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The dynamics analysis of a spatial linkage with flexible links and imperfect revolute joints

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Abstract: The algorithm for generating the dynamics equations of the two-dof spatial linkage is considered in the paper. The presented linkage is composed of the five rigid or flexible links which form a serial closed-loop kinematic chain. It is assumed that revolute joints can be imperfect. The dynamics equations are derived using the Lagrange equations of the second kind. The joint coordinates together with homogeneous transformation matrices are applied to generate the equations of motion. The presented algorithm gives the opportunity to generalize it for any linkages with a tree closed-loop kinematic structure. The flexible links are modelled by means of the Rigid Finite Element method in the sense of classic approach. Author's spatial model of the revolute joint with a radial and axial clearance is proposed to take into account clearance effects. In this model a revolute joint is discretized by means of the contact elements located on the cylindrical and frontal surfaces of the journal and bearing. Such approach allows us to detect automatically collisions in many points of the contacting surfaces. The normal contact force is calculated using the Nikravesh-Lankarani formula which is an extension of the classic Hertz model because it additionally takes into account the energy dissipation. The LuGre friction model is applied to model friction phenomenon in joints. In numerical simulations, an interaction between the links' flexibility and clearance in joint during the motion of the linkage is analysed.

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