

SPACE DEBRIS SYMPOSIUM (A6)
Modelling and Risk Analysis (2)

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OPTIMAL COLLISION AVOIDANCE MANEUVER TO MAINTAIN A LEO STATION KEEPING

Abstract

Introduction: In Korea, the KOMPSAT-5 (KOrea Multi-Purpose SATellite-5) is scheduled to be launched until the end of this year, which has a mission altitude of 550 km in a Dawn-Dusk Sun-synchronous orbit. This mission orbit is lying within a region of populated space debris. Moreover, the solar activity is continuously increasing during the mission lifetime. Thus, the mission requirement of maintain its station keeping (i.e., maximum ground track deviation is 2 km) may be tight in case that a collision avoidance maneuver should be considered during a solar maximum period due to the fuel constraint.

Methodology: A genetic algorithm is used to yield an optimized collision avoidance maneuver plan. Moreover, collision avoidance strategy to minimize the effect on the LEO station keeping is developed. For this problem, two kinds of objectives are considered. One is to minimize the fuel consumption of collision avoidance maneuver and another is to maximize the gap between ground track maintenance maneuvers. Thus, a genetic algorithm is modified to deal with multi-objectives and the penalty strategy using a weighting factor is also implemented.

Discussion: A normal period of station keeping for the KOMPSAT-5 is 1 2 weeks depending on a solar activity. For instance, delta-V of 0.2 m/s is needed to maintain the ground track boundary and the total delta-V of 8.398 m/s is needed during one year. This fuel consumption is up to 25 kg during the mission lifetime (i.e., 5 years). As a solar activity and collision hazard between the KOMPSAT-5 and space debris is increasing, the fuel consumption is also increasing and then the allocated fuel budget may be insufficient. To cope with that problem, possible avoidance maneuver generated by a genetic algorithm is evaluated and then propagated until a ground track deviation is violated upper or lower boundary. At this moment, the penalty is added to the fitness function if the violation occurs.

Results: This paper describes a new approach to optimize a collision avoidance maneuver considering a LEO station keeping. The approach using a genetic algorithm is demonstrated through a simulation study and the effectiveness of algorithm is successfully presented. The results show that total fuel consumption during a mission lifetime of the KOMPSAT-5 is satisfied the designated fuel budget, even though a collision avoidance to mitigate the space debris hazard is considered at the same time.