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Author: Mr. TENG HE
National Key Laboratory of Aerospace Flight Dynamics, Northwestern Polytechnical University, Xi'an, China, het@mail.nwpu.edu.cn

Prof. Zhanxia Zhu
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China, zhuzhanxia@nwpu.edu.cn
Prof. Luo Jianjun
National Key Laboratory of Aerospace Flight Dynamic, Northwestern Polytechnical University, China, jjluo@nwpu.edu.cn
Prof. Jianping Yuan
National Key Laboratory of Aerospace Flight Dynamics,Northwestern Polytechnical University,Xi'an, China, jyuan@nwpu.edu.cn

DYNAMIC ANALYSIS OF A THREE-BODY TETHERED SATELLITE SYSTEM WITH DEPLOYMENT/RETRIEVAL IN THREE-DIMENSIONAL

Abstract

Three-body tethered satellite system have great potential value to future space missions, such as cleaning the space debris, high atmosphere observation, and what is more, transport of supplies between two spacecraft. In this paper, we focused on the problem of dynamic analysis of a three-body tethered satellite system deployment/retrieval in three-dimensional. A three-body tethered satellite system consist of three-point masses, one main satellite and two subsatellites, connected with two straight, massless and inextensible tethers. Due to the deployment/retrieval motion of the tether, the libration motion of two subsatellites is produced. The recent research demonstrates that this libration motion could lead to the tumbling of the three-body tethered satellite system if the deployment/retrieval motion with a high speed or some bad initial conditions. However, the research for the effect of libration motion of three-body tethered satellite system is still limited. The influence of in-plane libration motion of a three-body tethered satellite system was investigated. Consequently, large oscillations may arise for the big initial in-plane angles. Whereas, few papers were proposed to how does the out-plane libration motion affect the dynamic characteristics of the system, though it can be seen that the out-plane libration motion may arise during a space tether is deploying. In response to the problems and deficiencies of extant research, the dynamic problem of three-body tethered satellite system deployment/retrieval in three-dimensional is solved as follows. Firstly, A novel dynamic model, which is simple and explicit physical significance, was modeled by a two-piece dumbbell model and dynamics equations was derived by applying Newton's Second Law. Besides, some basic assumptions and coordinates were formed to simplify the process of model building. Secondly, a comparison of this new model with other model formed by the Lagrange equation was presented to show the efficiency of our model. Thirdly, owing to the physical meaning of each part of the dynamics equations, the out-plane dynamic performances of the system were investigated and analyzed. Results show that parts of libration energy can be delivered from out-plane to in-plane, while libration energy do not transfer from in-plane motion to out-plane motion. Finally, a deployment strategy was proposed to suppress the libration motion during the phase of tether expansion. Furthermore, simulation results were presented to show effectiveness and efficiency of the method.