MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Structures 2 - Development and Verification (Deployable and Dimensionally Stable Structures) (2)

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STRUCTURAL AND DYNAMIC ANALYSIS OF A LONG SELF DEPLOYING ANTENNA FOR JUPITER GANYMEDE ORBITER SUB SURFACE SOUNDER

Abstract

This paper deals with the study design and testing of a double boom deployable antenna on board of the Jupiter Ganymede Orbiter of ESA, focusing the attention on the structural and dynamics aspects. The two booms are subunits of the Sub Surface Radar (SSR) instrument, whose purpose is to penetrate the ice crust of Ganymede and Callisto to understand its consistency and if possible to identify the presence of water by detecting the transition between the ice and liquid water. A 10 m dipole antenna with a total mass of about 4 [kg] is foreseen. To minimize the volume in stowed condition the two booms, their deployment mechanisms and the hold down and release mechanisms have to be packed with a very high packaging ratio. One of the most challenging aspect is the structural and dynamics behavior of the

deployment which affects the reliability, and the maximum angular deviation from straight condition once the deployment is ultimate (the maximum allowed value is about 2 degrees).

The selected approach employs articulated constant-torque spring hinges, which drive the deployment and comprise thin curved tape springs, bending over wide angular ranges by means of buckling. The boom hinges are equipped with a redundant spring mechanism, and the system is designed to guarantee an accurate positioning of the boom after deployment. This technology allows a precise tuning of the active torque (during the design phase) and a repeatable deployment.

Emphasis has been given to the dynamic 3D multi-body mathematical model. Due to the high number of parameters affecting the results of the deployment simulation and the assessment of a worst case scenario, a Monte Carlo approach has been implemented.

The presented models and analyses include: a) the main results obtained from the multi-body deployment kinematics and dynamics using a multi-parameters model with flexible bodies, b) the structural analysis for stowed, the deployment and deployed condition for the investigation of stress distribution, expected margin, eigen-modes, structure buckling modes, thermal induced loads and distortions for both the proposed solutions.

The flexibility effects have been included into the 3D multi-body simulation. This operation has been performed with a dedicated linear finite element analysis using the Craig-Bampton method. A non-linear model is implemented for the evaluation of the torque moment as a function of the aperture angle of each hinge.