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Control of a Chain of Flexible Bodies Using Lyapunov's Stability Theory

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The paper considers systems that can be modelled by N lumped masses connected by $N-1$ uniaxial structural members. Typical examples of such systems are multi-tethered satellite systems and space manipulators consisting of long flexible links. Control of the motion in the large of the former system is studied. A Lyapunov function is constructed by modifying the Hamiltonian appropriately and control laws are formulated using Lyapunov's stability theory. Results for several examples are presented.

Introduction

There are several cases when a space system can be modelled as a chain of flexible bodies. One example is the multi-tethered satellite system in which a set of orbiting bodies are connected by a series of flexible tethers. Another example is a space manipulator system consisting of long flexible links. The dynamical models of such systems are usually quite complex. They can be even more complicated if the geometry is variable, for example, due to variable length of tethers during retrieval and deployment phases. Control of these systems is usually carried out after linearizing the equations of motion, i.e., by considering small motion about an equilibrium configuration or about a nominal trajectory. Control of their motion in the large is fairly difficult. One approach to devise control laws valid for large motion is to use Lyapunov's stability theory. Although the principles behind the Lyapunov approach is quite straight-forward, in practice, it is often difficult to construct an appropriate Lyapunov function.

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