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机器人倾倒碰撞动力学建模与不同刚度下碰撞响应

Dynamics modeling of slipping collision of robot and impact response under different stiffness

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中文关键词: 机器人,柔性结构,动力学模型,接触碰撞,假设模态,刚柔耦合,刚度

英文关键词:robots flexible structures dynamic models contact-impact assumed modes rigid-flexible coupling stiffness

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中文摘要:

为了确定刚度对柔性臂倾倒碰撞力的影响，基于混合坐标法建立柔性臂运动学模型，利用假设模态法对柔性变形解耦，基于Hertz接触理论和非线性阻尼理论建立接触碰撞力模型，利用Lagrange方程建立了含碰撞的动力学方程。编写了变步长变精度的四阶Runge-Kutta数值求解算法。对不同刚度下柔性臂的碰撞响应进行仿真，得到了接触力、关节转角、角速度和弹性变形曲线。对比可得，随着抗弯刚度增大，接触力变大且峰值出现的相位提前，且碰撞后柔性臂关节转角变小，弹性变形和角速度的振动都减小；材质结构阻尼对弹性振动变形有明显的抑制。该文所建模型和求解方法有效。

英文摘要:

In order to ascertain the affect of stiffness on slipping collision of flexible arm, the kinematics model was established by hybrid coordinate method, and flexible deformation was decoupled by using the assumed modes. Contact-impact model was established by using the Hertz impact theory and nonlinear spring-damper theory, collision dynamics of flexible arm was derived through Lagrange equations. The fourth-order Runge-Kutta numerical solution algorithm with variable step-size and precision was designed for solving dynamical equation. Simulation of the impact responses of flexible arm collision under different stiffness were completed, and curves of contact force, joint angle, angle velocity and elastic deformation were given. Based on comparative analysis, with bending stiffness increasing, contact force enlarged and the phase of peak force advanced, the flexible arm joint angle turned smaller, vibration of elastic deformation and angular velocity became lower. Material structural damping had obvious inhibition on the elastic deformation vibration. The model and solving algorithm of this paper are proved effective.