SPACE DEBRIS SYMPOSIUM (A6)
Modelling and Orbit Determination (9)

Author: Dr. Mengping Zhu
China Academy of Space Technology (CAST), China

Dr. Xinlong Chen
China Academy of Space Technology (CAST), China
Mr. Zhi Li
China
Prof. YongChun Xie
Beijing Institute of Control Engineering, China Academy of Space Technology (CAST), China
Dr. Dongxia Wang
Beijing Satellite Navigation Center, China

DYNAMICAL EVOLUTION OF DEFUNCT GEO SATELLITES WITH FLEXIBLE SOLAR ARRAYS SUBJECT TO SOLAR RADIATION PRESSURE AND GRAVITY

Abstract

Currently one of the most pressing problems in space is the increasing population of space debris, especially in the GEO regions as GEO positions are quite limited. According to statistics, more than a half of the GEO objects are nonfunctional spacecraft. To clear up these objects, a good knowledge of their dynamics is needed. It was once believed that the defunct spacecraft are tumbling along their maximum axes. However, according to observations, the attitude behavior for even similar spacecraft can vary significantly. The reason of the difference can be either internal processes leading to change of the mass property of the spacecraft or an action of external forces. In recent years, some researchers have made much effort to understand the attitude evolution of the uncontrolled objects in high earth orbit. As the solar radiation perturbation is especially effective on objects with sufficiently high area-to-mass ratios (HAMR), most of the objects investigated in current literature are asteroids or multi-layer-objects, both of which are considered as rigid bodies. Early studies concentrated on developing high-fidelity or high-efficient solar radiation pressure models. And many researchers assumed the attitude of the objects were in a steady state such that the orbit motion can be investigated separately from the attitude motion. However, for HAMR, the orbit propagation is based on the precise attitude information, so in recent years, some researchers have tended to investigate the coupled orbit and attitude evolution of HAMR objects. The weaknesses of the previous work are mainly in the following two areas. First, only a few cases were studied and the objects were treated as HAMR, which most defunct spacecraft cannot be considered as HAMR. Second, the objects studied were treated as rigid bodies. However, internal process, such as energy dissipation caused by the elastic vibration of solar sails, can also lead to attitude variation. Therefore, the goal of this study is to further the previous work and attempt to fix the previous short-comings. To address the first weakness, uncontrolled GEO satellites which were non-HAMR objects were modeled. A wide variety of initial conditions were studied. This was a straightforward extension of the previous work. Second, the flexible vibration of the solar arrays was taken into consideration in the dynamical evolution. GEO defunct satellites with flexible solar arrays were simulated and the influence of the gravitation field, direct solar radiation pressure on the coupled orbit and attitude motion was studied.