



Research Article

NONLINEAR DAMPING CONTROL FOR UNCERTAIN NONLINEAR MULTI-BODY MECHANICAL SYSTEMS[†]

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ABSTRACT:

Descriptions of real-life complex multi-body mechanical systems are usually uncertain, and their effective control must take into account uncertainties that arise from two general sources: uncertainties in the knowledge of the physical system and uncertainties in the 'given' forces applied to the system. Both categories of uncertainties, which we assume to be time varying and unknown, yet bounded, are considered in this paper. In the face of such uncertainties, what is available in hand is therefore just the so-called 'nominal system,' which is simply our best assessment and description of the actual real-life situation. The aim of this paper is to develop a general control methodology, which when applied to a real-life uncertain multi-body system, causes this system to track a desired reference trajectory that is pre-specified for the nominal system to follow. An example of a simple mechanical system demonstrates the efficacy and ease of implementation of the tracking control methodology.

Keywords: *Constrained Motion; Energy Control; Uncertain System; Nonlinear Damping Control*

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1. INTRODUCTION

All real-life physical systems are known only to within some bounds of uncertainty that may depend on the various levels of their description. Controlling the motion of such uncertain complex multi-body systems to follow prescribed reference trajectories has become a topic of great interest during the past few years. References [1–7] give a brief sampling of some of the researchers who have made substantial contributions, yet several questions remain unanswered at the present time. The uncertainties that arise in complex mechanical systems stem from two main sources: (i) uncertainties in our knowledge of the physical system, like uncertainties in the stiffness and mass distribution, the nature of damping, etc.; and, (ii) uncertainties in our knowledge of the externally applied forces acting on the system, like air drag, solar wind, gravity gradients, etc., when considering, for example, precise satellite motion control. The two sources of uncertainty are simultaneously considered in this paper, and in what follows, all these uncertainties are included in what we call the 'real-life mechanical system,' or the 'actual system,' whose description is known only imprecisely. While not known precisely, it is assumed, however, that these uncertainties are, in general, time varying and unknown, but bounded. Our best assessment of a given actual system will be referred to as the 'nominal multi-body system,' or the 'nominal system,' for short. This term naturally includes the best assessment of our characterization of the physical system and of the nature of the 'given' forces acting on it.

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