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FUEL MINIMIZING CONTROL FOR CONSTRAINED RELATIVE SATELLITE ORBITS

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Dedicated to Professor N.U. Ahmed on the occasion of his 75th birthday

Abstract. In this paper, we study the fuel minimization problem of hovering satellite subject to a practical constraint on the trajectory of the deputy satellite. It is first shown that the constraint condition can be expressed equivalently as maximum flight time inequalities. On this basis, a cost function relating to the fuel burn is formulated. A numerical procedure is developed and an illustrative example is solved.

Keywords. Relative satellite orbits, optimal control, constrained orbits, fuel burn, fuel minimizing cost function.

1 Introduction

With the ground monitoring, space target recognition, space operations and orbit maneuver capability can be much improved. Hovering technology will be an important direction for the future development in aerospace applications, such as orbit maintenance, photographic observation, rendezvous and docking, and asteroid exploration (see [2] and [3]). Besides these applications, there are also some industry applications, such as Demonstration of Autonomous Rendezvous Technology (DART), eXperimental Satellite System-11 (XSS- 11), and Orbital Express missions (see [4]).

Previous works on hovering satellite mainly consider the trajectory of the deputy satellite in the inertial plane of the chief satellite. In [5], it is found that if a single impulse burn is occurred at a point so as to keep a deputy satellite to stay within a constrained region, the trajectory of the deputy satellite will intersect itself by utilizing the natural drift of the relative orbit. In [6], a simpler closed-form solution is obtained for designing the size and shape of the trajectory for the deputy satellite to move.

In this paper, our goal is to minimize the fuel consumption, subject to constraining the trajectory of the deputy satellite to stay within a constrained