Paper ID: 50282
student

17th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Modelling and Risk Analysis (2)

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THE OPTIMAL COLLISION AVOIDANCE MANEUVER WITH MULTIPLE OBJECTS IN GEO

Abstract

Recently, the continuous growth of the space objects is increasing the collision risk between them. In the future, it will be necessary to operate satellites while avoiding much space objects. Since there is a limit of the load capacity of propellant, it is not acceptable to consume much propellant by collision avoidance maneuvers (CAMs). Therefore, it is required to reduce CAMs and save the propellant for maneuvers as much as possible. Strategies to satisfy such requirements have hardly been studied in the geostationary region (GEO), however. Thus, this study aims to devise an effective strategy to operate satellites safely and long in GEO. An ideal CAM is to avoid collisions with multiple objects that are likely to approach and also to perform regular orbit maintenance simultaneously. Such ideal CAM was achieved by Lee et al. They developed a method to simultaneously perform CAM and orbit maintenance maneuver (OMM) to suppress consumption of the propellant by genetic algorithm. In this study, CAM is also conducted as a consequence of OMM and its starting time and amount of impulse are optimized based on multi-objective genetic algorithm. This study simulates east-west (E/W) control and north-south (N/S) control separately. In E/W control, the thruster is burned only in the tangential direction of the trajectory and the longitude is adjusted. On the other hands, in N/S control, taking the advantage that the inclination is small, the thruster is burned in the orthogonal and tangential direction of the trajectory and both longitude and latitude are adjusted. This study assumes that two objects, being considered separately, are approaching to a geostationary satellite. The first generation has the starting time of maneuver and amount of impulse as genes. The fitness is evaluated in terms of collision probability with the two objects, the amount of impulse required, and the resulting distance from original point that the satellite is kept. In the final generation, the best individual is determined by the minimum collision probability with the two objects. Initially, the miss distance from the satellite to each object is 0.06 km and 1.0 km and the maximum collision probability was 5.0×10^{-5} and 3.0×10^{-5}. After optimization, the miss distance was 1.4 km and 4.3 km and the maximum collision probability was 1.7×10^{-5} and 4.0×10^{-9} by E/W control maneuver. In the case of N/S, miss distance was 1.8 km and 3.1 km and the maximum collision probability was 9.5×10^{-6} and 3.6×10^{-7}.