Paper ID: 11814
student

ASTRODYNAMICS SYMPOSIUM (C1)
Attitude Dynamics - Part 1 (5)

Author: Dr. Limin Xie
Fuzhou University, China

Prof. Li Chen
Fuzhou University, China

ROBUST AND ADAPTIVE COMPOSITE CONTROL OF SPACE FLEXIBLE MANIPULATOR WITH BOUNDED TORQUE INPUTS BASED ON THE SINGULAR PERTURBATION APPROACH

Abstract

In the practical operation, the free-floating space manipulator is usually uncertain because of the changes of the parameters, loads, fuels and other factors. And because the space manipulator has the characteristics of light weight, long arms, fast speed and heavy load, it is often flexible. The flexible manipulator will cause the high frequency vibration of the system, influence the accuracy and stability of the system's control. Compared with the rigid manipulator, the control of the flexible manipulator system requires the system can not only achieve the precise positioning, but also eliminate the elastic vibration. The most of the designs of the controllers are based on the assumption that the torque inputs always satisfy the requirement. But in the practical application, the control torque inputs are limited because of the physical constraints. In this case, the motion of the space robot is restrained. Or it needs a huge drive control system to support the required torque inputs, guarantee the stabilization of the system. Therefore, the designs of the controllers should take bounded torque inputs into account. This paper proposes a robust and adaptive composite control method to deal with the control problem of the free-floating space flexible manipulator system with uncertain parameters and bounded torque inputs. We use Lagrange-Assumed mode method to obtain the dynamic equation of the free-floating space flexible manipulator system. Then based on singular perturbation approach, the system is decomposed into a fast subsystem and a slow subsystem. For the fast subsystem, the second optimization control is used to restrain the vibration caused by the flexible link. For the slow subsystem, a robust and adaptive composite controller is designed to achieve the trajectory tracking of the system. The continuous differentiable increasing functions with errors are applied in the control law to ensure the bound of torque inputs. Compared with conventional controller, the propose controller has faster convergence, better tracking performance, and it can strictly guarantee the bound of the torque inputs. Moreover, for the parameters uncertainty, regardless of whether the parameter-region is precise or not, the control accuracy is also guaranteed. That reflects the strong robustness. The simulation demonstrates the effectiveness of the proposed control method.