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MISSION PLANNING FOR ORBITAL RENDEZVOUS USING MIXED INTEGER NONLINEAR PROGRAMMING

Abstract

In the rendezvous and docking mission, for acquiring the good docking condition, the chaser must execute plenty of complicated operations such as maneuvers, rendezvous sensor switching and communications. For obtaining steady rendezvous trajectory, several hold points are deployed on the horizontal axis of target, and then the rendezvous process is divided into several phases such as homing, closing and approaching. The constraint in environment conditions and onboard operations and the limitation in onboard resource must be considered in operational mission planning. Previous studies mainly focused on rendezvous trajectory planning for single phase and few studies dealt with the entire rendezvous mission planning. The goal of this paper is to propose a rendezvous mission planning method, which considers operational constraints and treats several rendezvous phases as an entirety. Firstly, several holding-point candidates and sensor switching-point candidates are deployed according to relative distance. The design variables are composed of two parts. The first part is integer variables which include whether or not to hold position at a holding-point candidate, whether or not to switch sensor at a switching-point candidate, and the number of maneuvers. The second part is continuous variables which include the duration for position holding, the duration for accomplishing the mission of each rendezvous phase, the time for orbital maneuvers, the time for communications, the direction and magnitude of maneuver impulses, etc. The constraints such as the limitations in onboard sources, the requirements of sensors' operation and communication, and the restrictions of maneuvers' executing are considered. The objective function is a combination of propellant consumed and the terminal precision of each rendezvous phase. The formulated planning model is a complicated mixed integer nonlinear programming (MINLP) problem. For reducing the computation cost, the lighting condition and communication window are transformed to time intervals according to target's trajectory, and the terminal precision of each rendezvous phase is evaluated by linear covariance method. Then the MINLP problem is solved by genetic algorithm. The proposed method is testified by a practical rendezvous mission planning problem. The results show that the rendezvous mission scheme obtained satisfies the operational constraints, has high propellant efficiency and achieves good terminal precision. Compared with single-phase planning method, the proposed method is better in entire performance.