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Author: Prof. Min Hu
Space Engineering University (Beijing), China, jlhm09@163.com

Mr. Jiuyang Li
Space Engineering University (Beijing), China, 739266068@qq.com
Mr. Xuyu Wang
Space Engineering University (Beijing), China, 1097450469@qq.com

STATIONKEEPING AND DEORBITING STRATEGY FOR LEO MEGA WALKER CONSTELLATIONS

Abstract

Purpose

LEO Walker constellations usually can provide convenient services for remote sensing, satellite communication, and navigation augmentation. In recent years, mega LEO constellations have gained widely attention, such as Starlink, Oneweb, LeoSat, Hongyan, and Hongyun. This study focuses on the optimal stationkeeping strategy for on-orbit operation, and the deorbiting strategy at the end-of-life, which can save the fuels and reduce the orbit control times.

Approach

Firstly, the perturbation forces in LEO region are established, including the Earth non-spherical perturbation, the atmosphere drag perturbation, and the solar radiation pressure perturbation. Then, the reasons causing the secular drifts of the LEO mega Walker constellations are analyzed, and the control thresholds of the relative in-plane phase angle, the relative right ascension of the ascending node are put forward. Thirdly, relative control method is adopted for the stationkeeping of LEO mega Walker constellations. The stationkeeping strategy is decomposed into two parts, one is to control the relative right ascension of the ascending node, and the other one is to control the mean argument of latitude. The relative right ascension of the ascending node is controlled based on the bias of the orbital elements. The mean argument of latitude is controlled by the electric propulsion, and the control time, control angle, control budget are optimized. Finally, the deorbiting approach is proposed based on the electric propulsion, the optimal decay orbit is designed based on the augmented Lagrangian particle swarm algorithm, and the control budget is calculated. Walker 950/19/1:900km,87is adopted to validate the proposed methods.

Practical implications

One aim of this research is to provide theoretical basis for the perturbation analysis for mega LEO constellations, the other is to provide references for the operational control of mega LEO constellations.

Results

The perturbation compensation approach by offsetting the relative semi-major axis and the inclination is effective, the optimal decay orbit design method is valid, and the deorbiting strategy by using the electric propulsion is feasible.