8th. World Congress on Computational Mechanics (WCCM8)
5th European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 –July 5, 2008
Venice, Italy

CONTROL CONSTRAINTS IN THE COMPUTER SIMULATION OF MULTIBODY DYNAMICS

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Key Words: *Underactuated Mechanical Systems, Feedforward Control, Differential-Algebraic Equations, Trajectory Tracking, Differential Flatness.*

ABSTRACT

The present work aims at the incorporation of control (or servo) constraints into finite-dimensional mechanical systems subject to holonomic constraints. In particular, we focus on underactuated systems, defined as systems in which the number of degrees of freedom exceeds the number of inputs. The corresponding equations of motion can be written in the form of differential-algebraic equations (DAEs) with a mixed set of holonomic and control constraints. Apart from closed-loop multibody systems, the present formulation accommodates the so-called rotationless formulation of (flexible) multibody dynamics. The rotationless formulation has proven to be especially well-suited for the design of energy-momentum conserving schemes which typically exhibit superior numerical stability, see [1-3].

Subsequent to the incorporation of the servo constraints we deal with a reformulation of the underlying DAEs which is amenable to a direct numerical discretization. To this end, we apply a specific projection method to the DAEs in terms of redundant coordinates. A similar projection approach has been previously developed in the framework of generalized coordinates by Blajer & Kołodziejczyk [4]. We aim at the design of energy consistent time-stepping schemes. If no control constraints are present the original energy-momentum scheme should be recovered. Representative numerical examples will deal with underactuated multibody systems such as rotary cranes and free floating manipulators.

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