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THE OPTIMAL TRAJECTORY FOR OBSERVING NON-COOPERATIVE TARGET USING SMALL SATELLITE

Abstract

With the development of technologies, the small satellites have attracted more interest than ever before. Some drawbacks of small satellites, like short time lifetime and payload mass limitation, also arise. The traditional spacecrafts have their own advantages, such as fuel sufficient, strong maneuvering capability. Therefore, making small satellites as supplement of the traditional spacecraft and developing both of them at the same time can make full use of the technological advantages of them. For large mission satellites, using small satellites onboard to observe a spacecraft is the precondition, especially for non-cooperative spacecrafts, in a proximity operations mission. For a spacecraft, it always has its own sensor, such as onboard camera which is the most common. To observe the bottom of target, the view of sensor is needed to avoid. Additionally, the spacecraft is considered as rigid body in practice. Therefore, avoiding the target's sensor field of view and avoiding collision with the target must be considered.

In this paper, a small satellite is released to be a chaser spacecraft from main satellite, and the main power is provided by main satellite when small satellite is released. The main satellite with small satellite (chaser) and target are on the same orbit. The initial position of main satellite is assumed behind of target with angle α. The first keep out zone (KOZ) is the target, and it is designed to be a sphere with finite radius. The radius R is slightly larger than the dimension of the target. Another KOZ is the target's sensor field of view cone. The apex of the cone is located on the centroid of target. The constraints of KOZs are given using the radius and the apex angle which can be changed in different cases. The goal is to transfer the chaser from the initial position to the final position to observe the bottom of target while avoiding the KOZs. When the chaser is released from main satellite, radial and normal thrusts are provided by release mechanism on main satellite. The transferring trajectory is presented analytically under the CW equation. Depending on some conditions, such as apex angle of cone, radius of sphere, the transferring trajectory is optimized. The optimal trajectory is presented analytically. The final position of chaser is ahead of target with same angle α.The trajectories with drift term and initial error of position and velocity are discussed. The numerical analysis is performed in MATLAB.