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COMPLIANCE CONTROL OF DUAL-ARM SPACE ROBOT CAPTURE SATELLITE OPERATION BASED ON BARRIER LYAPUNOV FUNCTION

Abstract

Space robot will inevitably contact and impact with target satellite during the capture operation. If its joints are not effectively protected in this process, it is easy to cause the failure of the capture operation. Therefore, a Spring Damper Device (SDD) is added between the joint motor and the manipulator, which can not only absorb the impact energy and suppress the flexible vibration, but also can design compliance strategy to achieve compliance of capture operation. The dynamic mode of dual-arm space robot open-loop system and satellite system before capture are established using Lagrange function based on dissipation theory and Newton-Euler function respectively. After that, combined with Newton's third law, velocity constraints of contact points, closed-chain geometric constraints, the closed-chain dynamic model of hybrid system after capture is obtained, and the impact effect and impact force are calculated utilize the momentum conservation. Because the target satellite has a certain initial velocity, the impact effect will cause the hybrid system to be in a serious unstable state, such as spin. If this state is not constrained, it will be difficult to realize the stabilization control of the hybrid system. In recent years, Barrier Lyapunov Functions (BLFs) are increasingly used to solve time-varying constraint problems. Therefore, a fuzzy adaptive control method based on BLFs is designed to control the unstable hybrid system, and realize the high-precision tracking of the trajectory. The BLFs is used in each backstepping control to strictly prevent set constraints from being exceeded. The fuzzy controller is used to estimate the uncertainties of the system. The stability of the system is proved by Lyapunov theorem, and the impact resistance of the SDD and the effectiveness of the proposed strategy are verified by numerical simulation. The results show that the maximum impact torque can be reduced by 53.10%, and the trajectory tracking accuracy can reach 0.001m.