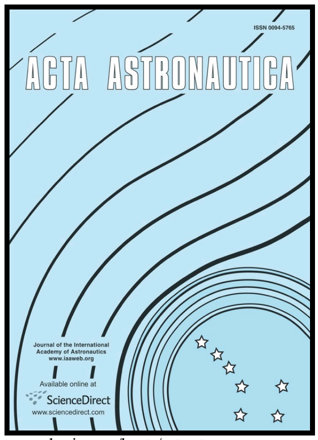

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Yunhe Meng, Qifeng Chen, Qing Ni

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A New Geometric Guidance Approach to Spacecraft Near-Distance Rendezvous Problem

Yunhe Meng[a*] Qifeng Chen[b], Qing Ni[a]

[a]National University of Defense Technology, Changsha, Hunan, 410073, China
[b]Central South University, Changsha, Hunan, 410083, China
[*]Corresponding author. Tel: +8673184573139. mengyunhe_nudt@163.com

Abstract

For the near-distance rendezvous problem of spacecraft, the classical guidance methods, such as R-bar and V-bar, are restricted by the initial relative positions and velocities and require a long period of time to rendezvous. In this paper, a new geometric guidance approach based on continuous low-thrust, which avoids the restrictions on initial states and decreases rendezvous time dramatically and has the advantages of robustness, is presented. First, based on the classical differential geometric curve theory, the dynamics equation of near-distance rendezvous is presented and a derivative term of spacecraft velocity is introduced, by which the relative velocity can be adjusted. Then, a spacecraft guidance curvature law is derived and one navigation ratio and two velocity feedback control gains are provided based on the analysis of motion in the normal and tangential directions of line-of-sight. Moreover, a method to improve the geometric guidance by using a modified linear-quadratic regulator, in which the time and the cost for rendezvous may be optimized by adjusting a 'decay factor', is proposed. Finally, numerical simulations about the selection of guidance parameters, about the comparison with the glideslope method, and about the guidance convergence with measurement errors, which prove the validity of the geometric approach for the rendezvous guidance problem of spacecraft, are presented.

Keywords

Spacecraft; Guidance; Near-distance rendezvous; Differential geometric; Linear-quadratic regulator