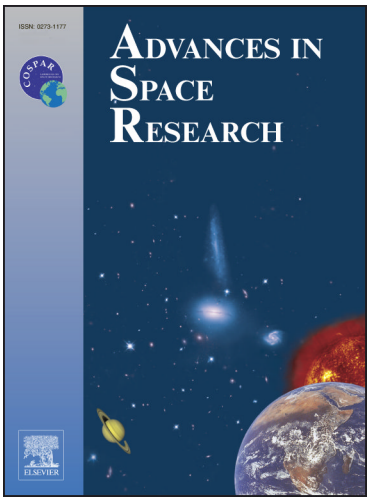

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Robust finite time control of heliostationary flight over asteroids

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Abstract:

Maintaining a heliostationary flight over an asteroid is challenging because of the complex dynamical environment. During exploration, external disturbances and uncertainties make it difficult for a spacecraft to stably hover at the libration point to complete its mission. In this paper, a globally robust finite time control law is proposed to solve this problem. First, we design a time variant sliding mode control law for the convergence of the tracking error to zero. Based on this, a nonsingular terminal sliding mode control law is designed to maintain the underlying track error at zero. The performance of the proposed control law is demonstrated through numerical simulations.

Keywords: heliostationary flight, libration point, asteroid exploration, finite time control

1. Introduction

Recently, scientific and technological developments such as in dynamics and components have promoted the exploration of unknown fields, especially exploring asteroids in the solar system as well as planetary defense missions (Wie et al., 2017). Among these, the study of spacecraft hovering is very important because of the complexity of the dynamical environment around asteroids and the disturbances within their gravitational fields.

From the perspective of the control methods used to maintain the required relative position in relation to an asteroid, spacecraft hovering is divided into heliostationary flight and body-fixed hovering (Lee and Vukovich, 2015; Scheeres, 2012). Body-fixed hovering refers to hovering in relation to a body-fixed frame, which can be used to obtain high-resolution images of asteroid landforms, and even rock samples on asteroids after the successful rendezvous (Zeng et al., 2014a). The other hovering method is heliostationary flight, which can realize observations of an asteroid's panorama and flight around it. Scheeres designed an open-loop control law for body-fixed hovering over an asteroid (Scheeres, 1999). Based on this open-loop control, Sawai designed a closed-loop control law based on

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