitude errors while avoiding any accidental collision between the two spacecraft, even in the presence of external disturbance. Numerical simulations are carried out to demonstrate the effectiveness of the designed control laws.

Keywords: spacecraft rendezvous; collision avoidance; relative position tracking; attitude synchronization; sliding mode control; artificial potential function.

1. Introduction

With the rapid development of space technology in recent years, autonomous on-orbit servicing (OOS) has received increasing attention [1]. Many space activities such as on-orbit assembly, space debris removing, spacecraft repairing and/or upgrading, and spatial refueling have been thought as the potential applications of OOS [2-3]. Among these applications, autonomous rendezvous and docking (AR&D) that requires precise relative position tracking and attitude synchronization is regarded as one of the most challenging technologies, especially in the case of non-cooperative