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STUDY ON DYNAMIC MODELING AND NEURAL NETWORK CONTROL FOR FREE-FLOATING SPACE FLEXIBLE-JOINT ROBOT TO TRACK DESIRED TRAJECTORY IN JOINT SPACE

Abstract

Space manipulators are proposed for assisting the outer space explorations. Their modeling and control problems have been the challenging research topics of human beings in recent years. At early stage of research, space manipulator is usually regarded as a pure rigid dynamic system with rigid links and rigid joints, and various algorithms have been proposed for the system to accomplish the specified motions, either in joint space or in work space. Howerver, as the development of space manipulator systems, structural flexibility becomes an issue of increasingly greater concern, due to their adverse effect on stability and performance of the system. In general, the structural flexibility of space manipulator systems mainly includes two parts: link flexibility and joint flexibility. In this paper, the dynamic and control problems of free floating space manipulator system with general flexible joints are discussed. With the relationship of linear and angular momentum conservation, the dynamic equations of the system are derived by Lagrangian formulation. To overcome the shortage of singular perturbation approach that can only be utilized in the control of manipulators with weak joint flexibility, a joint flexibility compensator that can effectively improve the equivalent joint stiffness is introduced. By using the singular perturbation theory, the system dynamics model after flexibility compensation can be easily decomposed into two subsystems: the fast subsystem and the slow subsystem. Then, a neural network control scheme is proposed for the slow subsystem to track the desired trajectory in joint space, while the stability of the fast subsystem is guaranteed well by a torque differential feedback controller. A simulation example is carried out to illustrate the validity of the proposed control scheme.

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