Mechanical-Attitude Controller Co-design of Large Flexible Space Structures

This paper provides an overview on the application and advantages of novel sub-structuring techniques in defining the multi-flexible body dynamics of an open mechanical chain. It employs single and double input-output port models that represent the six Degree Of Freedom (DOF) dynamics of terminal and intermediate appendages in the chain, with one and two connection points respectively. The interface that links the Finite Element Model (FEM) modal analysis output of the sub-structure to its parametric model in SIMULINK has also been explained. Also an analytical double port model of the six DOF dynamics of a uniform beam element with two connection points, called super-element, has been derived. Different combinations of the sub-structure configurations are validated through the dynamics simulation of the Biomass satellite, selected as the 7-th Earth Explorer Core Mission of the European Space Agency. A robust reduced order H-infinity attitude controller that will meet the satellite performance requirement in terms of perturbation rejection, has been designed. Furthermore, the Linear Fractional Transformation (LFT) form of an uncertain parametric model is subjected to a non-smooth optimization that simultaneously tunes the attitude controller and the geometric parameters of an antenna section, so as to meet pointing requirements and save mass.