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RELATIVE REACHABLE DOMAIN COMPUTING OF SPACECRAFT WITH SINGLE IMPULSE IN MISSING PERIOD

Abstract

With the growing number of on-orbit spacecraft and debris, the maneuver ability of the spacecraft with limited fuel is very important, especially for the proximity operation. For common maneuver mode, the problem of reachable domain of spacecraft is worth to be studied. For on-orbit serving in proximity operation, the target's position is very important. However, because of earth shadowing, light of sun and load-sensor performance for detecting, the target will not be detected all the time. If the special space target maneuvers when the chaser cannot observe it, the chaser will miss initiative for on-orbit serving. If the relative position between chaser and target with maneuvering, e.g. relative reachable domain is predetermined, maneuver can be actuated for chaser to prepare for further operation.

In this paper, the relative reachable domain between chaser and target with a single impulse for target in missing period is studied. The equations of relative reachable domain are based on CW dynamics model. The direction of impulse is arbitrary, and the magnitude of impulse must be small, implying that all the trajectories are ellipses. Three cases are analyzed for relative reachable domain: a) The point of application is fixed and the direction of impulse is arbitrary; b) The point of application is arbitrary and the direction of impulse is fixed; c) Both the point of application and the direction of impulse are arbitrary. The arbitrary point of application is response for the arbitrary time in missing period. The relative trajectories after applying a single impulse form a family of curves in space. The equations of relative trajectories are derived analytically. Additionally, initial position and velocity errors are also considered. The relative trajectories with perturbation, disturbance and control errors are studied. On the other hand, the impulse constraints and time constraints are also considered while formulating the problem. The simulation results give the relative reachable domain between chaser and target with a single impulse for target in missing period. Moreover, we contrast the reachable domain with constraints with the relative reachable domain without constraints.

The relative reachable domain in missing period can assist chaser to obtain the region of target. The chaser is able to maneuver autonomously for further operation. Meantime, it will reduce dependence on the ground-based observations. It is beneficial to improve autonomous operation ability and guarantee serviceable distance between chaser and target. It will save considerable time for on-orbit serving.