DYNAMIC ANALYSIS OF OPTICAL BEAM POINTING

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Abstract

The effect of mechanically induced structural vibrations on the pointing accuracy of an imaging instrument mounted on a large spacecraft is studied. The structural analysis of this phenomenom is performed using MSC/NASTRAN.

Two types of analyses are described. The first analysis consists of a fixed base model of the instrument. The instrument is reduced to a modal model using MSC's Generalized Dynamic Reduction (GDR). The generalized mass and stiffness matrices generated by GDR are used as dynamic representations of the instrument. Modes up to 150 Hz are retained in the instrument. Both modal coordinates and physical coordinates are contained in the matrices. The modal matrices are obtained from the instrument model assuming the control systems are inactive. Excitation is then applied in the form of a fixed base acceleration using peak accelerations from a separate analysis of the spacecraft. The optical beam path is described utilizing an optical sensitivity matrix generated by an optics program. The beam pointing measures are written as functions of key structural displacements and incorporated using multi-point constraint equations. The control systems which control the beam pointing are approximated as second order systems with the coefficiants calculated to simulate the electronic control circuits. sensors and actuators. These are incorporated in MSC/NASTRAN using the Dynamic Transfer Function and Direct Matrix Input capabilities. The beam pointing response with the control system active is then analyzed using a sine sweep input and MSC/NASTRAN modal frequency response capability.

The second analysis consists of a coupled instrument/spacecraft model. The modal matrices described above are introduced into the spacecraft model using the direct matrix input capabilites. The control systems are re-introduced using the same technique that was applied to the fixed base model. The load-

ing condition considered is that due to reaction/momentum wheel imbalance. The loads are applied to the coupled spacecraft/instrument model and the resulting beam jitter is obtained.

The paper outlines the analysis techniques and implementations described above. Comparisions between the uncoupled approach (first analysis) versus the coupled approach (second analysis) are made. Finally the effects of using fixed base instrument modes versus free-free instrument modes are described and discussed.