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Dynamics and vibration analysis of a spatial linkage model with flexible links and joint friction subjected to position and velocity motion constraints

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Abstract: In the paper a spatial linkage (SL), i.e. a serial closed-loop kinematic chain composed of rigid and flexible links subjected to work regime velocity programmed constraints (VPC) is analysed. The key component of the SL dynamics derivation is an automated computational procedure for constrained dynamics generation. It serves systems subjected to holonomic and first order nonholonomic constraints and proved its effectiveness to rigid or flexible open chain models. The contribution of our research is twofold. Firstly, it extends the procedure on SL models composed of flexible links with closed-loop kinematics, for which a spanning tree can have a serial or tree structure. Secondly, it analyzes dynamics and vibration of the SL motion with VPC that come from work regime or requirements on it. The procedure for constrained dynamics generation provides reference dynamics, which solutions satisfy all constraints on the SL. The basic distinction between this procedure and others, usually Lagrange based, is that final equations are in the reduced state form, i.e. constraint reaction force are eliminated during derivation. This is the essential advantage of the presented procedure. It provides the smallest set of dynamics equations, which may serve for motion planning. Analysis of desired motion and vibrations caused by adding VPC, enable designing proper velocity ranges for the SL in work regimes and assessing kinematic parameters needed to follow these motions. The theoretical development of automated generation of constrained dynamics is illustrated by an example of the SL model.

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