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MODELING AND ANALYSIS OF CONTACT-IMPACT DYNAMICS OF A SPACE FLEXIBLE NET WITH AN INFLATABLE BOOM

Abstract

Space flexible net system is a new space technology used to capture large space debris and abandoned satellites in orbit. On the other hand, more and more inflatable structures are proposed and tested on current and future satellites. Since those inflatable structures are large in size and extended from satellite main body, it is very possible that the space flexible net will contact and impact with those inflatable flexible structures during capturing. In the past years, a few literatures have studied the contact dynamics of a space flexible net with a rigid satellite [1,2]. However, the contact impact between a space flexible net with a similar flexible inflatable structure has not been paid much attention. In this paper, the contact dynamics of a space flexible net with flexible inflatable appendage is studied numerically. Nonlinear finite element software ABAQUS is applied to analyze the contact and impact process of a flexible net with an inflatable boom. The inflatable boom is modeled by M3D3 and M4D4 membrane elements. In addition, considering that the rope of net can only withstand tensile loads, but not compressive load and bending load, the truss elements which can only withstand axial tension force are used. The contact and friction interaction between the net and the inflatable boom are modeled in ABAQUS. Since the finite element analysis model contains a large number of flexible elements, the Dynamic/Explicit analysis module of ABAQUS is used to save dynamic simulation time. The detailed contact and impact procedure of the two flexible structures are analyzed and obtained. The effect of initial impact velocity, the relative attitude and the air pressure of the inflatable boom are analyzed and discussed. The results show that the contact impact procedure of two flexible bodies is different from the procedure of a rigid with a flexible net. The shape of the net, the contact force, the structural stress and the reaction force at the boom root during the impact procedure are analyzed. The resulted deformation at different time instance in impact procedure shows that the inflatable boom will eventually bounce off the space net and it largely affects the capturing result. The air pressure inside the boom gives the basic structure stiffness and is identified as a main factor influencing the contact force and reaction force to satellite main body. This study can give a reference for the future design of the space flexible net for capturing satellites. Reference: [1] Gołębowski W, Michalczyk R, Dyrek M, Battista U, and Wormnes K, Validated Simulator for Space Debris Removal with Nets and Other Flexible Tethers Applications, 66th International Astronautical Congress, International Astronautical Federation (IAF) Paper D1.1.6, Jerusalem, Israel, 2015 [2] Boting Xu, Yueneng Yang, Bin Zhang, and Ye Yan, Simulation of Space Flexible webs on Capture Process Based on Nonlinear Finite Element Method, IOP Conference Series Materials Science and En