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Author: Prof. Fu-Ling Guan
Zhejiang University, China

Mr. Yan XU
Space Structure Research Center, China

DEPLOYMENT ANALYSIS OF INFLATABLE ANTENNA STRUCTURES BASED ON SPRING-MASS SYSTEM

Abstract

Inflatable membrane structures were applied in spaceflight missions broadly. Fold and deployment simulation of inflatable structures is the key technology of structure dynamic analysis. A new method for dynamic deployment simulation of membrane structure was mentioned based on new improved spring-mass system. This system considers the actual property of membrane material and elastic coefficients of each spring changes during deployment time steps. During development process of structure, self-contact or collision of membrane film may occur widely. The distinguish rule of self-contact elements was advanced and penalty function method was used to solve this difficult problem. Finite different method was used to solve the motion of system in each time step. At first, tube structure with Z fold tube and curve fold pattern were analyzed by this method. Membrane inflatable tube is one of most important members for spatial inflatable structure. It is necessary and difficult to analysis the deployment dynamic of inflatable tube structure. These time history of inflatable pressure and other gas parameters of each tube part were analyzed. The tube between two hinges was equal to cantilever beams and the deployable moment tending to straighten the tube is obtained. This deployable moment was equal to drive forces which are subjected to the spring-mass system. Numerical examples were presented to show that analyze method can simulate the 3D deployment motion of inflatable tube structure. Compared to the experiment result from the reference, the validity of this simulataion method was shown and the analysis precision is high. Then this method was used to analyze the deployment dynamic of the whole inflatable antenna structure. Initial state and fold state of main members of inflatable antenna were described and numerical modeled, which include inflatable tube, inflatable torus and reflector etc. Deployable drive forces and deployable process order of each part were analyzed. The numerical model of antenna like IAE antenna was built and simulated by the fore mentioned system. Each state configuration during deployment process, velocity and acceleration of each node were obtained. The example was used to validate the simulation method and the fold scheme of inflatable antenna.