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Modeling and Experiments on Stable Stepladder Walking

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Modeling and control of underactuated mechanical systems, such as bipedal robots, remains a challenging task despite decades of intensive research. This study examines a less common but conceptually similar mechanical system: a stepladder with a decorator/operator. The system features nonlinear, high-dimensional, and hybrid dynamics. The primary objective is to identify the stable cyclic walking behavior of the stepladder induced by specific actuation patterns of the decorator. To achieve this, we first establish a detailed 3D model of the system with time-dependent actuation parameters derived from a video sequence. Subsequently, we develop multiple variants of 2D reduced-order models (ROMs) to capture the system's essential dynamics. The parameters of these ROMs are identified by solving an inverse problem using data extracted through image-processing software. Finally, a suitable ROM is selected to approximate the system dynamics and synthesize a stable cyclic walking motion in some sense optimal.

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Numerical Comparison of the Continuous and the Discrete Adjoint Method for Sensitivity Analysis of Multibody Systems Using Various Integration Schemes

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Gradient-based optimization is an established tool to improve the performance of dynamical systems. This requires sensitivity information depending on the optimization problem. The adjoint variable method is often the most efficient approach to perform the sensitivity analysis of multibody systems. In this work, the continuous and the discrete adjoint method are applied to the sensitivity analysis of rigid multibody systems using various integration schemes. The multibody systems are formulated as differential algebraic equations and then transformed into ordinary differential equations. The numerical behavior of both adjoint methods is investigated and compared to each other. In particular, numerical problems that arise when using the continuous adjoint method are addressed.

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Real-Time Simulation of Flexible Bodies with Ray-Traced Contact in the Unity Game Engine

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Computer simulations in structural mechanics, such as Finite Element Method (FEM) models, are traditionally performed offline, limiting real-time interaction during simulations. This paper explores