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Thermal-structural analysis for an attitude maneuvering flexible spacecraft under solar radiation

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Abstract

A coupled thermal-structural analysis for an attitude maneuvering spacecraft under solar radiation is conducted and the interaction between the thermally induced vibration and attitude maneuver is studied. The spacecraft consists of a rigid hub and a solar array composed of honeycomb panel. By considering the thermal stress of solar panel, the system's rigid-flexible-thermal coupling dynamic model is established in terms of the Lagrange equation and non-constrained modes. Based on the finite difference method, an explicit recursive algorithm is developed to compute the transient cross-sectional temperature distribution of solar panel which is modeled as a three-layer laminated structure. The coupled thermal-structural analysis reveals that the torque, which can maneuver the spacecraft to the desired attitude in the simulation of rigid-flexible model, cannot accomplish the attitude maneuver mission for a spacecraft under solar radiation even though the desired attitude is small. In the case of large final incident angle of heat flux (the sum of initial incident angle and the maneuver attitude angle), the thermally induced vibration of a spacecraft with small damping may be unstable and the thermal flutter may occur. Moreover, the thermally induced vibration decays with time in the case of large damping.