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Author: Dr. Min Hu
Equipment Academy, China, jlhm09@163.com

Dr. Li Fan
Tsinghua University, China, fanlinudt@163.com
Dr. Mingqi Yang
Equipment Academy, China, myyang_041@163.com

OPTIMAL DISPOSAL ORBIT DESIGN FOR MEO NAVIGATION CONSTELLATIONS

Abstract

The MEO (Medium earth orbit) region will be more and crowded as the European Galileo and Chinese Beidou navigation system are in the build-up phase, let alone the operational American GPS and Russian GLONASS. However, there is lack of an internationally agreed mitigation guidelines for LEO region, it is necessary to investigate the disposal strategies for MEO decommissioned navigation satellites.

Until now, the retired GPS satellites in orbit were 36 in total, most of them are maneuvered to a higher orbit than nominal operation orbit, and noeccentricity control strategy was implemented. The retired GLONASS satellites were 100 in total, and all were left in the operational orbit. The first Beidou-M1 test-bed satellite was maneuvered 924km above the operational orbit, with a very low eccentricity and an inclination reduction by 3.4 degree.

This paper focus on the disposal strategy to eccentricity build-up orbits, with particular emphasis on Chinese Beidou system. Firstly, the theoretical analysis of orbital variations is carried out, which can be exploited for the optimal choice of the disposal orbits. Secondly, an optimizationmodel is established, which minimizes the interferences among the GNSS (Global navigation satellite systems) constellations. A hybrid particle swarm optimization (PSO) - sequential quadratic programming (SQP) algorithm is also proposed to optimize the disposal orbital parameters, such as semi-major axis, eccentricity, and inclination. Then, long-term simulations over 200 years of the disposal orbit are simulated, which considers the main perturbation forces. Moreover, the characteristics of the disposal orbit are also analyzed. Based on these results, a possible mitigation strategy of MEO navigation constellations is proposed.

The proposed optimal disposal orbit design method can be applied for the current four navigation constellations to reduce the orbital lifetime of MEO satellites after end-of-mission.