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FUZZY ADAPTIVE CONTROL OF COORDINATED MOTION FOR FREE-FLOATING SPACE FLEXIBLE MANIPULATOR BY SINGULAR PERTURBATION APPROACH

Abstract

Space robot system will play an important role for a number of important missions in space.For example, to construct future space station, or to repair and serve satellites in earth orbit. Considerable research efforts have been directed to the dynamics and control problems of space robot system. Space robot system is the one that the spacecraft's position and attitude are not actively controlled during manipulators activity to conserve attitude control fuel. In such case, the spacecraft will move freely in response to the dynamical disturbances caused by the manipulators' motions. It represented as high dynamic coupling between the manipulators and the spacecraft. This made the control of the space robot been very difficult, especially with uncertainties which always happened under actually applications. Meanwhile, since the robot manipulators are light weight and high load-carrying capacity, structure flexibility of the space robot's links can not be ignored. In this paper, the fuzzy adaptive control of coordinated motion and flexible vibration active control for free-floating space flexible manipulator with an attitude-uncontrolled base are studied. First, Under the conversation of the linear momentum, the kinematics and dynamics of a space flexible manipulator is analyzed. Second, the jacobian relationship between end-point velocity and the general velocities is derived. Based on the results and under the assumption of two-time scale, singular perturbation model of the space flexible manipulator system is obtained. The fast subsystem controller will damp out the vibration of the flexible link using a optimal Linear Quadratic Regulator (LQR) method. For the slow subsystem, aiming at the case of free-floating space flexible manipulator system with uncertain payload parameters, a composite scheme of a computed torque controller plus a fuzzy compensator is proposed to track desired trajectories in inertial space. Namely, it'll make up impact of system's unknown parameters to computed torque controller through fuzzy adaptive compensation system controller, to ensure the whole closed-loop control system's asymptotic stability with the existence of unknown parameters. The mentioned control scheme can effectively control end-effector of space flexible manipulator to stably track the desired trajectory ininertial.It has obvious advantages that with needless feedback and measured the position, velocity, acceleration, attitude angle velocity and attitude angle acceleration of the floating base, at the same time, no any requirements for the dynamic equations of the system are linearly dependent on inertial parameters. The numerical simulation is carried out, which confirms the controller proposed is feasible and effective.

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