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Author: Mr. Lincheng Li
Beijing Institute of Technology (BIT), China

Prof. Jingrui Zhang
China
Mr. Shuge Zhao
Beijing Institute of Technology, China
Mr. Anrui Shi
Beijing Institute of Technology, China

AUTONOMOUS STATION-KEEPING STRATEGY FOR GEOSTATIONARY SATELLITE WITH ELECTRIC PROPULSION SYSTEM

Abstract

Geostationary satellites, which play a significant role in the field of communication, navigation, early-warning and so on, are getting increasing attention. Effective station-keeping guarantees the normal functions of the geostationary satellites. It is desirable to maintain longitude and latitude in the specific region during the station-keeping procedure. Traditional ground-station-based method deals with longitude and latitude separately, resulting in a long control period. When it comes to the geostationary satellites with an electric propulsion system, the characters of high specific impulse and maneuvering frequency even cause much burden on the ground-based facilities. Therefore, the research on the autonomous onboard control strategy becomes a necessity. However, quantities of researchers are stuck in integrated control of both longitude and latitude and fail in designing a feed-forward controller. In this study, the autonomous control strategy for geostationary satellites with electric propulsion system, which uses mean orbital elements as feed-forward inputs, is developed. Firstly, the analytical dynamical model considering Earth's triaxiality, lunisolar perturbations, and solar radiation pressure is established. Then the mapping from osculating elements to mean elements is formulated through a proper filtering algorithm. A three-dimensional joint drift ring for both longitude and latitude is described by mean orbital elements. Meanwhile, singular points hiding in the envelope are discussed particularly to confirm the continuity of the whole process. According to the preliminary, the drift ring can be divided into three regions: the edge, the individual part and the joint part. Regarding mean orbital elements as inputs, the closed-loop control laws are discussed separately in the three cases above. Finally, the accuracy and efficiency of the strategy are validated through numerical simulations of the station keeping mission. The reminder of the paper will be organized as follows. Section I is the introduction. Section II gives the analytical dynamical model including three major perturbations. The control law based on mean orbital elements will be outlined in Section III. Section IV presents the numerical simulations. Conclusions are made in Section V. Up to now, the theoretical derivation for the dynamical model has already been finished, the same as the three-dimensional joint drift ring for both longitude and latitude. The major efforts will be put into the design of the control law in three different cases as well as the numerical simulations.