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Brief 67-10081

NASA TECH BRIEF

Rigid-Body Motion Extracted from Total Motion of a Flexible Body

The problem:

Devise a method to eliminate or reduce flexibility effects on the manual and automatic control of large flexible vehicles. The complexity of conventional control systems is greatly increased by the introduction of structural feed-back at frequencies close to the closed-loop, rigid-body control mode frequency.

The solution:

A method that extracts rigid-body motion from combined rigid-body and flexible-body motion. The method is well adapted to situations where a flexible-body frequency coincides with or differs only slightly from the control mode frequency.

How it's done:

The method involves the extraction of rigid-body motion from the total motion of a flexible body. The technique uses series expansion of the motion of the elastic system in terms of normal modes and generalized coordinates. A normal mode of free vibration is the spatial function or shape that a vibrating beam assumes when it oscillates at one of its natural frequencies. The generalized coordinates define the time variation of modal amplitude. Normal modes of free vibration of an elastic system can be derived from a knowledge of the mass distribution, flexural stiffness, and shear stiffness. By equating measured sensor outputs to the motion described by a series of normal modes and generalized coordinates, a system of equations is obtained which can be solved for the rigid-body components of the motion. The number of sensors equals the number of terms of the series, although only a few terms of the series will be needed to adequately solve for the rigid-body components. The solution of this system of equations evolves in the form of a series of products of processing functions and sensor outputs. The processing functions operate on the sensor outputs in such a way that the sum of the processed outputs gives the rigid-body motion. Advantages of the proposed method are its simplicity and the absence of any need for computer capability. Separation and rejection of bending motion is accomplished even in situations where a bending frequency coincides with the frequency of the closed-loop rigid-body mode.

Note:

Further information concerning this invention is presented in NASA TN D-3109, "A Frequency Independent Technique for Extracting the Rigid-Body Motion from the Total Motion of a Large Flexible Launch Vehicle" by James C. Howard, November 1965, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price $3.00. Inquiries may also be directed to:

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Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, non-exclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

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